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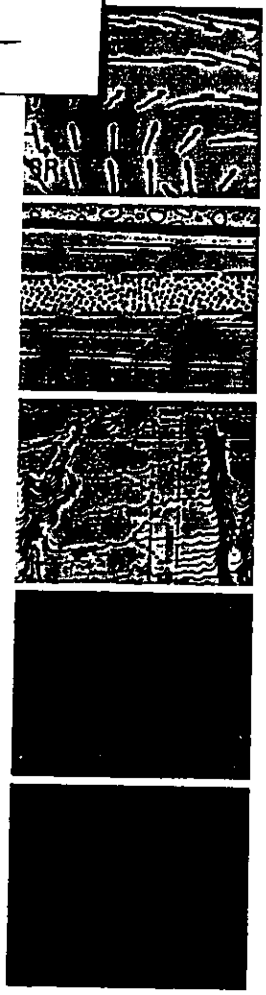

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ADDITIONAL ASSESSMENT OF IMPACTS ON THE CHASSAHOWITZKA PSD CLASS I AREA FOR THE RIDGE GENERATING STATION PROJECT

APRIL 1992

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April 3, 1992

Florida Department of Environmental Regulation
Division of Air Resources Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Attention: C.H. Fancy, P.E.
Chief, Bureau of Air Regulation

Re: Permit Application AC 53-206244, PSD-FL-183
Ridge Generating Station

Dear Mr. Fancy:

Item 6 in your letter dated January 17, 1992, requested an additional evaluation of impacts on the Chassahowitzka PSD Class I area resulting from Ridge Generating Station emissions. A summary response to Item 6 was provided in a letter from the project partners dated March 27, 1992. A meeting was then held on April 1, 1992, with Tom Rogers and Cleve Holladay of the Air Modeling and Assessment Section to discuss requirements for a detailed response. The attached report constitutes the detailed response. At the suggestion of Mr. Rogers and Mr. Holladay, we are sending a copy of the report to Mr. John Notar at the Air Quality Division of the National Park Service.

Included in the attached report are the results of an additional modeling evaluation of PSD Class I area impacts. Printouts and computer files supporting these results are being sent under separate cover.

Please call me (404-262-2915) or Matt Killeen at Wheelabrator Environmental Systems (1-800-682-0026) if you have any questions.

Sincerely,

Dames & Moore, Inc.

James W. Little

James W. Little
Associate

Attachments
cc: J. Notar, National Park Service, Air Quality Division ✓
J. Reynolds, Florida Department of Environmental Regulation
C. Holladay, Florida Department of Environmental Regulation
M. Whiting, Decker Energy-Ridge, Inc.
R. Stone, Wheelabrator Polk Inc.
M. Killeen, Wheelabrator Environmental Systems Inc.
Cleve Holladay
Jewell A. Harper, EPA-Region IV } 4-7-92

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SIX PIEDMONT CENTER, SUITE 500, 3525 PIEDMONT ROAD, ATLANTA, GEORGIA 30305
(404) 262-2915 FAX: (404) 233-2271

April 3, 1992

Mr. John Notar
National Park Service
Air Quality Division
12795 West Alameda Parkway
Lakewood, Colorado 80228

PSD Class I Impact Evaluation
Ridge Generating Station Project
Auburndale, Florida

Dear Mr. Notar:

Ridge Generating Station Limited Partnership is proposing to develop an independent power production facility near Auburndale, Florida. Known as the Ridge Generating Station (RGS) project, the proposed facility will be capable of combusting a mixture of wood, tires, and landfill gas to generate up to 45 MW of electricity.

An air emissions permit application for the project was submitted to the Florida Department of Environmental Regulation (DER) in December 1991. We understand that a copy of the application was forwarded by DER to the Air Quality Division of the National Park Service during DER's initial application completeness review. After reviewing the application, DER requested that an additional evaluation be performed on the impacts of RGS emissions at the Chassahowitzka PSD Class I area. That additional evaluation is the subject of the attached report. DER suggested that we send a copy of the report directly to your office.

The primary subject of the attached report is an additional modeling evaluation of sulfur dioxide impacts. In reviewing this section of the report, we request that you keep in mind the sulfur dioxide control system that will be installed at RGS as described in the original permit application. This system will consist of a spray dryer absorber (scrubber) and fabric filter, which will provide for very effective sulfur oxides control. Use of a flue gas desulfurization system on a boiler fueled predominantly by wood demonstrates the commitment of the project developers to minimize sulfur oxides emissions.

DAMES & MOORE

Mr. John Notar
National Park Service
April 3, 1992
Page -2-

Please call if you have any questions.

Sincerely,

Dames & Moore, Inc.

James W. Little

James W. Little
Associate

Attachment

cc: C. Holladay, Florida DER
M. Whiting, Decker Energy-Ridge, Inc.
R. Stone, Wheelabrator Polk Inc.

ADDITIONAL ASSESSMENT OF IMPACTS ON THE CHASSAHOWITZKA PSD CLASS I AREA FOR THE RIDGE GENERATING STATION PROJECT
(Permit Application AC 53-206244, PSD-FL-183)

This additional assessment for the Ridge Generating Station is in response to the following item in the request for information from the Florida Department of Environmental Regulation dated January 17, 1992:

6. *The predicted maximum SO_2 24-hour and 3-hour concentrations in the Chassahowitzka PSD Class I area due to the Ridge Generating Station boiler emissions are greater than the National Park Service proposed 24-hour and 3-hour significant impact levels of 0.07 and 0.48 $\mu g/m^3$, respectively. Please perform a cumulative 24-hour and 3-hour SO_2 Class I increment analysis as required by the National Park Service. An air quality related values (AQRVs) analysis should also be done since there are presently no significant impact levels that exempt a proposed PSD project from performing this analysis. The AQRVs analysis includes impacts to soils, vegetation, and wildlife.*

RESPONSE

ADDITIONAL AIR QUALITY MODELING ANALYSIS

An additional analysis of SO_2 impacts at the Chassahowitzka PSD Class I area is provided in Attachment A. This additional impact analysis is based on use of the standard ISCST model and a long-range transport model, the MESOPUFF II model. The following conclusions result from this additional analysis: (1) Predicted maximum 3-hour SO_2 concentrations at the Chassahowitzka PSD Class I area due to Ridge Generating Station (RGS) emissions are less than the National Park Service significant impact level of 0.48 $\mu g/m^3$. (2) Predicted maximum 24-hour SO_2 concentrations due to RGS emissions exceed the National Park Service significant impact level of 0.07 $\mu g/m^3$, but only on an infrequent basis. Furthermore, during the meteorological conditions when RGS emissions result in concentrations above the significant impact level, the cumulative predicted maximum 24-hour concentrations due to all PSD sources identified by DER are less than the PSD Class I increment. Therefore, RGS emissions neither cause nor contribute to a violation of the PSD Class I increment at the Chassahowitzka PSD Class I area.

AIR QUALITY RELATED VALUES ANALYSIS

An air quality related values analysis is provided in Attachment B. The conclusions reached from this analysis are that the RGS project (1) will not diminish the national significance of the Chassahowitzka National Wilderness Area (which comprises the PSD Class I area), (2) will not impair the quality of the visitor experience at this area, and (3) will not impair the structure and functioning of the ecosystems within the area.

ATTACHMENT A

ADDITIONAL PSD CLASS I AREA AIR QUALITY MODELING ANALYSIS FOR RIDGE GENERATING STATION SULFUR DIOXIDE EMISSIONS

INTRODUCTION

The Chassahowitzka PSD Class I area impact analysis provided in the Ridge Generating Station (RGS) permit application involved use of the ISCST model. The ISCST model is a straight-line trajectory, steady-state Gaussian dispersion model that assumes meteorological conditions at the time of plume release will persist over the entire distance from the point of release to the receptors of interest. Over relatively short distances, the assumptions of the ISCST model are reasonably valid. The deficiencies of steady-state models for assessing impacts at more distant receptors are well recognized, however.

The RGS site is separated from the modeled receptors in the Chassahowitzka PSD Class I area by distances ranging from 100.5 to 119.0 km. The uncertainties in using the ISCST model at these great distances are such that the maximum PSD Class I SO_2 impacts presented in the application are expected to exceed actual impacts. To further assess PSD Class I impacts attributable to RGS SO_2 emissions, a modeling analysis has been performed using a combination of the ISCST model used previously and the MESOPUFF II model - a model specifically developed to estimate concentrations at distances of as much as 400 km from an emission source.

The MESOPUFF II portion of the additional modeling evaluation was conducted by Sigma Research Corporation under the direction of Mr. Joseph Scire. Mr. Scire was one of the original developers of the MESOPUFF II model and is experienced in its use. Attached is a technical report prepared by Sigma Research describing the method of applying MESOPUFF II and the results obtained from its use. Presented below is a discussion of the overall additional modeling evaluation using both ISCST and MESOPUFF II.

EVALUATION METHOD

General Approach

From the previous modeling evaluation based on the ISCST model, the determination was made that predicted maximum SO_2 concentrations due to RGS emissions are less than the PSD Class I area significant impact levels recommended by the U.S. Environmental Protection Agency (EPA). The National Park Service (NPS), however, has proposed lower significant impact levels for SO_2. The previous ISCST modeling evaluation demonstrated that maximum annual concentrations at the Chassahowitzka PSD Class I area due to RGS emissions are less than the proposed NPS annual average significant impact level but that predicted maximum 3-hour and 24-hour concentrations exceed the NPS proposed significant impact levels.

Accordingly, the first step in the additional modeling evaluation was to use the MESOPUFF II model to predict whether maximum 3-hour and 24-hour SO_2 concentrations due to RGS SO_2 emissions alone are still higher than the NPS levels. This step resulted in the finding that predicted maximum 3-hour concentrations are less than the National Park Service significant impact concentration of 0.48 $\mu g/m^3$ (see modeling results section below). Therefore, assessing the cumulative impact of other PSD sources on 3-hour concentrations is not necessary. Operation of the RGS project will not cause or contribute to a violation of the 3-hour SO_2 PSD Class I increment at the Chassahowitzka PSD Class I area.

The next step in the evaluation was to assess 24-hour impacts taking into account both RGS emissions and the emissions of other PSD sources in the general vicinity of the Chassahowitzka PSD Class I area. Based on an approach discussed with DER, this cumulative impact analysis pertains just to 24-hour periods in the modeled meteorological data set when a significant contribution (concentrations greater than or equal to 0.07 $\mu g/m^3$) due to RGS emissions is predicted using MESOPUFF II. Consideration of other periods is not necessary because RGS would not be a contributor under those meteorological conditions.

Emission Source Distance Consideration

In the 24-hour cumulative impact assessment, the ISCST model was used to estimate concentrations due to sources located less than 20 km from the Class I area, and the MESOPUFF II model was used to estimate concentrations from sources located 20 km or more from the Class I area. The results from the two models were then summed, as further discussed in the modeling results section below.

As mentioned in the introduction, results from the ISCST model become increasingly uncertain as the distance increases between the emission source and the points at which concentrations are calculated. The choice of 20 km as the distance at which to change from the ISCST model to another model is consistent with findings that show possible inaccuracies with the ISCST model at even closer distances. It is also consistent with the objective of assessing cumulative impacts when concentrations due to RGS emissions are "significant" as defined by the proposed NPS significant impact levels. Information obtained through DER indicates that the National Park Service accepts use of the MESOPUFF II model at distances of 20 km and greater.

Another important consideration in selecting a 20-km distance for application of the MESOPUFF II model relates to the location of the PSD sources in the inventory provided by DER. All but one of the 83 sources in this inventory (or 84 sources including RGS) are located at distances of 20 km or more from the Chassahowitzka PSD Class I area. Therefore, use of the MESOPUFF II model for sources starting at 20 km provides a much more consistent modeling approach than having to mix the results from the ISCST model for a large portion of the 84 sources with the results from the MESOPUFF II model for the remaining portion of the sources as would be the case if a greater distance criterion were used.

Modeling Options

In running the MESOPUFF II model, the dry deposition and chemical transformation options of the model were specified. The attached report from Sigma Research contains additional information on model options. The ISCST model was run in the standard regulatory default mode.

EMISSION SOURCE DATA

The initial emission source modeled was the RGS boiler. RGS emission source characteristics considered in the additional evaluation are the characteristics representing the maximum continuous rating (MCR) case. Previous evaluations had demonstrated that the MCR operating level produces higher PSD Class I impacts than either the 75 percent load level or the 50 percent load level. Specific RGS boiler emissions data evaluated with the MESOPUFF II model are as follows:

- SO_2 emission rate = 13.78 g/s (109.4 lb/hr)
- Stack height = 99.06 m (325 ft)
- Stack diameter = 3.05 m (10 ft)
- Exit temperature = 349.82 K (170 °F)
- Exit velocity = 14.54 m/s (48.1 ft/s)
- UTM coordinates = 416690 m E., 3100380 m N.

Data on PSD sources other than RGS were supplied by DER. These sources are listed in Table A-1, divided into two groups. One group consists of SO_2 sources (actually, only one source) located less than 20 km from the PSD Class I area and modeled with the ISCST model. The second group consists of those sources located 20 km or more from the PSD Class I area and modeled with the MESOPUFF II model. Note that the modeled emission source inventory consists of both increment-consuming sources and increment-expanding sources (baseline sources that have shut down or reduced emissions). Increment-expanding sources are denoted by a negative emission rate.

METEOROLOGICAL DATA

As discussed in the attached report, meteorological data from four surface stations (Tampa, Orlando, Gainesville, and Daytona Beach) and one upper air station (Tampa) were processed for use with MESOPUFF II. A detailed meteorological data base was modeled by considering an entire year of data for each of the surface stations and for the upper air station. The meteorological year selected for evaluation with MESOPUFF II is year 1986.

At the recommendation of DER, the meteorological data station selected for the ISCST portion of the modeling evaluation is Tampa (Tampa surface and Tampa upper air data). For consistency, 1986 data were used with the ISCST model as well.

RECEPTORS

The PSD Class I area receptors assessed in the additional modeling evaluation consist of 13 receptors specified by DER. The UTM coordinates of these receptors are shown in Table A-2.

MODELING RESULTS

Sulfur Dioxide 3-Hour Concentrations

The predicted maximum 3-hour concentration attributable to RGS emissions is 0.26 $\mu g/m^3$ as shown in Table A-3. This predicted maximum concentration is much less than the proposed NPS significant impact level of 0.48 $\mu g/m^3$. Therefore, no need exists to develop a cumulative SO_2 3-hour concentration impact analysis with other PSD sources considered.

Sulfur Dioxide 24-Hour Concentrations

Predicted highest 24-hour SO_2 concentrations attributable to RGS emissions exceed the proposed NPS significant impact level of 0.07 $\mu g/m^3$. However, 24-hour meteorological periods producing predicted "significant" concentrations are infrequent. Table A-4 shows that three days in the 1986 meteorological data set which produce significant concentrations. The predicted maximum 24-hour concentration due to RGS emissions alone is 0.09 $\mu g/m^3$.

A cumulative impact analysis was performed for the three meteorological periods when RGS emissions produce concentrations that equal or exceed the proposed NPS significant impact level. Modeling results for all 84 PSD sources (RGS plus 83 other sources) are presented in Tables A-5, A-6, and A-7 for each of these days. The "Total" concentration column in these tables is simply the sum of the MESOPUFF II concentration at a specific receptor plus the ISCST concentration at the same receptor.

The highest cumulative concentration at any receptor where RGS emissions produce a significant impact (as proposed by NPS) is 4.68 $\mu g/m^3$ which is less than the PSD Class I increment of 5 $\mu g/m^3$. Therefore, when RGS is a "contributor" to 24-hour SO_2 concentrations at the Chassahowitzka PSD Class I area, compliance with the PSD Class I increment is predicted.

CONCLUSION

Based on the additional modeling evaluation described in this attachment, SO_2 emissions from the proposed RGS boiler will neither cause nor contribute to a violation of PSD increments within the Chassahowitzka PSD Class I area.

TABLE A-1
EMISSION SOURCES CONSIDERED
IN THE ADDITIONAL PSD CLASS I
MODELING EVALUATION

I. Sources Less than 20 Kilometers from Chassahowitzka PSD Class I Area (modeled with ISCST model)

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
22	1.45	356200	3169900	27.40	470.2	7.48	4.88

(continued on next page)

II. Sources Greater than or Equal to 20 Kilometers from Chassahowitzka PSD Class I Area (modeled with MESOPUFF II model)

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
RGS[a]	13.78	416690	3100380	99.06	349.82	14.54	3.05
9900200	466.4	467500	3197200	15.24	819.8	56.21	4.21
9900500	310.9	446300	3126000	15.24	819.8	56.21	4.21
9900800	276.1	446300	3126000	15.24	880.8	32.07	7.04
1	98.4	360008	3162398	97.6	442.0	23.23	4.88
6	-50.4	388000	3116000	60.35	353.0	16.40	2.44
7	54.6	388000	3116000	60.35	353.0	17.77	2.44
9	-50.4	388000	3116000	60.35	353.0	16.40	2.44
10	54.6	388000	3116000	60.35	353.0	17.77	2.44
30	654.7	361900	3075000	149.4	342.2	19.81	7.32
31	-2436.0	361900	3075000	149.4	422.0	28.65	7.32
33	-1218.0	361900	3075000	149.4	418.0	14.33	7.32
40	14.1	347100	3139200	83.82	394.3	15.70	3.05
46	1008.8	334200	3204500	182.90	398.0	21.00	6.90
47	1008.0	334200	3204500	182.90	398.0	21.00	6.90
48	-314.0	334200	3204500	152.00	422.0	42.10	4.57
49	-1859.0	334200	3204500	153.00	422.0	42.10	4.88
50	105.4	483500	3150600	167.60	325.7	21.60	5.80
51	242.4	483500	3150600	167.60	324.2	23.50	5.80
52	32.1	460100	3129300	18.30	422.0	38.00	3.66

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
53	277.6	404800	3057400	22.90	389.0	23.90	4.88
54	-52.07	325600	3116700	49.00	293.0	3.60	1.20
55	500.1	408500	3105800	76.20	350.0	19.70	4.88
56	21.4	368200	3092700	50.00	491.0	18.30	1.80
57	62.24	335300	3084400	49.10	522.0	27.72	2.74
61	0.2	383300	3135800	12.30	466.2	9.20	0.40
70	2.25	361400	3168400	8.50	357.4	10.95	1.08
71	2.25	359900	3162400	12.20	377.0	10.58	1.37
90	29.11	409185	3102754	30.48	783.2	28.22	5.79
91	-170.1	396600	3078900	61.00	350.0	14.28	2.60
92	182.85	396600	3078900	61.00	350.0	15.31	2.60
93	121.9	396600	3078900	60.70	350.0	15.31	2.60
94	5.54	396600	3078900	36.60	319.1	20.15	1.83
101	5.04	385600	3139000	30.48	384.3	17.13	3.35
102	5.04	434000	3198800	30.48	384.3	17.13	3.35
111	-110.6	408500	3083000	30.50	350	14.60	1.68
112	4.30	408500	3083000	9.10	450	22.50	0.70
113	52.90	408500	3083000	67.10	351	9.80	2.40
114	21.02	361800	3088300	30.00	375	20.00	0.61
115	-15.20	398400	3084200	30.50	308	18.90	1.80
116	42.00	398400	3084200	45.70	352	10.30	2.30
117	-54.56	409500	3079500	30.48	311	20.18	1.37

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DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
118	67.16	409500	3079500	30.48	355	9.27	2.29
119	41.96	409500	3079500	45.72	355	9.65	2.44
120	18.40	389550	3067930	38.10	339	10.13	2.90
121	21.17	389550	3067930	38.10	346	18.40	2.44
128	63.00	396560	3078640	60.70	350	15.55	2.60
129	3.78	396750	3079350	52.40	322	13.00	2.40
130	5.36	396830	3079430	52.40	319	7.10	2.40
131	5.54	396450	3079150	36.60	319	20.80	1.80
132	63.00	396490	3078640	60.70	350	15.55	2.60
133	-34.27	396680	3078860	21.04	347	18.56	2.13
134	-146.00	396530	3078750	61.00	350	11.14	2.50
135	189.00	396530	3078750	61.00	350	16.71	2.50
136	-257.60	406700	3085200	51.00	356	9.90	2.13
137	35.70	406700	3085200	61.00	360	12.20	2.13
140	63.00	416120	3068620	53.40	355	15.91	2.59
141	63.00	416120	3068620	53.40	355	15.91	2.59
142	-78.80	416210	3068740	29.00	314	6.77	3.02
143	-216.00	409700	3086000	45.70	352	16.50	1.40
144	73.60	409700	3086000	61.00	346	7.30	2.80
145	72.00	409500	3086500	61.00	347	28.40	1.52
147	-196.30	363400	3082400	22.60	322	19.50	1.52
148	-50.71	363400	3082400	45.70	355	9.20	2.29

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
149	36.75	363400	3082400	45.70	355	9.20	2.29
150	0.60	394800	3067720	8.20	505	7.57	0.41
151	16.35	394850	3069770	30.50	334	7.26	1.82
152	13.40	389500	3068000	38.10	339	15.20	2.44
153	30.64	414700	3080300	13.70	330	40.40	1.22
154	2.44	398290	3084290	25.90	339	15.20	2.29
250	2.99	382200	3166100	9.14	478	4.57	0.61
260	0.82	386700	3155800	10.67	327	8.99	1.83
270	2.09	359800	3164900	7.62	347	6.29	1.83
280	0.23	340600	3119200	12.2	339	6.47	3.05
290	3.67	355900	3143700	9.14	408	16.0	1.30
300	0.06	331200	3124500	10.98	544	3.88	0.31
310	0.03	331200	3124500	10.98	544	3.88	0.31
320	0.08	333400	3141000	10.98	533	4	0.31
330	0.08	333400	3141000	10.98	533	4	0.31
340	7.25	340700	3119500	9.14	436	22.3	1.40
350	3.54	390300	3129400	6.1	422	21	1.38
400	-75.6	407500	3071300	45.73	350	26.4	1.6
410	113.5	407500	3071300	45.73	350	39.06	1.6

[a] Ridge Generating Station

TABLE A-2

UTM COORDINATES OF CHASSAHOWITZKA PSD CLASS I AREA RECEPTORS

Receptor	East UTM Coordinate (m)	North UTM Coordinate (m)
1	340300	3165700
2	340300	3167700
3	340300	3169800
4	340700	3171900
5	342000	3174000
6	343000	3176200
7	343700	3178300
8	342400	3180600
9	341100	3183400
10	339000	3183400
11	336500	3183400
12	334000	3183400
13	331500	3183400

TABLE A-3

PREDICTED MAXIMUM 3-HOUR SULFUR DIOXIDE CONCENTRATION AT THE CHASSAHOWITZKA PSD CLASS I AREA ATTRIBUTABLE TO RIDGE GENERATING STATION (RGS) EMISSIONS

Predicted Maximum 3-Hour Concentration[a] ($\mu g/m^3$) and Associated Meteorological Period
0.26 (Day 343, Ending Hour 6)

[a] "Significant" concentration is 0.48 $\mu g/m^3$ as proposed by the National Park Service.

TABLE A-4

PREDICTED "SIGNIFICANT" 24-HOUR SULFUR DIOXIDE CONCENTRATIONS AT THE CHASSAHOWITZKA PSD CLASS I AREA ATTRIBUTABLE TO RIDGE GENERATING STATION EMISSIONS

Predicted Concentrations ($\mu g/m^3$) and Associated Meteorological Day
0.08 (Day 282)
0.09 (Day 332)
0.08 (Day 333)

NOTE: "Significant" concentration is 0.07 $\mu g/m^3$ as proposed by the National Park Service.

TABLE A-5

PREDICTED CUMULATIVE 24-HOUR SULFUR DIOXIDE CONCENTRATIONS ON DAYS WHEN RIDGE GENERATING STATION (RGS) EMISSIONS PRODUCE A "SIGNIFICANT" CONTRIBUTION

(concentrations in $\mu g/m^3$)

Meteorological Period: Day 282

Receptor	Contribution from Sources ≥20 km from PSD Class I Area[a] (Modeled with MESOPUFF II)	Contribution from Sources <20 km from PSD Class I Area (Modeled with ISCST)	Total	Contributions from RGS Emissions Alone
1	3.01	0.04	3.05	0.075
2	3.29	0.00	3.29	0.073
3	3.59	0.00	3.59	0.070
4	b	b	b	0.067
5	b	b	b	0.063
6	b	b	b	0.059
7	b	b	b	0.055
8	b	b	b	0.053
9	b	b	b	0.050
10	b	b	b	0.052
11	b	b	b	0.053
12	b	b	b	0.054
13	b	b	b	0.055

[a] Includes RGS emissions.

[b] RGS contribution is less than proposed National Park Service significant impact level at this receptor.

TABLE A-6

PREDICTED CUMULATIVE 24-HOUR SULFUR DIOXIDE
CONCENTRATIONS ON DAYS WHEN RIDGE GENERATING STATION (RGS)
EMISSIONS PRODUCE A "SIGNIFICANT" CONTRIBUTION
(concentrations in $\mu g/m^3$)

Meteorological Period: Day 332

Receptor	Contribution from Sources ≥20 km from PSD Class I Area[a] (Modeled with MESOPUFF II)	Contribution from Sources <20 km from PSD Class I Area (Modeled with ISCST)	Total	Contributions from RGS Emissions Alone
1	3.84	0.03	3.87	0.088
2	3.60	0.02	3.62	0.088
3	3.80	0.03	3.83	0.087
4	4.32	0.04	4.36	0.086
5	4.28	0.06	4.34	0.084
6	4.30	0.13	4.43	0.084
7	4.43	0.02	4.45	0.084
8	4.51	0.01	4.52	0.083
9	4.62	0.01	4.63	0.082
10	4.67	0.01	4.68	0.083
11	4.54	0.01	4.55	0.085
12	4.38	0.01	4.39	0.088
13	4.33	0.03	4.36	0.091

[a] Includes RGS emissions.

TABLE A-7

PREDICTED CUMULATIVE 24-HOUR SULFUR DIOXIDE CONCENTRATIONS ON DAYS WHEN RIDGE GENERATING STATION (RGS) EMISSIONS PRODUCE A "SIGNIFICANT" CONTRIBUTION
(concentrations in $\mu g/m^3$)

Meteorological Period: Day 333

Receptor	Contribution from Sources ≥20 km from PSD Class I Area[a] (Modeled with MESOPUFF II)	Contribution from Sources <20 km from PSD Class I Area (Modeled with ISCST)	Total	Contributions from RGS Emissions Alone
1	b	b	b	0.032
2	b	b	b	0.031
3	b	b	b	0.030
4	b	b	b	0.029
5	b	b	b	0.026
6	b	b	b	0.026
7	b	b	b	0.026
8	b	b	b	0.028
9	b	b	b	0.031
10	b	b	b	0.038
11	b	b	b	0.050
12	b	b	b	0.065
13	1.22	0.01	1.23	0.081

[a] Includes RGS emissions.

[b] RGS contribution is less than proposed National Park Service significant impact level at this receptor.

ATTACHMENT B

CHASSAHOWITZKA PSD CLASS I AREA AIR QUALITY RELATED VALUES ANALYSIS FOR RIDGE GENERATING STATION

INTRODUCTION

The proposed Ridge Generating Station (RGS) is located approximately 100 km from the closest point in the Chassahowitzka prevention of significant deterioration (PSD) Class I area. Based on estimated emissions from the RGS boiler at maximum continuous rating, the facility will be a "significant" emission source (as defined by PSD regulations) for sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, particulate matter, lead, and beryllium.

Although any additional increase in pollutant levels resulting from a specific emission source could theoretically have some effect on air quality related values (AQRV's), recognition of the magnitude of an expected increase is still an important consideration. The highest predicted sulfur dioxide concentration increases at the Chassahowitzka PSD Class I area due to RGS emissions are a 3-hour concentration of 0.26 $\mu g/m^3$ (0.000099 ppm), a 24-hour concentration of 0.09 $\mu g/m^3$ (0.000034 ppm), and an annual average concentration of 0.01 $\mu g/m^3$ (0.0000038 ppm). Predicted concentration increases for other pollutants emitted in significant amounts is similarly low. For example, the highest predicted annual average nitrogen dioxide concentration increase due to RGS emissions is 0.01 $\mu g/m^3$ (0.0000053 ppm). Simply on the face of these small predicted concentration increases, no adverse effect on AQRV's would be expected as result of Ridge Generating Station operation. This conclusion is supported by the following AQRV's evaluation which considers effects on vegetation, soils, wildlife, and visibility.

CHARACTERISTICS OF THE CHASSAHOWITZKA PSD CLASS I AREA

The Chassahowitzka PSD Class I area is defined by the boundaries of the Chassahowitzka National Wilderness Area (NWA). The Chassahowitzka NWA comprises most but not all of the Chassahowitzka National Wildlife Refuge. Pertinent air quality, vegetation, soils, and wildlife characteristics of the Chassahowitzka NWA are as follows:

Existing and Projected Ambient Sulfur Dioxide Levels -- No ambient monitoring stations are located at the Chassahowitzka PSD Class I area. To obtain an approximation of SO_2 levels in this area, monitoring data summarized in DER's annual reports for 1989 and 1990 were reviewed. Second highest 3-hour and 24-hour concentrations were considered for evaluation of short-term concentration. For the entire state of Florida including metropolitan and industrialized areas, measured concentrations are typically well below ambient standards. At the two monitoring stations in Citrus County, which are the stations closest to the Chassahowitzka PSD Class I area, second highest 3-hour concentrations ranged from 85 to 248 $\mu g/m^3$ in 1989 and 1990, and second highest 24-hour concentrations ranged from 18 to 64 $\mu g/m^3$. Annual means ranged from 4 to 7 $\mu g/m^3$. By comparison, the national ambient air quality standards are a 3-hour standard of 1,300 $\mu g/m^3$ (0.5 ppm), a 24-hour standard of 365 $\mu g/m^3$ (0.14 ppm), and an annual average standard of 80 $\mu g/m^3$ (0.03 ppm).

New emission sources can, of course, add to current levels. However, based on discussions with DER about recent permit application modeling results for projects in central Florida, potential SO_2 concentration increases at the Chassahowitzka PSD Class I area due to proposed new sources are at the PSD Class I increments level - that is, 3- hour concentrations less than 25 $\mu g/m^3$ and 24-hour concentrations less than 5 $\mu g/m^3$. Therefore, even with proposed new sources considered, current short-term SO_2 concentrations at the Chassahowitzka PSD Class I area are expected to be on the order of 300 $\mu g/m^3$ (0.11 ppm) or less for 3-hour averages, and on the order of 70 $\mu g/m^3$ (0.03 ppm) or less for 24-hour averages. Annual mean concentrations are expected to be less than 10 $\mu g/m^3$ (0.004 ppm). These levels are far below national ambient standards.

Existing Ambient Levels of Other Pollutants -- Based on 1989 and 1990 Florida ambient monitoring data for nitrogen dioxide, carbon monoxide, particulate matter, and lead, concentrations of these pollutants at the Chassahowitzka PSD Class I area should be below ambient standards. However, monitoring data specific to Chassahowitzka are not available.

Vegetation -- Vascular species that are typical of central Florida Gulf coastal areas like the Chassahowitzka NWA include tree species such as slash pine, laurel oak, live oak, sweetgum, and red maple; shrubs such as sawtooth palm, gallberry, and yaupon holly; and other plants such as black and soft needle rush, maiden cane, and red mangrove. Non-vascular vegetation species would include mosses and lichens.

Soils -- The characteristic soils in the Chassahowitzka NWA can be generally classified as sulfihemist soils. Such soils are dominantly organic and contain sulfidic materials within 1 meter of the surface. Based on soil survey data for Citrus and Hernando Counties (U.S. Department of Agriculture, 1991a and 1991b), the sulfur content of this upper soil layer can range up to 4 percent.

Wildlife -- The terrestrial wildlife species expected to be present in the Chassahowitzka NWA are the species common to the central Florida Gulf Coast. These include mammals such as white-tailed deer and raccoons, amphibians such as southern toads and leopard frogs, reptiles such as rat snakes and box turtles, and a variety of birds.

VEGETATION EFFECTS

Sulfur Dioxide

As DER is aware, the literature on vegetation effects from SO_2 exposure is extensive. Rather than trying to select and summarize specific studies that may be most pertinent to vegetation species in the Chassahowitzka NWA, reference can be made to a U.S. Environmental Protection Agency (EPA) review of the 3-hour secondary SO_2 ambient air quality standard established to protect against adverse vegetation effects. This review (found in the 4/26/88 edition of the *Federal Register*, 53 FR 14926) was included in EPA's proposal to retain the current 3-hour standard of 1,300 $\mu g/m^3$ (0.5 ppm). The following is an excerpt from the summary (p. 14931). In this excerpt, CD stands for criteria document (U.S. Environmental Protection Agency, 1982a), SP stands for staff paper (U.S. Environmental Protection Agency, 1982b), and CASAC stands for Clean Air Scientific Advisory Committee.

> "The basis for the existing 3-hour secondary standard rests on studies documenting acute effects on sensitive plants (38 FR 25678; September 1973). The effects of concern include reduced growth and yield, and foliar injury. The staff assessment of the greatly expanded scientific data base as summarized in the criteria document (CD, Chapter 7) found even stronger support for the 3-hour standard (SP, pp. 108-112). As a result of this most recent review, both staff and CASAC recommended retaining a 3-hour standard at or slightly below the level of the current standard (0.5 ppm)(SP, p. 126). CASAC pointed out that evidence suggesting effects at lower levels is very uncertain (SP, Appendix E, p. 8)."

While recognizing that some studies have indicated adverse vegetation effects on sensitive species at concentrations below the current 3-hour ambient air quality standard, information as summarized in the EPA statement above suggests that concentrations on the order of the 3-hour standard are protective. (For example, a CASAC letter attached to the EPA staff paper recommends that the 3-hour standard be limited to the range 0.4 to 0.5 ppm if the standard were revised.) Since current short-term concentrations in the Chassahowitzka PSD Class I area are estimated to be far below the ambient standard, no reason exists to expect that vegetation species are under stress due to SO_2 exposures. Furthermore, the extremely small increase in SO_2 concentrations predicted to result from RGS emissions will not alter current conditions. Therefore, SO_2 emissions from the RGS project are not expected to create or contribute to adverse impacts on vegetation.

Nitrogen Oxides

With respect to short-term (acute) exposures, data from a variety of experiments on crops and native plants indicate that nitrogen dioxide exposures less than 1,880 $\mu g/m^3$ (1.0 ppm) for one hour have not caused adverse effects (Taylor and Eaton, 1966; Tingey and others, 1971; Taylor and others, 1975; U.S. Environmental Protection Agency, 1982c). Current NO_2 ambient levels at the Chassahowitzka PSD Class I area combined with the minor increase in concentrations due to RGS emissions are expected to be far below this level. Therefore, no acute adverse vegetation impacts are expected to result from RGS NO_x emissions.

Long-term (chronic) exposures to high levels of NO_2 can result in such adverse effects as inhibition of photosynthesis and reduced yield. Ashenden and Mansfield (1978) found that an NO_2 concentration of 207 $\mu g/m^3$ (0.11 ppm) for 103 hours per week over a period of 20 weeks reduced yields of several turf grasses. Other studies (Taylor and others, 1975; U.S. Environmental Protection Agency, 1982c) indicate that yield effects are unlikely to occur in most crops at levels below 470 $\mu g/m^3$ (0.25 ppm). Since these values are far above the national ambient air quality standards and even further above the Chassahowitzka PSD Class I area concentration levels likely to exist after RGS begins operating, no long-term adverse effects on vegetation are expected to result from RGS NO_x emissions.

Ozone

Nitrogen oxides and volatile organic compounds, which are ozone precursors, will be emitted from the RGS facility in significant amounts. However, compared to current ozone precursor emission levels in central Florida (including the metropolitan areas of Tampa-St. Petersburg, Orlando, and the Lakeland area) that could affect the Chassahowitzka PSD Class I area, RGS emissions will be minor. Accordingly, the effect of RGS emissions on Chassahowitzka PSD Class I area ozone concentrations and related vegetation impacts should be negligible.

Other Significant Pollutants

The other significant pollutants that will be emitted from the RGS facility are carbon monoxide, particulate matter, lead, and beryllium. The potential for phytotoxic effects from these emissions at the distance of the Chassahowitzka PSD Class I area is negligible.

SOILS EFFECTS

Sulfur Dioxide

As discussed above, the dominant soils of the Chassahowitzka PSD Class I area are naturally high in sulfur content. The additional sulfur deposition resulting from RGS emissions would be negligible by comparison. In addition, tidal effects and the flushing effect of storms and tributary inflow further reduce the chances of soil sulfur level increases resulting from RGS emissions. Therefore, Chassahowitzka NWA soil composition properties and soil organism makeup should be unaffected by the proposed project.

Other Significant Pollutants

Deposition of other significant pollutants emitted by RGS are not expected to affect the existing soil characteristics of the Chassahowitzka PSD Class I area. This is especially true for lead and beryllium since these metals will be emitted in such small amounts.

WILDLIFE EFFECTS

Sulfur Dioxide

Total levels of sulfur dioxide within the Chassahowitzka PSD Class I area are expected to be well below those levels producing direct adverse toxicological effects on animals. More to the point, as discussed for vegetation, is the incremental effect of RGS emissions. The extremely small increase in concentrations predicted to resulting from RGS SO_2 emissions is highly unlikely to produce an observable effect on wildlife. A similar conclusion can be reached regarding indirect effects on wildlife that might result from damage to vegetation habitat. That is, no adverse impact on wildlife habitat should result from RGS emissions and, consequently, no indirect adverse effect on wildlife.

Other Significant Pollutants

The conclusions for sulfur dioxide also apply to the other significant pollutants.

VISIBILITY EFFECTS

The potential effect of RGS boiler emissions on visibility conditions within the Chassahowitzka PSD Class I area is assessed in Section 7.0 of the permit application. Based on a conservative screening modeling approach, RGS emissions are highly unlikely to produce an adverse visibility impact.

CONCLUSION

Based on this evaluation of air quality related values consisting of effects on vegetation, soils, wildlife, and visibility, significant pollutant emissions from the proposed RGS boiler are not expected to produce adverse impacts within the

Chassahowitzka PSD Class I area. Restated in terms of the PSD Class I adverse impact guidelines developed by the Assistant Secretary for Fish and Wildlife and Parks (see, for example, 57 FR 4465, 2/5/92), the RGS project (1) will not diminish the national significance of the Chassahowitzka NWA, (2) will not impair the quality of the visitor experience, and (3) will not impair the structure and functioning of the ecosystems with the Chassahowitzka NWA.

REFERENCES

Ashenden, T.W., and T.A. Mansfield, 1978. Extreme pollution sensitivity of grasses when SO_2 and NO_2 are present in the atmosphere together. Nature, Vol. 273, p. 142-143.

Taylor, O.C. and F.N. Eaton, 1966. Suppression of plant growth by nitrogen dioxide. Plant Physiology, Vol. 41, p. 132-135.

Taylor, O.C., C.R. Thompson, D.T. Tingey, and R.A. Reinert, 1975. Oxides of nitrogen. In J.B. Mudd and T.T. Kozlowski (eds.), Responses of Plants to Air Pollution, Academic Press, Inc., p. 121- 139.

Tingey. D.T., R.A. Reinert, J.A. Dunning, and W.W. Heck, 1971. Vegetation injury form the interaction of nitrogen dioxide and sulfur dioxide. Phytopathology, Vol. 61, p. 1506-1511.

U.S. Department of Agriculture, 1991a. Survey of Citrus County, Florida. Soil Conservation Service in cooperation with University of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Stations and Soil Science Department.

U.S. Department of Agriculture, 1991b. Survey of Hernando County, Florida. Soil Conservation Service in cooperation with University of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Stations and Soil Science Department.

U.S. Environmental Protection Agency, 1982a. Air quality criteria for particulate matter and sulfur dioxides (three volumes). Office of Research and Development, EPA-600/8-82-029af-cf.

U.S. Environmental Protection Agency, 1982b. Review of the national ambient air quality standards for sulfur oxides: assessment of scientific and technical information; OAQPS staff paper. Office of Air Quality Planning and Standards, EPA-450/5-82-007.

U.S. Environmental Protection Agency, 1982c. Air quality criteria for oxides of nitrogen; final report. Environmental Criteria and Assessment Office.

Class I Impact Analysis of the Ridge Generating Station and Background PSD Sources at the Chassahowitzka National Wilderness Area in Florida

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1. INTRODUCTION

The proposed Ridge Generating Station (RGS) is located near the city of Lakeland, Florida between Orlando and Tampa. Initial modeling of the RGS conducted by Dames & Moore with the Industrial Source Complex Short Term (ISCST) model predicted maximum 24-hour and 3-hour average SO_2 concentrations at receptors in the Chassahowitzka National Wilderness Area PSD Class I area due to the RGS which were greater than the 24-hour and 3-hour SO_2 significance limits of 0.07 $\mu g/m^3$ and 0.48 $\mu g/m^3$, respectively, proposed by the National Park Service.

The Chassahowitzka Class I area is located a minimum of 100 km to the northwest of the RGS along the Gulf of Mexico coast of Florida. The limitations of straight-line trajectory models such as ISCST which assume steady-state meteorological conditions over the entire travel path of plume are well known. Over source-receptor distances of 10-50 km, the spatial and temporal variability in transport winds and other meteorological fields can have a significant effect in determining plume trajectories and dispersion rates. In addition, as distance increases, chemical transformation and pollutant removal mechanisms become increasingly important for reactive and soluble pollutants such as SO_2.

The MESOPUFF II model (Scire et al., 1984a) is a Lagrangian variable-trajectory puff superposition model suitable for transport distances beyond the range of conventional steady-state Gaussian plume models (i.e., beyond about 10 to 50 km). MESOPUFF II is listed in Appendix B and Supplement B (draft) of the *Guideline on Air Quality Models (Revised)* (EPA, 1986 and EPA, 1991) as a model which may be applied on a case-by-case basis for long-range transport problems. In the current study, MESOPUFF II was used to obtain more refined estimates of short-term average SO_2 concentrations at the Chassahowitzka Class I area due to emissions from the RGS and other background increment-consuming and increment-expanding PSD sources in the area.

2. OVERVIEW OF MESOPUFF II

As illustrated in Figure 1, the MESOPUFF II model is one element of a modeling package which includes components for processing meteorological data and postprocessing predicted concentration results. The various programs in the modeling system are:

READ56/READ62 reads and processes twice-daily upper air wind and temperature data. READ62 is a modified version of READ56 which accommodates the new TDF-6200 upper air data format used by the National Climatic Data Center (NCDC). READ62 was used in the current study.

MESOPAC II is the meteorological model which computes time-varying and space-varying fields of meteorological variables (e.g., transport winds, mixing heights). The fields produced by MESOPAC II include hourly, gridded winds at two levels: a lower layer representing flow within the atmospheric boundary layer and an upper layer representing flow above the boundary layer.

MESOPUFF II is the Gaussian dispersion modeling component of the modeling system. MESOPUFF II contains modules accounting for plume transport, diffusion, chemical transformation, wet removal, and dry deposition. In the current analysis, wet removal effects were not considered.

MESOFILE II is a postprocessing program which time averages the concentrations produced by MESOPUFF II. It was used to compute 3-hour and 24-hour averaged SO_2 concentrations at discrete receptors in the Chassahowitzka Class I area.

2.1 Program Modifications

Several modifications were made to the MESOPUFF II model in order to accommodate its use on a 486 PC computer with a large number of sources and

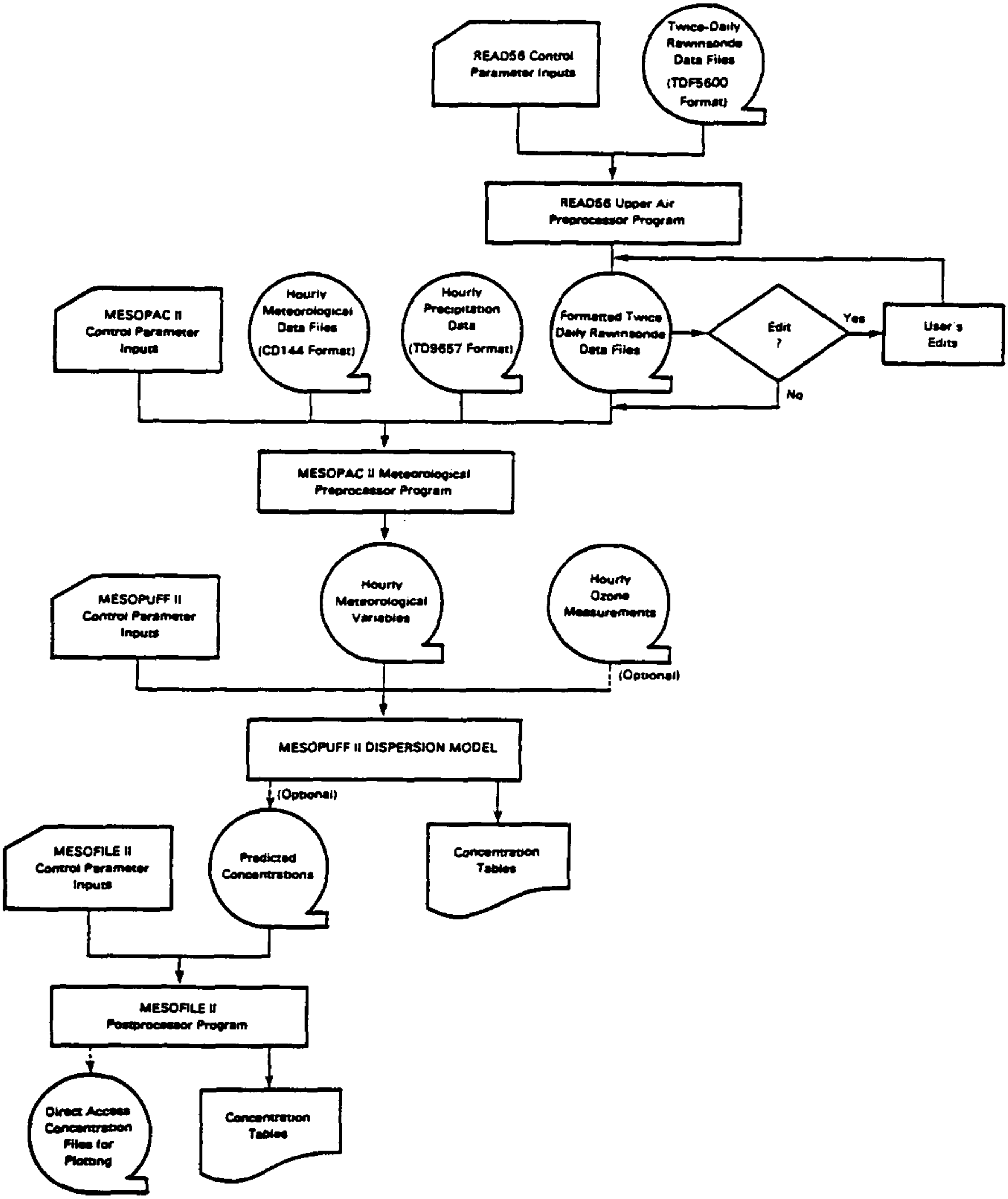

Figure 1. Major Components of the MESOPUFF II Modeling Package.

to avoid computational problems associated with divide by zero errors for variables with no minimum values.

- The dimensions of all arrays relating to the maximum number of puffs were increased from 500 to 8,000.

- Fortran subroutines to compute the error function (ERF) and the difference of two error functions (ERFDIF) were implemented into the MESOPUFF II sampling routine (SAMPLE).

- Small, minimum values were assigned to certain variables which were used in the denominator of equations and which otherwise were allowed to have zero values. These changes were made to avoid divide by zero runtime errors.
  - -- SUBR. PRISE - replaced the variable "U" in the denominator of the unstable plume rise equation with the variable "UU", which has a minimum value assigned to it.
  - -- SUBR. DEPVEL - set a minimum value of $1x10^{-30}$ for the surface friction velocity (u_*).
  - -- MAIN program - set a minimum value of 1 meter for the absolute value of the Monin-Obukhov length (L).

- Several minor modifications were made to the output format to improve the readability of the output listing.

A call to the Lahey Fortran UNDERO subroutine was added to all programs in order to properly treat very small numbers (i.e., $< \sim 10^{-38}$). In addition, the location in the code of the list file write statements in SUBR. ADD2 of the MESOFILE II postprocessor were moved from outside the time loop to within the time loop. This change corrected an error which prevented all except the last time period to be printed in the output list file.

The MESOPAC II program was modified to restrict mixing heights to a maximum height of 3000 m. This change is necessary because the model requires that the mixed-layer height not exceed the height of the 700-mb level when the default wind options are used.

3. TECHNICAL APPROACH

The purpose of the current study was to develop more refined estimates of the maximum 3-hour and 24-hour SO_2 concentrations due to emissions from the RGS at the Chassahowitzka National Wilderness Area and, during periods for which the RGS contributions were predicted to be above proposed NPS "significance limits", to assess the cumulative net impact of emissions from other PSD sources in the region. The study was designed to assess whether emissions from the RGS will cause or contribute to an exceedance of the PSD Class I increment at the Chassahowitzka Class I area.

The RGS and other background PSD sources were modeled with MESOPUFF II for the one year period, 1986. The year selected was based on previous modeling with ISCST for the five year period (1982-1986) conducted by Dames & Moore. The year 1986 was predicted by ISCST to have the highest 24-hour contributions from RGS at the Class I area. (The 24-hour averaging period is the limiting averaging period in this case.)

The approach used with MESOPUFF II was to first model emissions from the RGS alone in order to determine those time periods when the RGS contribution at any receptors within the Chassahowitzka Class I area were above the proposed NPS 3-hour and 24-hour SO_2 significance limits of 0.48 $\mu g/m^3$ and 0.07 $\mu g/m^3$, respectively. A total of 82 other background PSD sources were also modeled with MESOPUFF II for the one year period. During periods when the RGS contribution exceeded the significance limits at a particular receptor, the net predicted contribution of background PSD sources were added to the RGS concentration in order to determine the total cumulative impact for comparison to Class I PSD increment standards. The sources modeled with MESOPUFF II are located at distances of 20 km or more from the Class I area receptors. An additional source located closer to the Class I area was modeled with ISCST.

As indicated in Figure 1, several steps are involved in performing the modeling. In Section 3.1, the development of the meteorological grid and preparation of the meteorological data fields are described. Section 3.2 describes the technical options and model inputs used in the MESOPUFF II simulations.

3.1 Meteorological Data Processing

Meteorological Grid System

A meteorological grid of 25 x 30 grid cells with a 10 km grid size was developed for the MESOPUFF II modeling. The domain allows the RGS source, the Chassahowitzka Class I area, and all of the background sources to be included within the modeling region with a buffer zone of at least three grid cells (30 km) from any source or receptor to the nearest boundary. The meteorological grid is shown in Figure 2.

Meteorological Data

Meteorological data from all the Class I National Weather Surface (NWS) stations within the modeling domain were used in the MESOPAC II modeling. The four surface meteorological stations used were Tampa, Orlando, Gainesville, and Daytona Beach. These stations all include hourly surface observations. Twice-daily upper air data from Tampa were also used. Figure 2 shows the location of the meteorological stations (TAMP, ORLD, GAIN, and DAYT) along with the RGS and receptors within the Class I area (X). Meteorological station information is summarized in Table 1.

The 1986 surface data from the Tampa station was obtained in CD144 format. The data from the other surface stations were downloaded from the U.S. EPA modeling bulletin board. Because MESOPAC II requires two parameters (station pressure, relative humidity) which are in the CD144-type records but not in the compressed EPA bulletin board format, the values of station pressure and relative humidity from Tampa were used throughout the grid. This was accomplished by substituting the Tampa pressure and relative humidity values into the appropriate blank fields in the Orlando, Gainesville, and Daytona Beach data records. MESOPUFF II is only weakly sensitive to station pressure and relative humidity, so this approach is considered appropriate for the domain of interest in the current application.

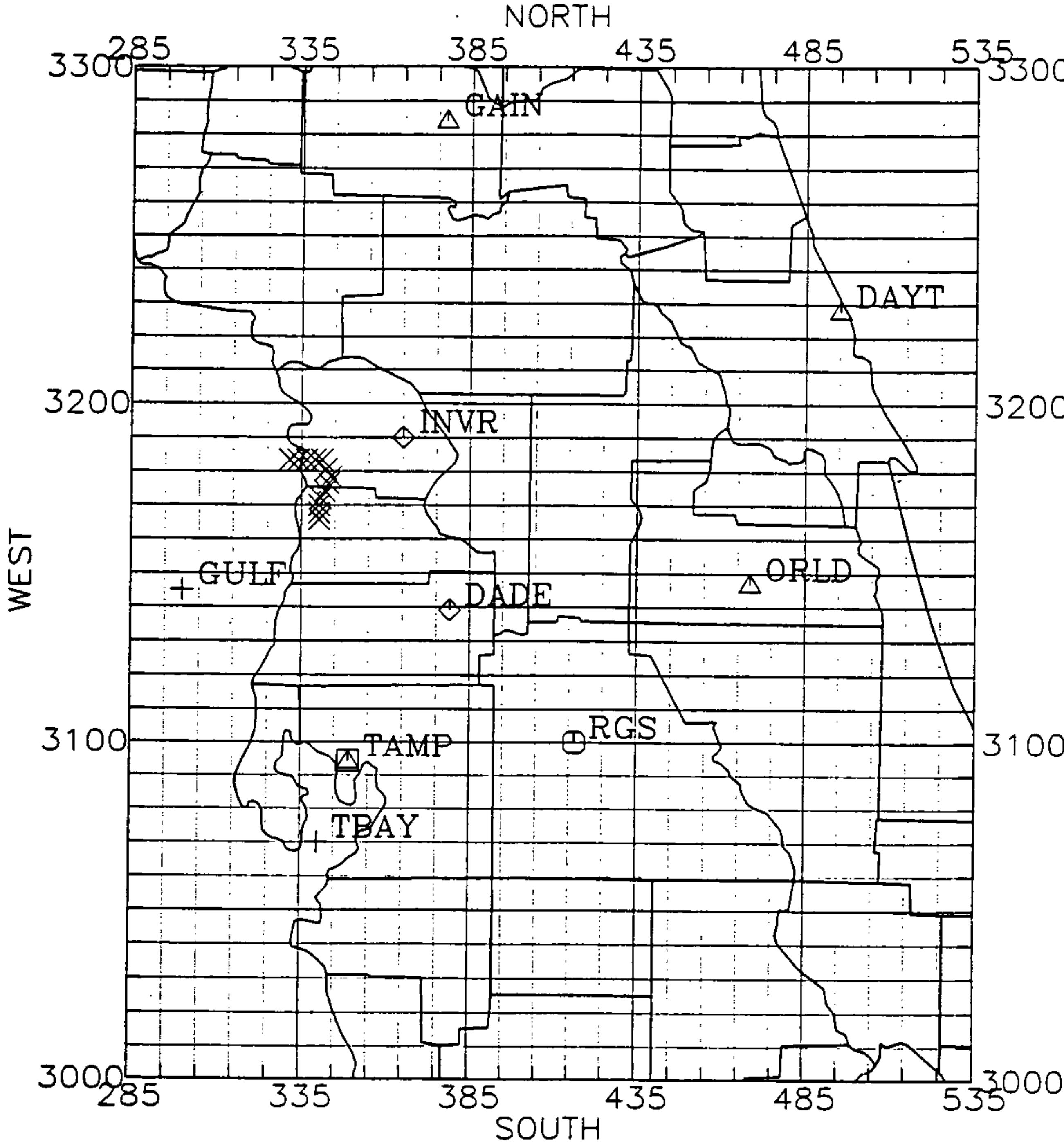

Figure 2. Meteorological Grid System (25 x 30) used in the MESOPUFF II modeling. Grid size is 10 km. (Meteorological stations: TAMP = Tampa, ORLD = Orlando, GAIN = Gainesville, DAYT = Daytona Beach; RGS = Ridge Generating Station; X = Chassohowitzka Class I area receptors).

Table 1

Meteorological Station Data

Station Name	Type	Station ID	Meteorological Grid Coordinate* X	Y	Latitude (deg.)	Longitude (deg.)
Tampa	surface	12842	7.40	10.50	27.97	82.53
Orlando	surface	12815	19.40	15.70	28.45	81.32
Gainesville	surface	12816	10.20	29.40	29.68	82.27
Daytona	surface	12834	22.00	23.80	29.18	81.05
Tampa	upper air	12842	7.40	10.50	27.97	82.53

* Meteorological grid coordinate (1,1) corresponds to UTM coordinate (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

The upper air data from Tampa were obtained from the NCDC in TDF-6200 data format. READ62 was executed using the following missing data control options: LHT = T, LTEMP = F, LWD = F, LWS = F. These options will eliminate a pressure level if the height field is missing, but retain the level if the temperature, wind speed, or wind direction is missing. Missing values of temperature or winds were interpolated from valid values in adjacent levels in order to provide a complete data set. The data from the surface to the 500 mb pressure level were extracted from the TDF-6200 data file by READ62.

READ62 identifies periods with missing or duplicate sounding data. Duplicate records were eliminated. Missing soundings were replaced by substituting the previous day's soundings at the same time of day (i.e., 00:00 GMT or 12:00 GMT).

Land Use Data

An estimation of the dominant land use type of each grid cell is one of the input fields required by the MESOPAC II model. The land use data for the grid shown in Figure 2 was based on the Geographic Information Systems (GIS) land cover data base provided as part of the ARM3 model (Morris et al., 1988). The GIS land use file has a resolution of roughly 35 km x 35 km. The land use data are specified in terms of a fractional coverage for each of ten land use categories.

The land use data are extracted from the archive using the ARM3 PRELND program. The user specifies the origin and size of the region. The grid origin used was UTM (x,y) = (285000, 3040000) meters, with a grid size of 10 km. MESOPAC II requires the specification of the dominant land use type in each grid cell, rather than fractional coverage of the cell for each land use category. Therefore, the land use category with the highest percentage of coverage in each cell was selected. The coastal areas and lakes were reset to water, if necessary, using map information so that the smaller scale features blurred by the lower resolution GIS data were not lost.

Because the GIS land use categories do not exactly correspond to those used in MESOPUFF II, the GIS categories were assigned to the most similar

MESOPUFF II categories based on the surface roughness characteristics. Table 2 illustrates the mapping of the GIS categories into the MESOPUFF II categories. For example, the GIS "agricultural/rangeland" category was mapped into the MESOPUFF II "cropland/grazing" category rather than the "irrigated crops" category because of a better match of the roughness length. Figure 3 contains the gridded MESOPUFF II land use categories used in the modeling.

MESOPAC II Model Options

The default model options were used for all of the technical options in MESOPAC II. These included the use of mixed-layer averaged winds for the lower-layer wind field, and mixing height to 700 mb averaged winds for the upper layer wind field. The model's mixing height constants, cloud-induced radiation reduction factors, and heat flux constants were set to the default values as described in the MESOPUFF II User's Guide.

The output file of gridded meteorological fields for a full year run of MESOPAC II for the 25x30 grid described above would require about 250 megabytes of disk storage. In order to reduce the size of this file and allow the modeling to be conducted simultaneously on multiple computers, the modeling was split into two six-month runs. The second run contained a four-day overlap period with the first in order to eliminate model initialization effects. Thus, the runs were for Julian days 1-181, and days 178-365, respectively. The MESOPUFF II results for Days 178-181 of the second run were discarded.

3.2 MESOPUFF II Dispersion Modeling

Technical Options

A number of important physical and chemical processes affect pollutants traveling over distance scales of tens of kilometers which are generally not important (and therefore not usually considered) in modeling applications for

Table 2

Mapping of ARM3 GIS Land Use Categories into MESOPUFF II Land Use Categories

GIS		MESOPUFF II		
Category	Roughness Length (m)	Category	Roughness Length (m)	Category Number
Urban	1.00	Urban	1.00	11
Agriculture	0.25	Crop/pasture	0.20	1
Rangeland	0.03	Grazing land	0.10	6
Forest - deci.	1.00	Grazed forest	0.90	4
Forest - coni.	1.00	Ungrazed forest	1.00	5
Swamp/forest	1.00	Ungrazed forest	1.00	5
Water	0.0002	Water	0.0001	12
Swamp	0.10	Swamp	0.20	9
Agric./rangeland	0.25	Cropland/grazing	0.30	2
Snow	0.005	-	-	-
-	-	Irrigated crops	0.05	3
-	-	Open woodland	0.20	7
-	-	Desert shrubland	0.30	8
-	-	Marshland	0.50	10

30	5	5	5	5	5	1	1	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12
29	5	5	5	5	5	1	1	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12
28	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12
27	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12
26	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12
25	5	5	5	5	5	5	5	5	5	1	1	1	5	5	5	5	5	5	5	5	12	12	12	12	12
24	12	5	5	5	5	5	5	5	5	1	1	1	5	5	5	5	5	5	5	5	5	12	12	12	12
23	12	12	12	12	5	5	5	5	5	1	1	1	5	5	5	5	5	5	5	5	5	5	12	12	12
22	12	12	12	12	5	5	5	5	5	1	1	1	5	5	5	5	5	5	5	5	5	5	12	12	12
21	12	12	12	12	5	5	5	5	5	1	1	1	1	1	1	1	1	5	5	5	5	5	5	12	12
20	12	12	12	12	12	5	5	5	5	1	1	1	1	1	1	1	1	5	5	5	5	5	5	12	12
19	12	12	12	12	12	5	5	5	5	5	5	5	1	1	1	1	1	5	5	5	5	5	5	12	12
18	12	12	12	12	12	5	5	5	5	5	5	5	1	1	1	1	1	5	5	5	5	5	5	12	12
17	12	12	12	12	12	5	5	5	5	1	1	1	1	1	1	1	1	5	5	5	5	5	9	12	12
16	12	12	12	12	12	5	5	5	5	1	1	1	1	1	1	1	1	5	5	5	5	5	9	12	12
15	12	12	12	12	12	5	5	1	1	5	5	5	5	5	12	12	12	5	5	6	6	6	5	5	12
14	12	12	12	12	5	5	5	1	1	5	5	5	5	5	12	12	12	5	5	6	6	6	5	5	12
13	12	12	12	12	5	5	5	1	1	1	1	1	1	1	5	5	5	12	12	1	1	1	1	1	12
12	12	12	12	12	5	5	5	1	1	1	1	1	12	12	1	1	1	6	6	6	6	6	1	1	12
11	12	12	12	12	5	5	5	1	1	1	1	1	12	12	1	1	1	6	6	6	6	6	1	1	1
10	12	12	12	5	12	12	5	5	5	5	5	5	5	5	1	1	1	6	6	6	6	6	1	1	1
9	12	12	12	5	5	12	12	12	5	5	5	5	5	5	1	1	1	6	6	6	6	6	1	1	1
8	12	12	12	12	5	12	12	1	1	1	1	1	1	1	1	1	1	5	5	1	1	1	6	6	6
7	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1	5	5	1	1	1	6	6	6
6	12	12	12	12	12	12	6	6	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	12	12	12	12	12	6	6	6	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1	6	6	1	1	1	1	1	1
1	12	12	12	12	12	12	12	6	6	6	6	6	1	1	1	1	1	6	6	1	1	1	1	1	1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Figure 3. Gridded MESOPUFF II land use categories for the 25x30 meteorological grid (1 = crop, 5 = forest, 6 = grazing land, 9 = swamp, 12 = water).

small source-receptor distances (i.e., < 10 km). These include gas and aqueous phase transformation of SO_2 into sulfate, dry deposition, and wet scavenging processes. In addition, the spatial and temporal variability in the meteorological fields is usually an important factor affecting concentration estimates at mesoscale distances. MESOPUFF II was developed specifically for transport distances greater than 10 km, and therefore has specific modules to parameterize these effects.

In the current application, the RGS and background PSD sources of SO_2 were modeled for the 1986 annual period. The recommendations contained in the MESOPUFF II User's Guide were used in the modeling with three exceptions. First, wet removal processes were not considered. This assumption is conservative in the sense that during wet periods, significant removal of SO_2 actually occurs. By neglecting this process, the modeling results obtained during periods with precipitation will tend to be overestimated, other factors being equal, than if it were considered. The decision to not include wet removal was based on the preference of the NPS.

The second change was to use a cross-over distance of 10 km instead of 100 km for the use of the time-dependent dispersion equations of Heffter (1965). The 10 km cross-over distance has been recommended by the model authors for several years, and in fact was used in the model evaluation study of MESOPUFF II conducted by the Argonne National Laboratory (ANL). The use of the 10 km cross-over distance was noted by ANL as one of the main factors leading to the superior performance of MESOPUFF II over some of the other models tested in the ANL study. Included in Appendix A are additional comments regarding this issue which were submitted to EPA in response to the request for public comments on the proposed Supplement B revisions to the EPA modeling guidelines.

The third change was the use of two-layer mode for deposition instead of the three-layer mode. This change was the result of sensitivity tests with and without deposition, which produced inconsistent results when the three-layer model was used. It is believed that the vertical dilution term in the three-layer model should be modified to account for the 10-meter surface layer. The two-layer deposition mode produced reasonable and consistent results as compared to the sensitivity run without deposition, and therefore it was used for the current application.

Appendix B contains a listing of a portion of a MESOPUFF II list file which shows the model options selected and values for the various input variables. The listing shown is for a run with the RGS source for the January to June time period. Sources located between 20 and 50 km from the Class I area were modeled with a minimum sampling rate of 8 per hour. Sources greater than 50 km from the Class I area (including the RGS source) used a minimum sampling rate of 2 per hour. As discussed in the MESOPUFF II technical report (Scire et al., 1984b), more frequent sampling is required as the source-receptor distance decreases (see Table 3). These values of the sampling rate should provide a good representation of the plumes for all sources modeled, including those as close as 20 km from the Class I area.

Although wet removal processes were not considered in the modeling analysis, the dry deposition and chemical transformation mechanisms of the model were invoked. This is an especially reasonable procedure in this case since the great majority of sources modeled (including nearly all of the larger sources) are located more than 50 km from the Class I area.

Receptor Locations

Thirteen discrete receptors in the Class I area were used in the modeling analysis. The coordinates of each receptor are listed in Table 4. These receptors were specified by the Florida DER.

Source Data

The stack coordinates, emission parameters, and stack parameters for each of the sources included in the MESOPUFF II modeling are shown in Tables 5a and 5b. The RGS is Source 1 in Table 5a. The background PSD source inventory was specified by the Florida DER. It consists of 63 increment-consuming PSD sources (Table 5a) and 19 increment-expanding sources (Table 5b). The increment-expanding sources are baseline sources which have stopped operations or reduced emissions. Their contribution was subtracted from that of the increment-consuming sources on a receptor-by-receptor and

Table 3

Comparison of MESOPUFF II Concentrations with Straight-Line Gaussian Plume Results as a Function of Source-Receptor Distance and Puff Sampling Rate (N)

(from Scire et al., 1984b)

(Wind Speed = 5 m/s, D Stability, Mixing Height = 1000 m, Uniform Vertical Distribution)

Distance (km)	σ_y (m)	Straight-Line Gaussian Eqn.	MESOPUFF II Sampling Algorithm N=1	N=2	N=4	N=8	N=16
10	518	1.54	1.69	1.09	1.33	1.51	1.55
20	966	0.83	0.59	0.72	0.81	0.83	0.83
30	1,392	0.57	0.63	0.54	0.59	0.57	0.57
40	1,803	0.44	0.39	0.44	0.45	0.44	0.44
50	2,203	0.36	0.41	0.37	0.36	0.36	0.36

Table 4

Meteorological Grid Coordinates of Receptors in the Chassahowitzka National Wildlife Refuge Class I Area

Receptor	Meteorological Grid Coordinates*	
	X	Y
1	6.53	17.57
2	6.53	17.77
3	6.53	17.98
4	6.57	18.19
5	6.70	18.40
6	6.80	18.62
7	6.87	18.83
8	6.74	19.06
9	6.61	19.34
10	6.40	19.34
11	6.15	19.34
12	5.90	19.34
13	5.65	19.34

* Meteorological grid coordinate (1,1) corresponds to UTM coordinate (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

Table 5a

Increment-Consuming PSD Sources Modeled with MESOPUFF II

SOURCE	METEOROLOGICAL* GRID COORDINATES X	Y	STACK HT (m)	DIAMETER (m)	EXIT VEL. (m/s)	TEMP. (deg K)	SO2 EMISSION RATE (g/s)
1	14.17	11.04	99.06	3.05	14.54	349.80	13.78
2	19.25	20.72	15.24	4.21	56.21	819.80	466.40
3	17.13	13.60	15.24	4.21	56.21	819.80	310.90
4	17.13	13.60	15.24	7.04	32.07	880.80	276.10
5	11.30	12.60	60.35	2.44	17.77	353.00	54.60
6	11.30	12.60	60.35	2.44	17.77	353.00	54.60
7	8.69	8.50	149.40	7.32	19.81	342.20	654.70
8	20.85	16.06	167.60	5.80	21.60	325.70	105.40
9	20.85	16.06	167.60	5.80	23.50	324.20	242.40
10	18.51	13.93	18.30	3.66	38.00	422.00	32.10
11	12.98	6.74	22.90	4.88	23.90	389.00	277.60
12	13.35	11.58	76.20	4.88	19.70	350.00	500.10
13	9.32	10.27	50.00	1.80	18.30	491.00	21.40
14	6.03	9.44	49.10	2.74	27.72	522.00	62.24
15	10.83	14.58	12.30	0.40	9.20	466.20	0.20
16	13.42	11.28	30.48	5.79	28.22	783.20	29.11
17	12.16	8.89	61.00	2.60	15.31	350.00	182.85
18	12.16	8.89	60.70	2.60	15.31	350.00	121.90
19	12.16	8.89	36.60	1.83	20.15	319.10	5.54
20	11.06	14.90	30.48	3.35	17.13	384.30	5.04
21	15.90	20.88	30.48	3.35	17.13	384.30	5.04
22	13.35	9.30	9.10	0.70	22.50	450.00	4.30
23	13.35	9.30	67.10	2.40	9.80	351.00	52.90
24	8.68	9.83	30.00	0.61	20.00	375.00	21.02
25	12.34	9.42	45.70	2.30	10.30	352.00	42.00
26	13.45	8.95	30.48	2.29	9.27	355.00	67.16
27	13.45	8.95	45.72	2.44	9.65	355.00	41.96
28	11.46	7.79	38.10	2.90	10.13	339.00	18.40
29	11.46	7.79	38.10	2.44	18.40	346.00	21.17
30	12.16	8.86	60.70	2.60	15.55	350.00	63.00

*Meteorological grid coordinate (1,1) corresponds to UTM coordinates (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

(Continued)

Table 5a

Increment Consuming PSD Sources Modeled with MESOPUFF II

(Concluded)

SOURCE	METEOROLOGICAL* GRID COORDINATES X	Y	STACK HT (m)	DIAMETER (m)	EXIT VEL. (m/s)	TEMP. (deg K)	SO2 EMISSION RATE (g/s)
31	12.18	8.94	52.40	2.40	13.00	322.00	3.78
32	12.18	8.94	52.40	2.40	7.10	319.00	5.36
33	12.15	8.92	36.60	1.80	20.80	319.00	5.54
34	12.15	8.86	60.70	2.60	15.55	350.00	63.00
35	12.15	8.88	61.00	2.50	16.71	350.00	189.00
36	13.17	9.52	61.00	2.13	12.20	360.00	35.70
37	14.11	7.86	53.40	2.59	15.91	355.00	63.00
38	14.11	7.86	53.40	2.59	15.91	355.00	63.00
39	13.47	9.60	61.00	2.80	7.30	346.00	73.60
40	13.45	9.65	61.00	1.52	28.40	347.00	72.00
41	8.84	9.24	45.70	2.29	9.20	355.00	36.75
42	11.98	7.77	8.20	0.41	7.57	505.00	0.60
43	11.99	7.98	30.50	1.82	7.26	334.00	16.35
44	11.45	7.80	38.10	2.44	15.20	339.00	13.40
45	13.97	9.03	13.70	1.22	40.40	330.00	30.64
46	12.33	9.43	25.90	2.29	15.20	339.00	2.44
47	11.53	13.94	6.10	1.38	21.00	422.00	3.54
48	13.25	8.13	45.73	1.60	39.06	350.00	113.50
49	8.50	17.24	97.60	4.88	23.23	442.00	98.40
50	7.21	14.92	83.82	3.05	15.70	394.30	14.10
51	5.92	21.45	182.90	6.90	21.00	398.00	1008.80
52	5.92	21.45	182.90	6.90	21.00	398.00	1008.00
53	8.64	17.84	8.50	1.08	10.95	357.40	2.25
54	8.49	17.24	12.20	1.37	10.58	377.00	2.25
55	10.72	17.61	9.14	0.61	4.57	478.00	2.99
56	11.17	16.58	10.67	1.83	8.99	327.00	0.82
57	8.48	17.49	7.62	1.83	6.29	347.00	2.09
58	6.56	12.92	12.20	3.05	6.47	339.00	0.23
59	8.09	15.37	9.14	1.30	16.00	408.00	3.67
60	5.62	13.45	10.98	0.31	3.88	544.00	0.06
61	5.62	13.45	10.98	0.31	3.88	544.00	0.03
62	5.84	15.10	10.98	0.31	4.00	533.00	0.08
63	5.84	15.10	10.98	0.31	4.00	533.00	0.08
64	6.57	12.95	9.14	1.40	22.30	436.00	7.25

*Meteorological grid coordinate (1,1) corresponds to UTM coordinates (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

Table 5b

Increment-Expanding PSD Sources Modeled with MESOPUFF II

SOURCE	METEOROLOGICAL* GRID COORDINATES X	Y	STACK HT (m)	DIAMETER (m)	EXIT VEL. (m/s)	TEMP. (deg K)	SO2 EMISSION RATE (g/s)
1	11.30	12.60	60.35	2.44	16.40	353.00	50.40
2	11.30	12.60	60.35	2.44	16.40	353.00	50.40
3	8.69	8.50	149.40	7.32	28.65	422.00	2436.00
4	8.69	8.50	149.40	7.32	14.33	418.00	1218.00
5	5.06	12.67	49.00	1.20	3.60	293.00	52.07
6	12.16	8.89	61.00	2.60	14.28	350.00	170.10
7	13.35	9.30	30.50	1.68	14.60	350.00	110.60
8	12.34	9.42	30.50	1.80	18.90	308.00	15.20
9	13.45	8.95	30.48	1.37	20.18	311.00	54.56
10	12.17	8.89	21.04	2.13	18.56	347.00	34.27
11	12.15	8.88	61.00	2.50	11.14	350.00	146.00
12	13.17	9.52	51.00	2.13	9.90	356.00	257.60
13	14.12	7.87	29.00	3.02	6.77	314.00	78.80
14	13.47	9.60	45.70	1.40	16.50	352.00	216.00
15	8.84	7.24	22.60	1.52	19.50	322.00	196.30
16	8.84	9.24	45.70	2.29	9.20	355.00	50.71
17	13.25	8.13	45.73	1.60	26.40	350.00	75.60
18	5.92	21.45	152.00	4.57	42.10	422.00	314.00
19	5.92	21.45	153.00	4.88	42.10	422.00	1859.00

*Meteorological grid coordinate (1,1) corresponds to UTM coordinates (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

hour-by-hour basis in the MESOFILE II postprocessing step of the analysis. Thus, the total net concentration for a particular time period can be either positive or negative, depending on the relative contribution of the various sources.

4. MESOPUFF II MODELING RESULTS

3-Hour SO_2 Concentrations

The peak predicted 3-hour SO_2 concentration predicted by MESOPUFF II due to emissions from the RGS was 0.26 μg/m^3 on Day 343 for the hours 03:00-0:600 LST. Because this value is less than the proposed 3-hour SO_2 significance level of 0.48 μg/m^3, a cumulative impact analysis with background PSD sources was not necessary.

24-Hour SO_2 Concentrations

MESOPUFF II modeling for the RGS source produced three days with predicted 24-hour SO_2 concentrations at or above the proposed NPS 24-hour significance level of 0.07 μg/m^3 at one or more of the Class I area receptors. As shown in Table 6, concentrations on Days 282, 332, and 333 exceeded the significance level, with the peak concentration (0.09 μg/m^3) predicted on Day 332.

Tables 7, 8, and 9 show the concentrations due to RGS and the total net contribution from the 82 background PSD sources located at or beyond 20 km from the Class I area added to the RGS contribution. The highest predicted concentrations at a receptor for which the RGS contribution was significant (i.e., ≥ 0.07 μg/m^3) was 4.67 μg/m^3.

In order to reach conclusions relating to compliance with the 24-hour PSD Class I increment for SO_2, the contributions of the one source located less than 20 km from the Class I area must be added to the values in Tables 7 to 9. The modeling of the additional source with the ISCST model was conducted by Dames & Moore. The results of that analysis are described in a separate report.

Table 6

Predicted Peak 24-Hour Average SO_2 Concentrations Due to RGS Emissions At or Above the Proposed NPS 24-Hour Significance Threshold of 0.07 $\mu g/m^3$

Day	Receptor	Concentration ($\mu g/m^3$)
282	1	0.08
332	13	0.09
333	13	0.08

Table 7

Predicted 24-Hour Average SO_2 Concentrations on Days when RGS Contributions Exceeded the Proposed NPS Significance Level

Day: 282

Receptor	Contribution from RGS	Contribution from Sources ≥ 20 km from Class I Area (Including RGS)
1	0.075	3.01
2	0.073	3.29
3	0.070	3.59
4	0.067	*
5	0.063	*
6	0.059	*
7	0.055	*
8	0.053	*
9	0.050	*
10	0.052	*
11	0.053	*
12	0.054	*
13	0.055	*

* At this receptor, the RGS contribution is less than the proposed NPS 24-hour significance level of 0.07 $\mu g/m^3$.

Table 8

Predicted 24-Hour Average SO_2 Concentrations on Days when RGS Contributions Exceeded the Proposed NPS Significance Level

Day: 332

Receptor	Contribution from RGS	Contribution from Sources ≥ 20 km from Class I Area (Including RGS)
1	0.088	3.84
2	0.088	3.60
3	0.087	3.80
4	0.086	4.32
5	0.084	4.28
6	0.084	4.30
7	0.084	4.43
8	0.083	4.51
9	0.082	4.62
10	0.083	4.67
11	0.085	4.54
12	0.088	4.38
13	0.091	4.33

Table 9

Predicted 24-Hour Average SO_2 Concentrations on Days when RGS Contributions Exceeded the Proposed NPS Significance Level

Day: 333

Receptor	Contribution from RGS	Contribution from Sources ≥ 20 km from Class I Area (Including RGS)
1	.032	*
2	.031	*
3	.030	*
4	.029	*
5	.026	*
6	.026	*
7	.026	*
8	.028	*
9	.031	*
10	.038	*
11	.050	*
12	.065	*
13	.081	1.22

* At this receptor, the RGS contribution is less than the proposed NPS 24-hour significance level of 0.07 $\mu g/m^3$.

5. REFERENCES

EPA, 1986: Guidance on air quality models (revised). EPA-450/2-78-027R, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 1991: Supplement B to the guideline on air quality models (revised). Draft. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Heffter, J.L., 1965: The variations of horizontal diffusion parameters with time travel periods of one hour or longer. *J. Applied Meteorol.*, **4**, 153-156.

Policastro, A.J., M. Wastag, L. Coke, R.A. Carhart and W.E. Dunn, 1986: Evaluation of short-term long-range transport models (Draft final report). U.S. Environmental Protection Agency, Research Triangle Park, NC.

Scire, J.S., F.W. Lurmann, A. Bass and S.R. Hanna, 1984a: User's guide to the MESOPUFF II model and related processor programs. EPA-600/8-84-013, U.S. Environmental Protection Agency, REsearch Triangle Park, NC.

Scire, J.S., F.W. Lurmann, A. Bass and S.R. Hanna, 1984b: Development of the MESOPUFF II dispersion model. EPA-600/3-84-057. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Appendix A

Comments on the use of MESOPUFF II

Sigma Research Corporation

Telephone: (508) 692-0330
Telefax: (508) 692-8547

234 Littleton Road, Suite 2E • Westford, Massachusetts 01886, U.S.A.

May 3, 1991

Air Docket (LE-131), Room M-1500
Waterside Mall
Attention: Docket A-88-04
U.S. Environmental Protection Agency
401 M Street SW
Washington, DC 20460

Dear Sir:

I am writing in response to the Federal Register Notice (AD-FRL-3908-3, Docket No. A-88-04, Monday February 25, 1991) requesting comments on the proposed revisions to the "Guideline on Air Quality Models (Revised)" and Supplement B to the Guideline. In particular, my comments relate to the EPA recommendations regarding the use of the MESOPUFF II dispersion model (Scire et al., 1984).

Supplement B notes that MESOPUFF II, listed in Appendix B of the Guidelines, may be applied on a case-by-case basis when long range transport estimates are needed. It is also noted that information on applying this model is contained in the EPA document "A Modeling Protocol for Applying MESOPUFF-II to Long-Range Problems" (Docket No. A-88-04, II-I-11).

The following changes are recommended to the EPA MESOPUFF II modeling protocol.

- MESOPUFF II contains a input parameter, TMDEP, which controls the distance at which the functions used to compute dispersion coefficients are switched from the distance-dependent equations of Turner to the time-dependent functions of Heffter (1965). The default value for this parameter is set at 100 km, indicating that the time-dependent functions are used at greater distances. However, in our review of the model evaluation protocol prepared by Argonne National Laboratory (ANL) in their evaluation of long-range transport models, we suggested that a value of 10 km be used for TMDEP. The model evaluation work done by ANL was based on a 10 km value for TMDEP. ANL concluded that "the use of 10 km as the transition distance between the use of the Turner curves and Heffter formula for lateral dispersion definitely improved concentration predictions" (page 6-7, Policastro et al., 1986). They also noted that a main cause of the under-prediction of lateral spreading by some of the other models evaluated was due to the use of the distance-dependent curves out to 50-100 km. They concluded that "the more correct distance is about 10 km" (page 6-3). Therefore, it is recommended that the EPA modeling protocol for MESOPUFF II be modified to recommend that a value of 10 km be used for TMDEP.

- The EPA modeling protocol recommends that MESOPUFF II be run for pollutants such as SO_2 with the chemical transformation and pollutant removal algorithms turned off. However, over source-receptor distances of 50 to 300 kilometers, these processes can have a very significant effect on the predicted concentrations. Wet deposition of SO_2 is a particularly efficient removal mechanism. For example, studies of observed scavenging ratios indicate typical removal rates of 10-20 *per hour* or higher for modest precipitation rates of only 1-2 mm/hr. (At an average transport speed of 5 m/s, over 16 hours is required to travel 300 km).

  Current EPA modeling guidelines allow consideration of SO_2 transformation in straight-line Gaussian models on even smaller spatial scales than those for which MESOPUFF II would be applied. For example, the modeling guidelines recommend a pollutant half life of 4 hours for SO_2 modeling in urban areas). Therefore, some allowance for chemical conversion and removal is consistent with current guidance and is justifiable on technical grounds. Although first-level screening analyses with removal and chemical conversion switched off is appropriate, it is suggested that more refined screening modeling with MESOPUFF II which accounts for SO_2 transformation and removal should be allowed.

- The modeling protocol recommends the use of MESOPUFF II at source-receptor distances greater than 50 km. It should be noted that the puff model can reproduce a straight-line Gaussian model results under steady-state conditions with the appropriate choice of puff release parameters at distances much less than 50 km (Table 9 in the MESOPUFF II report shows nearly identical results down to 10 km with N=16). Therefore, it is not so much an issue of when does the puff model become valid as when the straight-line, steady-state assumptions in conventional models become not appropriate. The straight-line Gaussian model is more efficient computationally over short distances, but because there are many flow situations when non-steady-state conditions occur over spatial scales less than 50 km, the use of the puff model may be justified.

The modeling protocol recommends application of MESOPUFF II for a full year period for small numbers of sources. Recent advances in the computational speed of advanced PCs and workstations have made large multi-source or multi-year simulations with the MESOPUFF II model practical. For example, the state agency in Massachusetts sponsored a study to simulate nearly 200 point and area sources of SO_2 for a full year with only modest computational resources. Similar studies have been performed in other states, including Minnesota and Maryland.

Thank you for the opportunity to comment on these issues.

Sincerely,

Joseph S. Scire

Joseph S. Scire
Chief Executive Officer

cc: J. Tikvart

References

Heffter, J.L., 1965: The variations of horizontal diffusion parameters with time travel periods of one hour or longer. *J. Applied Meteorol.*, 4, 153-156.

Policastro, A.J., M. Wastag, L. Coke, R.A. Carhart, and W.E. Dunn, 1986: Evaluation of short-term long-range transport models (Draft final report). U.S. Environmental Protection Agency, Research Triangle Park, NC.

Scire, J.S., F.W. Lurmann, A. Bass, S.R. Hanna, 1984: User's guide to the MESOPUFF II model and related processor programs. EPA-600/8-84-013. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Scire J.S., F.W. Lurmann, A. Bass, S.R. Hanna, 1984: Development of the MESOPUFF II dispersion model. EPA-600/3-84-057. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Appendix B

MESOPUFF II Output List File

(RGS Source, January - June, 1986)

```
                    MESOPUFF - VERSION 2.0 (DATED 85360)

                                              MESOPUFF   VERSION  2.0
************************************************************************************************************

MESOPUFF II - RGS - 1/1/86 - 6/30/86  w/dry dep and Chem

GENERAL RUN INFORMATION:
   YEAR OF RUN (NSYR) = 86
   JULIAN DAY OF START OF RUN (NSDAY) =   1
   HOUR OF START OF RUN (NSHR) =  0
   LENGTH OF RUN (NADVTS) = 4344 (HOURS)
   NUMBER OF POINT SOURCES (NPTS) =  1
   NUMBER OF AREA (URBAN) SOURCES (NAREAS) =  0
   NUMBER OF NONGRIDDED RECEPTORS (NREC) =  13
   NUMBER OF POLLUTANT SPECIES (NSPEC) =  1

COMPUTATIONAL VARIABLES:
   CONCENTRATION AVERAGING TIME (IAVG) =    1 (HOUR(S))
   PUFF RELEASE RATE (NPUF) =   4 (PUFFS/HOUR)
   MINIMUM SAMPLING RATE (NSAMAD) =  2 (SAMPLES/HOUR)
   SAMPLING RATE VARIED WITH WIND SPEED ? (LVSAMP) = T
   SAMPLING RATE WIND SPEED INTERVAL (WSAMP) =  2.00 (M/S)
   CONCENTRATIONS CALCULATED AT SAMPLING GRID POINTS ? (LSGRID) = F
   PUFFS YOUNGER THAN "AGEMIN" SECONDS ARE NOT SAMPLED (AGEMIN) =   900. (SECONDS)

GRID INFORMATION:
   BEGINNING OF COMPUTATIONAL GRID IN X-DIRECTION (IASTAR) =  1
   END OF COMPUTATIONAL GRID IN X-DIRECTION (IASTOP) = 25
   BEGINNING OF COMPUTATIONAL GRID IN Y-DIRECTION (JASTAR) =  1
   END OF COMPUTATIONAL GRID IN Y-DIRECTION (JASTOP) = 30
   BEGINNING OF SAMPLING GRID IN X-DIRECTION (ISASTR) =  1
   END OF SAMPLING GRID IN X-DIRECTION (ISASTP) = 25
   BEGINNING OF SAMPLING GRID IN Y-DIRECTION (JSASTR) =  1
   END OF SAMPLING GRID IN Y-DIRECTION (JSASTP) = 30
   SAMPLING GRID SPACING FACTOR (MESHDN) =  1

TECHNICAL OPTIONS:
   GAUSSIAN VERTICAL CONCENTRATION DISTRIBUTION ? (LGAUSS) = T
   CHEMICAL PROCESSES MODELED ? (LCHEM) = T
   DRY DEPOSITION MODELED ? (LDRY) = T
   WET REMOVAL MODELED ? (LWET) = F
   3 VERTICAL LAYERS ? (L3VL) = F

OUTPUT OPTIONS:
   CONCENTRATIONS STORED ON TAPE ? (LTAPE) = T
   CONCENTRATIONS PRINTED ? (LPRINT) = T
   PRINT INTERVAL (IPRINF) =   24
   PUFF PARAMETERS PRINTED EACH SAMPLING STEP ? (LDB) = F
   TIME STEPS FOR WHICH PUFF PARAMETERS PRINTED (NN1,NN2) =    0,   0
```

DEFAULT OVERRIDE OPTIONS (0=NO,1=YES)

USER INPUT SIGY, SIGZ VARIABLES (IOPTS(1)) = 1
USER INPUT VERTICAL DIFFUSIVITY CONSTANTS (IOPTS(2)) = 0
USER INPUT DRY DEP. SO2 CANOPY RESISTANCES (IOPTS(3)) = 0
USER INPUT OTHER DRY DEP. CONSTANTS (IOPTS(4)) = 0
USER INPUT WET REMOVAL CONSTANTS (IOPTS(5)) = 0
USER INPUT CHEMICAL TRANSFORMATION VARIABLES (IOPTS(6)) = 0

SIGY, SIGZ VARIABLES:

AY =	0.36000	0.25000	0.19000	0.13000	0.09600	0.06300
BY =	0.90000	0.90000	0.90000	0.90000	0.90000	0.90000
AZ =	0.00023	0.05800	0.11000	0.57000	0.85000	0.77000
BZ =	2.10000	1.09000	0.91000	0.58000	0.47000	0.42000
AZT (IN M) =	5.00000	3.87300	2.73900	1.87100	1.22500	0.70700

THDEP = 10000. (M)

STABILITY CLASS USED IN SIGY, SIGZ CALCULATIONS FOR PUFFS ABOVE BOUNDARY LAYER (JSUP) = 5
(0 = BOUNDARY LAYER STABILITY CLASS, 5 = E STABILITY, 6 = F STABILITY)

VERTICAL DIFFUSIVITY CONSTANTS:

CON1K = 0.010 (M**2/S)
CON2K = 0.100 (M**2/S)

LAND USE CATEGORY	SO2 CANOPY RESISTANCE (S/M)			
	A,B,C	D	E	F
1	100.00	300.00	1000.00	0.00
2	100.00	300.00	1000.00	0.00
3	100.00	300.00	1000.00	0.00
4	100.00	300.00	1000.00	0.00
5	100.00	300.00	1000.00	0.00
6	100.00	300.00	1000.00	0.00
7	100.00	300.00	1000.00	0.00
8	200.00	500.00	1000.00	1000.00
9	50.00	75.00	100.00	0.00
10	75.00	300.00	1000.00	0.00
11	1000.00	1000.00	1000.00	0.00
12	0.00	0.00	0.00	0.00

DRY DEPOSITION CONSTANTS:

CANOPY RESISTANCE FOR NOX IN S/M (RCNOX) = 130.00 (A,B,C) 500.00 (D) 1500.00 (E) 1500.00 (F)
SURFACE RESISTANCE CONSTANT FOR GASES (RSGCON) = 2.60
SURFACE RESISTANCE FOR PARTICLES (RSPART) = 1000.00 (S/M)

****

```
CHEMICAL TRANSFORMATION VARIABLES:
    SOX TRANSFORMATION METHOD FLAG (MSOX) =  2
        0 - NO TRANSFORMATION
        1 - USER SPECIFIED
        2 - ERT THEORETICAL EQUATION
        3 - GILLANI EQUATION
        4 - HENRY EQUATION FOR ST. LOUIS
        5 - HENRY EQUATION FOR LOS ANGELES
    NOX TRANSFORMATION METHOD FLAG (MNOX) =  2
        0 - NO TRANSFORMATION
        1 - USER SPECIFIED
        2 - ERT THEORETICAL EQUATION
    OZONE INPUT METHOD FLAG (MO3) =  0
        0 - DEFAULT OZONE VALUE USED
        1 - HOURLY OZONE VALUES READ
    DEFAULT BACKGROUND OZONE (CO3B) =   80.0 (PPB)
    TOTAL AMMONIA CONCENTRATION (CTNH3) =   10.0 (PPB)
    NIGHTTIME TRANSFORMATION RATES:
        SO2 LOSS RATE (RNITE(1)) =   0.2 (%/HOUR)
        NOX LOSS RATE (RNITE(2)) =   2.0 (%/HOUR)
        TOTAL NO3 FORMATION RATE (RNITE(3)) =   2.0 (%/HOUR)
```

MESOPUFF VERSION 2.0

****

POINT SOURCE DATA

SOURCE	GRID COORDINATES X	Y	STACK HT (M)	DIAMETER (M)	EXIT VEL. (M/S)	TEMP. (DEG K)	EMISSION RATES (G/S) SO2	SO4	NOX	HNO3	NO3
1	14.17	11.04	99.06	3.05	14.54	349.80	13.78	0.00	0.00	0.00	0.00

****

NONGRIDDED RECEPTOR LOCATIONS

RECEPTOR	X (GRID UNITS)	Y (GRID UNITS)
1	6.530	17.570
2	6.530	17.770
3	6.530	17.980
4	6.570	18.190
5	6.700	18.400
6	6.800	18.620
7	6.870	18.830
8	6.740	19.060
9	6.610	19.340
10	6.400	19.340
11	6.150	19.340
12	5.900	19.340
13	5.650	19.340

MESOPUFF VERSION 2.0

****

```
INFORMATION READ FROM METEOROLOGICAL DATA FILE:
    YEAR OF METEOROLOGICAL DATA = 86
    METEOROLOGICAL DATA BEGINS ON JULIAN DAY   1
    NUMBER OF HOURS OF METEOROLOGICAL DATA = 4345
    METEOROLOGICAL GRID SIZE IN X (WEST-EAST) DIRECTION = 25
    METEOROLOGICAL GRID SIZE IN Y (SOUTH-NORTH) DIRECTION = 30
    METEOROLOGICAL GRID SPACING =    10000.0 (M)
    BASE TIME ZONE = 5 (E.S.T.)
    VON KARMAN CONSTANT = 0.40
    CODE FOR LOWER-LEVEL WIND FIELD (ILWF) =  2
    CODE FOR UPPER-LEVEL WIND FIELD (IUWF) =  4
    NUMBER OF STATIONS USED IN CONSTRUCTION OF METEOROLOGICAL DATA FIELDS
         SURFACE:     4
         RAWINSONDE:  1
    STATION         GRID COORDINATES
      TYPE             X            Y
                 (GRID UNITS)  (GRID UNITS)

    SURFACE        7.40         10.50
    SURFACE       19.40         15.70
    SURFACE       10.20         29.40
    SURFACE       22.00         23.80
    RAWINSONDE     7.40         10.50
```

RECEIVED
APR 06 1992
Bureau of
Air Regulation

ADDITIONAL ASSESSMENT OF IMPACTS ON THE CHASSAHOWITZKA PSD CLASS I AREA FOR THE RIDGE GENERATING STATION PROJECT

APRIL 1992

DAMES & MOORE

ATLANTA, GEORGIA
Job No. 22250-004-049

DAMES & MOORE

SIX PIEDMONT CENTER, SUITE 500, 3525 PIEDMONT ROAD, ATLANTA, GEORGIA 30305
(404) 262-2915 FAX: (404) 233-2271

April 3, 1992

Florida Department of Environmental Regulation
Division of Air Resources Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Attention: C.H. Fancy, P.E.
Chief, Bureau of Air Regulation

Re: Permit Application AC 53-206244, PSD-FL-183
Ridge Generating Station

Dear Mr. Fancy:

Item 6 in your letter dated January 17, 1992, requested an additional evaluation of impacts on the Chassahowitzka PSD Class I area resulting from Ridge Generating Station emissions. A summary response to Item 6 was provided in a letter from the project partners dated March 27, 1992. A meeting was then held on April 1, 1992, with Tom Rogers and Cleve Holladay of the Air Modeling and Assessment Section to discuss requirements for a detailed response. The attached report constitutes the detailed response. At the suggestion of Mr. Rogers and Mr. Holladay, we are sending a copy of the report to Mr. John Notar at the Air Quality Division of the National Park Service.

Included in the attached report are the results of an additional modeling evaluation of PSD Class I area impacts. Printouts and computer files supporting these results are being sent under separate cover.

Please call me (404-262-2915) or Matt Killeen at Wheelabrator Environmental Systems (1-800-682-0026) if you have any questions.

Sincerely,

Dames & Moore, Inc.

James W. Little

James W. Little
Associate

Attachments

cc: J. Notar, National Park Service, Air Quality Division
J. Reynolds, Florida Department of Environmental Regulation
C. Holladay, Florida Department of Environmental Regulation
M. Whiting, Decker Energy-Ridge, Inc.
R. Stone, Wheelabrator Polk Inc.
M. Killeen, Wheelabrator Environmental Systems Inc.

DAMES & MOORE

SIX PIEDMONT CENTER, SUITE 500, 3525 PIEDMONT ROAD, ATLANTA, GEORGIA 30305
(404) 262-2915 FAX: (404) 233-2271

April 3, 1992

Mr. John Notar
National Park Service
Air Quality Division
12795 West Alameda Parkway
Lakewood, Colorado 80228

PSD Class I Impact Evaluation
Ridge Generating Station Project
Auburndale, Florida

Dear Mr. Notar:

Ridge Generating Station Limited Partnership is proposing to develop an independent power production facility near Auburndale, Florida. Known as the Ridge Generating Station (RGS) project, the proposed facility will be capable of combusting a mixture of wood, tires, and landfill gas to generate up to 45 MW of electricity.

An air emissions permit application for the project was submitted to the Florida Department of Environmental Regulation (DER) in December 1991. We understand that a copy of the application was forwarded by DER to the Air Quality Division of the National Park Service during DER's initial application completeness review. After reviewing the application, DER requested that an additional evaluation be performed on the impacts of RGS emissions at the Chassahowitzka PSD Class I area. That additional evaluation is the subject of the attached report. DER suggested that we send a copy of the report directly to your office.

The primary subject of the attached report is an additional modeling evaluation of sulfur dioxide impacts. In reviewing this section of the report, we request that you keep in mind the sulfur dioxide control system that will be installed at RGS as described in the original permit application. This system will consist of a spray dryer absorber (scrubber) and fabric filter, which will provide for very effective sulfur oxides control. Use of a flue gas desulfurization system on a boiler fueled predominantly by wood demonstrates the commitment of the project developers to minimize sulfur oxides emissions.

Please call if you have any questions.

Sincerely,

Dames & Moore, Inc.

James W. Little

James W. Little
Associate

Attachment

cc: C. Holladay, Florida DER
M. Whiting, Decker Energy-Ridge, Inc.
R. Stone, Wheelabrator Polk Inc.

ADDITIONAL ASSESSMENT OF IMPACTS ON THE CHASSAHOWITZKA PSD CLASS I AREA FOR THE RIDGE GENERATING STATION PROJECT
(Permit Application AC 53-206244, PSD-FL-183)

This additional assessment for the Ridge Generating Station is in response to the following item in the request for information from the Florida Department of Environmental Regulation dated January 17, 1992:

6. *The predicted maximum SO_2 24-hour and 3-hour concentrations in the Chassahowitzka PSD Class I area due to the Ridge Generating Station boiler emissions are greater than the National Park Service proposed 24-hour and 3-hour significant impact levels of 0.07 and 0.48 $\mu g/m^3$, respectively. Please perform a cumulative 24-hour and 3-hour SO_2 Class I increment analysis as required by the National Park Service. An air quality related values (AQRVs) analysis should also be done since there are presently no significant impact levels that exempt a proposed PSD project from performing this analysis. The AQRVs analysis includes impacts to soils, vegetation, and wildlife.*

RESPONSE

ADDITIONAL AIR QUALITY MODELING ANALYSIS

An additional analysis of SO_2 impacts at the Chassahowitzka PSD Class I area is provided in Attachment A. This additional impact analysis is based on use of the standard ISCST model and a long-range transport model, the MESOPUFF II model. The following conclusions result from this additional analysis: (1) Predicted maximum 3-hour SO_2 concentrations at the Chassahowitzka PSD Class I area due to Ridge Generating Station (RGS) emissions are less than the National Park Service significant impact level of 0.48 $\mu g/m^3$. (2) Predicted maximum 24-hour SO_2 concentrations due to RGS emissions exceed the National Park Service significant impact level of 0.07 $\mu g/m^3$, but only on an infrequent basis. Furthermore, during the meteorological conditions when RGS emissions result in concentrations above the significant impact level, the cumulative predicted maximum 24-hour concentrations due to all PSD sources identified by DER are less than the PSD Class I increment. Therefore, RGS emissions neither cause nor contribute to a violation of the PSD Class I increment at the Chassahowitzka PSD Class I area.

MESO Explanation of infrequent basis

AIR QUALITY RELATED VALUES ANALYSIS

An air quality related values analysis is provided in Attachment B. The conclusions reached from this analysis are that the RGS project (1) will not diminish the national significance of the Chassahowitzka National Wilderness Area (which comprises the PSD Class I area), (2) will not impair the quality of the visitor experience at this area, and (3) will not impair the structure and functioning of the ecosystems within the area.

ATTACHMENT A

ADDITIONAL PSD CLASS I AREA AIR QUALITY MODELING ANALYSIS FOR RIDGE GENERATING STATION SULFUR DIOXIDE EMISSIONS

INTRODUCTION

The Chassahowitzka PSD Class I area impact analysis provided in the Ridge Generating Station (RGS) permit application involved use of the ISCST model. The ISCST model is a straight-line trajectory, steady-state Gaussian dispersion model that assumes meteorological conditions at the time of plume release will persist over the entire distance from the point of release to the receptors of interest. Over relatively short distances, the assumptions of the ISCST model are reasonably valid. The deficiencies of steady-state models for assessing impacts at more distant receptors are well recognized, however.

The RGS site is separated from the modeled receptors in the Chassahowitzka PSD Class I area by distances ranging from 100.5 to 119.0 km. The uncertainties in using the ISCST model at these great distances are such that the maximum PSD Class I SO_2 impacts presented in the application are expected to exceed actual impacts. To further assess PSD Class I impacts attributable to RGS SO_2 emissions, a modeling analysis has been performed using a combination of the ISCST model used previously and the MESOPUFF II model - a model specifically developed to estimate concentrations at distances of as much as 400 km from an emission source.

The MESOPUFF II portion of the additional modeling evaluation was conducted by Sigma Research Corporation under the direction of Mr. Joseph Scire. Mr. Scire was one of the original developers of the MESOPUFF II model and is experienced in its use. Attached is a technical report prepared by Sigma Research describing the method of applying MESOPUFF II and the results obtained from its use. Presented below is a discussion of the overall additional modeling evaluation using both ISCST and MESOPUFF II.

EVALUATION METHOD

General Approach

From the previous modeling evaluation based on the ISCST model, the determination was made that predicted maximum SO_2 concentrations due to RGS emissions are less than the PSD Class I area significant impact levels recommended by the U.S. Environmental Protection Agency (EPA). The National Park Service (NPS), however, has proposed lower significant impact levels for SO_2. The previous ISCST modeling evaluation demonstrated that maximum annual concentrations at the Chassahowitzka PSD Class I area due to RGS emissions are less than the proposed NPS annual average significant impact level but that predicted maximum 3-hour and 24-hour concentrations exceed the NPS proposed significant impact levels.

Accordingly, the first step in the additional modeling evaluation was to use the MESOPUFF II model to predict whether maximum 3-hour and 24-hour SO_2 concentrations due to RGS SO_2 emissions alone are still higher than the NPS levels. This step resulted in the finding that predicted maximum 3-hour concentrations are less than the National Park Service significant impact concentration of 0.48 $\mu g/m^3$ (see modeling results section below). Therefore, assessing the cumulative impact of other PSD sources on 3-hour concentrations is not necessary. Operation of the RGS project will not cause or contribute to a violation of the 3-hour SO_2 PSD Class I increment at the Chassahowitzka PSD Class I area.

The next step in the evaluation was to assess 24-hour impacts taking into account both RGS emissions and the emissions of other PSD sources in the general vicinity of the Chassahowitzka PSD Class I area. Based on an approach discussed with DER, this cumulative impact analysis pertains just to 24-hour periods in the modeled meteorological data set when a significant contribution (concentrations greater than or equal to 0.07 $\mu g/m^3$) due to RGS emissions is predicted using MESOPUFF II. Consideration of other periods is not necessary because RGS would not be a contributor under those meteorological conditions.

Emission Source Distance Consideration

In the 24-hour cumulative impact assessment, the ISCST model was used to estimate concentrations due to sources located less than 20 km from the Class I area, and the MESOPUFF II model was used to estimate concentrations from sources located 20 km or more from the Class I area. The results from the two models were then summed, as further discussed in the modeling results section below.

As mentioned in the introduction, results from the ISCST model become increasingly uncertain as the distance increases between the emission source and the points at which concentrations are calculated. The choice of 20 km as the distance at which to change from the ISCST model to another model is consistent with findings that show possible inaccuracies with the ISCST model at even closer distances. It is also consistent with the objective of assessing cumulative impacts when concentrations due to RGS emissions are "significant" as defined by the proposed NPS significant impact levels. Information obtained through DER indicates that the National Park Service accepts use of the MESOPUFF II model at distances of 20 km and greater.

Another important consideration in selecting a 20-km distance for application of the MESOPUFF II model relates to the location of the PSD sources in the inventory provided by DER. All but one of the 83 sources in this inventory (or 84 sources including RGS) are located at distances of 20 km or more from the Chassahowitzka PSD Class I area. Therefore, use of the MESOPUFF II model for sources starting at 20 km provides a much more consistent modeling approach than having to mix the results from the ISCST model for a large portion of the 84 sources with the results from the MESOPUFF II model for the remaining portion of the sources as would be the case if a greater distance criterion were used.

Modeling Options

In running the MESOPUFF II model, the dry deposition and chemical transformation options of the model were specified. The attached report from Sigma Research contains additional information on model options. The ISCST model was run in the standard regulatory default mode.

EMISSION SOURCE DATA

The initial emission source modeled was the RGS boiler. RGS emission source characteristics considered in the additional evaluation are the characteristics representing the maximum continuous rating (MCR) case. Previous evaluations had demonstrated that the MCR operating level produces higher PSD Class I impacts than either the 75 percent load level or the 50 percent load level. Specific RGS boiler emissions data evaluated with the MESOPUFF II model are as follows:

- SO_2 emission rate = 13.78 g/s (109.4 lb/hr)
- Stack height = 99.06 m (325 ft)
- Stack diameter = 3.05 m (10 ft)
- Exit temperature = 349.82 K (170 °F)
- Exit velocity = 14.54 m/s (48.1 ft/s)
- UTM coordinates = 416690 m E., 3100380 m N.

Data on PSD sources other than RGS were supplied by DER. These sources are listed in Table A-1, divided into two groups. One group consists of SO_2 sources (actually, only one source) located less than 20 km from the PSD Class I area and modeled with the ISCST model. The second group consists of those sources located 20 km or more from the PSD Class I area and modeled with the MESOPUFF II model. Note that the modeled emission source inventory consists of both increment-consuming sources and increment-expanding sources (baseline sources that have shut down or reduced emissions). Increment-expanding sources are denoted by a negative emission rate.

METEOROLOGICAL DATA

As discussed in the attached report, meteorological data from four surface stations (Tampa, Orlando, Gainesville, and Daytona Beach) and one upper air station (Tampa) were processed for use with MESOPUFF II. A detailed meteorological data base was modeled by considering an entire year of data for each of the surface stations and for the upper air station. The meteorological year selected for evaluation with MESOPUFF II is year 1986.

At the recommendation of DER, the meteorological data station selected for the ISCST portion of the modeling evaluation is Tampa (Tampa surface and Tampa upper air data). For consistency, 1986 data were used with the ISCST model as well.

RECEPTORS

The PSD Class I area receptors assessed in the additional modeling evaluation consist of 13 receptors specified by DER. The UTM coordinates of these receptors are shown in Table A-2.

MODELING RESULTS

Sulfur Dioxide 3-Hour Concentrations

The predicted maximum 3-hour concentration attributable to RGS emissions is 0.26 $\mu g/m^3$ as shown in Table A-3. This predicted maximum concentration is much less than the proposed NPS significant impact level of 0.48 $\mu g/m^3$. Therefore, no need exists to develop a cumulative SO_2 3-hour concentration impact analysis with other PSD sources considered.

Sulfur Dioxide 24-Hour Concentrations

Predicted highest 24-hour SO_2 concentrations attributable to RGS emissions exceed the proposed NPS significant impact level of 0.07 $\mu g/m^3$. However, 24-hour meteorological periods producing predicted "significant" concentrations are infrequent. Table A-4 shows that three days in the 1986 meteorological data set which produce significant concentrations. The predicted maximum 24-hour concentration due to RGS emissions alone is 0.09 $\mu g/m^3$.

A cumulative impact analysis was performed for the three meteorological periods when RGS emissions produce concentrations that equal or exceed the proposed NPS significant impact level. Modeling results for all 84 PSD sources (RGS plus 83 other sources) are presented in Tables A-5, A-6, and A-7 for each of these days. The "Total" concentration column in these tables is simply the sum of the MESOPUFF II concentration at a specific receptor plus the ISCST concentration at the same receptor.

The highest cumulative concentration at any receptor where RGS emissions produce a significant impact (as proposed by NPS) is 4.68 $\mu g/m^3$ which is less than the PSD Class I increment of 5 $\mu g/m^3$. Therefore, when RGS is a "contributor" to 24-hour SO_2 concentrations at the Chassahowitzka PSD Class I area, compliance with the PSD Class I increment is predicted.

CONCLUSION

Based on the additional modeling evaluation described in this attachment, SO_2 emissions from the proposed RGS boiler will neither cause nor contribute to a violation of PSD increments within the Chassahowitzka PSD Class I area.

TABLE A-1
EMISSION SOURCES CONSIDERED
IN THE ADDITIONAL PSD CLASS I
MODELING EVALUATION

I. Sources Less than 20 Kilometers from Chassahowitzka PSD Class I Area (modeled with ISCST model)

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
22	1.45	356200	3169900	27.40	470.2	7.48	4.88

(continued on next page)

II. Sources Greater than or Equal to 20 Kilometers from Chassahowitzka PSD Class I Area (modeled with MESOPUFF II model)

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
RGS[a]	13.78	416690	3100380	99.06	349.82	14.54	3.05
9900200	466.4	467500	3197200	15.24	819.8	56.21	4.21
9900500	310.9	446300	3126000	15.24	819.8	56.21	4.21
9900800	276.1	446300	3126000	15.24	880.8	32.07	7.04
1	98.4	360008	3162398	97.6	442.0	23.23	4.88
6	-50.4	388000	3116000	60.35	353.0	16.40	2.44
7	54.6	388000	3116000	60.35	353.0	17.77	2.44
9	-50.4	388000	3116000	60.35	353.0	16.40	2.44
10	54.6	388000	3116000	60.35	353.0	17.77	2.44
30	654.7	361900	3075000	149.4	342.2	19.81	7.32
31	-2436.0	361900	3075000	149.4	422.0	28.65	7.32
33	-1218.0	361900	3075000	149.4	418.0	14.33	7.32
40	14.1	347100	3139200	83.82	394.3	15.70	3.05
46	1008.8	334200	3204500	182.90	398.0	21.00	6.90
47	1008.0	334200	3204500	182.90	398.0	21.00	6.90
48	-314.0	334200	3204500	152.00	422.0	42.10	4.57
49	-1859.0	334200	3204500	153.00	422.0	42.10	4.88
50	105.4	483500	3150600	167.60	325.7	21.60	5.80
51	242.4	483500	3150600	167.60	324.2	23.50	5.80
52	32.1	460100	3129300	18.30	422.0	38.00	3.66

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
53	277.6	404800	3057400	22.90	389.0	23.90	4.88
54	-52.07	325600	3116700	49.00	293.0	3.60	1.20
55	500.1	408500	3105800	76.20	350.0	19.70	4.88
56	21.4	368200	3092700	50.00	491.0	18.30	1.80
57	62.24	335300	3084400	49.10	522.0	27.72	2.74
61	0.2	383300	3135800	12.30	466.2	9.20	0.40
70	2.25	361400	3168400	8.50	357.4	10.95	1.08
71	2.25	359900	3162400	12.20	377.0	10.58	1.37
90	29.11	409185	3102754	30.48	783.2	28.22	5.79
91	-170.1	396600	3078900	61.00	350.0	14.28	2.60
92	182.85	396600	3078900	61.00	350.0	15.31	2.60
93	121.9	396600	3078900	60.70	350.0	15.31	2.60
94	5.54	396600	3078900	36.60	319.1	20.15	1.83
101	5.04	385600	3139000	30.48	384.3	17.13	3.35
102	5.04	434000	3198800	30.48	384.3	17.13	3.35
111	-110.6	408500	3083000	30.50	350	14.60	1.68
112	4.30	408500	3083000	9.10	450	22.50	0.70
113	52.90	408500	3083000	67.10	351	9.80	2.40
114	21.02	361800	3088300	30.00	375	20.00	0.61
115	-15.20	398400	3084200	30.50	308	18.90	1.80
116	42.00	398400	3084200	45.70	352	10.30	2.30
117	-54.56	409500	3079500	30.48	311	20.18	1.37

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
118	67.16	409500	3079500	30.48	355	9.27	2.29
119	41.96	409500	3079500	45.72	355	9.65	2.44
120	18.40	389550	3067930	38.10	339	10.13	2.90
121	21.17	389550	3067930	38.10	346	18.40	2.44
128	63.00	396560	3078640	60.70	350	15.55	2.60
129	3.78	396750	3079350	52.40	322	13.00	2.40
130	5.36	396830	3079430	52.40	319	7.10	2.40
131	5.54	396450	3079150	36.60	319	20.80	1.80
132	63.00	396490	3078640	60.70	350	15.55	2.60
133	-34.27	396680	3078860	21.04	347	18.56	2.13
134	-146.00	396530	3078750	61.00	350	11.14	2.50
135	189.00	396530	3078750	61.00	350	16.71	2.50
136	-257.60	406700	3085200	51.00	356	9.90	2.13
137	35.70	406700	3085200	61.00	360	12.20	2.13
140	63.00	416120	3068620	53.40	355	15.91	2.59
141	63.00	416120	3068620	53.40	355	15.91	2.59
142	-78.80	416210	3068740	29.00	314	6.77	3.02
143	-216.00	409700	3086000	45.70	352	16.50	1.40
144	73.60	409700	3086000	61.00	346	7.30	2.80
145	72.00	409500	3086500	61.00	347	28.40	1.52
147	-196.30	363400	3082400	22.60	322	19.50	1.52
148	-50.71	363400	3082400	45.70	355	9.20	2.29

DER Source Number	SO_2 Emission Rate (g/s)	UTM East Coordinate (m)	UTM North Coordinate (m)	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
149	36.75	363400	3082400	45.70	355	9.20	2.29
150	0.60	394800	3067720	8.20	505	7.57	0.41
151	16.35	394850	3069770	30.50	334	7.26	1.82
152	13.40	389500	3068000	38.10	339	15.20	2.44
153	30.64	414700	3080300	13.70	330	40.40	1.22
154	2.44	398290	3084290	25.90	339	15.20	2.29
250	2.99	382200	3166100	9.14	478	4.57	0.61
260	0.82	386700	3155800	10.67	327	8.99	1.83
270	2.09	359800	3164900	7.62	347	6.29	1.83
280	0.23	340600	3119200	12.2	339	6.47	3.05
290	3.67	355900	3143700	9.14	408	16.0	1.30
300	0.06	331200	3124500	10.98	544	3.88	0.31
310	0.03	331200	3124500	10.98	544	3.88	0.31
320	0.08	333400	3141000	10.98	533	4	0.31
330	0.08	333400	3141000	10.98	533	4	0.31
340	7.25	340700	3119500	9.14	436	22.3	1.40
350	3.54	390300	3129400	6.1	422	21	1.38
400	-75.6	407500	3071300	45.73	350	26.4	1.6
410	113.5	407500	3071300	45.73	350	39.06	1.6

[a] Ridge Generating Station

TABLE A-2

UTM COORDINATES OF CHASSAHOWITZKA PSD CLASS I AREA RECEPTORS

Receptor	East UTM Coordinate (m)	North UTM Coordinate (m)
1	340300	3165700
2	340300	3167700
3	340300	3169800
4	340700	3171900
5	342000	3174000
6	343000	3176200
7	343700	3178300
8	342400	3180600
9	341100	3183400
10	339000	3183400
11	336500	3183400
12	334000	3183400
13	331500	3183400

TABLE A-3

PREDICTED MAXIMUM 3-HOUR SULFUR DIOXIDE CONCENTRATION AT THE CHASSAHOWITZKA PSD CLASS I AREA ATTRIBUTABLE TO RIDGE GENERATING STATION (RGS) EMISSIONS

Predicted Maximum 3-Hour Concentration[a] ($\mu g/m^3$) and Associated Meteorological Period
0.26 (Day 343, Ending Hour 6)

[a] "Significant" concentration is 0.48 $\mu g/m^3$ as proposed by the National Park Service.

TABLE A-4

PREDICTED "SIGNIFICANT" 24-HOUR SULFUR DIOXIDE CONCENTRATIONS AT THE CHASSAHOWITZKA PSD CLASS I AREA ATTRIBUTABLE TO RIDGE GENERATING STATION EMISSIONS

Predicted Concentrations ($\mu g/m^3$) and Associated Meteorological Day
0.08 (Day 282)
0.09 (Day 332)
0.08 (Day 333)

NOTE: "Significant" concentration is 0.07 $\mu g/m^3$ as proposed by the National Park Service.

TABLE A-5

PREDICTED CUMULATIVE 24-HOUR SULFUR DIOXIDE CONCENTRATIONS ON DAYS WHEN RIDGE GENERATING STATION (RGS) EMISSIONS PRODUCE A "SIGNIFICANT" CONTRIBUTION

(concentrations in $\mu g/m^3$)

Meteorological Period: Day 282

Receptor	Contribution from Sources ≥20 km from PSD Class I Area[a] (Modeled with MESOPUFF II)	Contribution from Sources <20 km from PSD Class I Area (Modeled with ISCST)	Total	Contributions from RGS Emissions Alone
1	3.01	0.04	3.05	0.075
2	3.29	0.00	3.29	0.073
3	3.59	0.00	3.59	0.070
4	b	b	b	0.067
5	b	b	b	0.063
6	b	b	b	0.059
7	b	b	b	0.055
8	b	b	b	0.053
9	b	b	b	0.050
10	b	b	b	0.052
11	b	b	b	0.053
12	b	b	b	0.054
13	b	b	b	0.055

a Includes RGS emissions.

b RGS contribution is less than proposed National Park Service significant impact level at this receptor.

TABLE A-6

PREDICTED CUMULATIVE 24-HOUR SULFUR DIOXIDE CONCENTRATIONS ON DAYS WHEN RIDGE GENERATING STATION (RGS) EMISSIONS PRODUCE A "SIGNIFICANT" CONTRIBUTION
(concentrations in $\mu g/m^3$)

Meteorological Period: Day 332

Receptor	Contribution from Sources ≥20 km from PSD Class I Area[a] (Modeled with MESOPUFF II)	Contribution from Sources <20 km from PSD Class I Area (Modeled with ISCST)	Total	Contributions from RGS Emissions Alone
1	3.84	0.03	3.87	0.088
2	3.60	0.02	3.62	0.088
3	3.80	0.03	3.83	0.087
4	4.32	0.04	4.36	0.086
5	4.28	0.06	4.34	0.084
6	4.30	0.13	4.43	0.084
7	4.43	0.02	4.45	0.084
8	4.51	0.01	4.52	0.083
9	4.62	0.01	4.63	0.082
10	4.67	0.01	4.68	0.083
11	4.54	0.01	4.55	0.085
12	4.38	0.01	4.39	0.088
13	4.33	0.03	4.36	0.091

[a] Includes RGS emissions.

TABLE A-7

PREDICTED CUMULATIVE 24-HOUR SULFUR DIOXIDE CONCENTRATIONS ON DAYS WHEN RIDGE GENERATING STATION (RGS) EMISSIONS PRODUCE A "SIGNIFICANT" CONTRIBUTION
(concentrations in $\mu g/m^3$)

Meteorological Period: Day 333

Receptor	Contribution from Sources ≥20 km from PSD Class I Area[a] (Modeled with MESOPUFF II)	Contribution from Sources <20 km from PSD Class I Area (Modeled with ISCST)	Total	Contributions from RGS Emissions Alone
1	b	b	b	0.032
2	b	b	b	0.031
3	b	b	b	0.030
4	b	b	b	0.029
5	b	b	b	0.026
6	b	b	b	0.026
7	b	b	b	0.026
8	b	b	b	0.028
9	b	b	b	0.031
10	b	b	b	0.038
11	b	b	b	0.050
12	b	b	b	0.065
13	1.22	0.01	1.23	0.081

[a] Includes RGS emissions.

[b] RGS contribution is less than proposed National Park Service significant impact level at this receptor.

ATTACHMENT B

CHASSAHOWITZKA PSD CLASS I AREA AIR QUALITY RELATED VALUES ANALYSIS FOR RIDGE GENERATING STATION

INTRODUCTION

The proposed Ridge Generating Station (RGS) is located approximately 100 km from the closest point in the Chassahowitzka prevention of significant deterioration (PSD) Class I area. Based on estimated emissions from the RGS boiler at maximum continuous rating, the facility will be a "significant" emission source (as defined by PSD regulations) for sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, particulate matter, lead, and beryllium.

Although any additional increase in pollutant levels resulting from a specific emission source could theoretically have some effect on air quality related values (AQRV's), recognition of the magnitude of an expected increase is still an important consideration. The highest predicted sulfur dioxide concentration increases at the Chassahowitzka PSD Class I area due to RGS emissions are a 3-hour concentration of 0.26 $\mu g/m^3$ (0.000099 ppm), a 24-hour concentration of 0.09 $\mu g/m^3$ (0.000034 ppm), and an annual average concentration of 0.01 $\mu g/m^3$ (0.0000038 ppm). Predicted concentration increases for other pollutants emitted in significant amounts is similarly low. For example, the highest predicted annual average nitrogen dioxide concentration increase due to RGS emissions is 0.01 $\mu g/m^3$ (0.0000053 ppm). Simply on the face of these small predicted concentration increases, no adverse effect on AQRV's would be expected as result of Ridge Generating Station operation. This conclusion is supported by the following AQRV's evaluation which considers effects on vegetation, soils, wildlife, and visibility.

CHARACTERISTICS OF THE CHASSAHOWITZKA PSD CLASS I AREA

The Chassahowitzka PSD Class I area is defined by the boundaries of the Chassahowitzka National Wilderness Area (NWA). The Chassahowitzka NWA comprises most but not all of the Chassahowitzka National Wildlife Refuge. Pertinent air quality, vegetation, soils, and wildlife characteristics of the Chassahowitzka NWA are as follows:

Existing and Projected Ambient Sulfur Dioxide Levels -- No ambient monitoring stations are located at the Chassahowitzka PSD Class I area. To obtain an approximation of SO_2 levels in this area, monitoring data summarized in DER's annual reports for 1989 and 1990 were reviewed. Second highest 3-hour and 24-hour concentrations were considered for evaluation of short-term concentration. For the entire state of Florida including metropolitan and industrialized areas, measured concentrations are typically well below ambient standards. At the two monitoring stations in Citrus County, which are the stations closest to the Chassahowitzka PSD Class I area, second highest 3-hour concentrations ranged from 85 to 248 $\mu g/m^3$ in 1989 and 1990, and second highest 24-hour concentrations ranged from 18 to 64 $\mu g/m^3$. Annual means ranged from 4 to 7 $\mu g/m^3$. By comparison, the national ambient air quality standards are a 3-hour standard of 1,300 $\mu g/m^3$ (0.5 ppm), a 24-hour standard of 365 $\mu g/m^3$ (0.14 ppm), and an annual average standard of 80 $\mu g/m^3$ (0.03 ppm).

New emission sources can, of course, add to current levels. However, based on discussions with DER about recent permit application modeling results for projects in central Florida, potential SO_2 concentration increases at the Chassahowitzka PSD Class I area due to proposed new sources are at the PSD Class I increments level - that is, 3- hour concentrations less than 25 $\mu g/m^3$ and 24-hour concentrations less than 5 $\mu g/m^3$. Therefore, even with proposed new sources considered, current short-term SO_2 concentrations at the Chassahowitzka PSD Class I area are expected to be on the order of 300 $\mu g/m^3$ (0.11 ppm) or less for 3-hour averages, and on the order of 70 $\mu g/m^3$ (0.03 ppm) or less for 24-hour averages. Annual mean concentrations are expected to be less than 10 $\mu g/m^3$ (0.004 ppm). These levels are far below national ambient standards.

Existing Ambient Levels of Other Pollutants -- Based on 1989 and 1990 Florida ambient monitoring data for nitrogen dioxide, carbon monoxide, particulate matter, and lead, concentrations of these pollutants at the Chassahowitzka PSD Class I area should be below ambient standards. However, monitoring data specific to Chassahowitzka are not available.

Vegetation -- Vascular species that are typical of central Florida Gulf coastal areas like the Chassahowitzka NWA include tree species such as slash pine, laurel oak, live oak, sweetgum, and red maple; shrubs such as sawtooth palm, gallberry, and yaupon holly; and other plants such as black and soft needle rush, maiden cane, and red mangrove. Non-vascular vegetation species would include mosses and lichens.

Soils -- The characteristic soils in the Chassahowitzka NWA can be generally classified as sulfihemist soils. Such soils are dominantly organic and contain sulfidic materials within 1 meter of the surface. Based on soil survey data for Citrus and Hernando Counties (U.S. Department of Agriculture, 1991a and 1991b), the sulfur content of this upper soil layer can range up to 4 percent.

Wildlife -- The terrestrial wildlife species expected to be present in the Chassahowitzka NWA are the species common to the central Florida Gulf Coast. These include mammals such as white-tailed deer and raccoons, amphibians such as southern toads and leopard frogs, reptiles such as rat snakes and box turtles, and a variety of birds.

VEGETATION EFFECTS

Sulfur Dioxide

As DER is aware, the literature on vegetation effects from SO_2 exposure is extensive. Rather than trying to select and summarize specific studies that may be most pertinent to vegetation species in the Chassahowitzka NWA, reference can be made to a U.S. Environmental Protection Agency (EPA) review of the 3-hour secondary SO_2 ambient air quality standard established to protect against adverse vegetation effects. This review (found in the 4/26/88 edition of the *Federal Register*, 53 FR 14926) was included in EPA's proposal to retain the current 3-hour standard of 1,300 $\mu g/m^3$ (0.5 ppm). The following is an excerpt from the summary (p. 14931). In this excerpt, CD stands for criteria document (U.S. Environmental Protection Agency, 1982a), SP stands for staff paper (U.S. Environmental Protection Agency, 1982b), and CASAC stands for Clean Air Scientific Advisory Committee.

> "The basis for the existing 3-hour secondary standard rests on studies documenting acute effects on sensitive plants (38 FR 25678; September 1973). The effects of concern include reduced growth and yield, and foliar injury. The staff assessment of the greatly expanded scientific data base as summarized in the criteria document (CD, Chapter 7) found even stronger support for the 3-hour standard (SP, pp. 108-112). As a result of this most recent review, both staff and CASAC recommended retaining a 3-hour standard at or slightly below the level of the current standard (0.5 ppm)(SP, p. 126). CASAC pointed out that evidence suggesting effects at lower levels is very uncertain (SP, Appendix E, p. 8)."

While recognizing that some studies have indicated adverse vegetation effects on sensitive species at concentrations below the current 3-hour ambient air quality standard, information as summarized in the EPA statement above suggests that concentrations on the order of the 3-hour standard are protective. (For example, a CASAC letter attached to the EPA staff paper recommends that the 3-hour standard be limited to the range 0.4 to 0.5 ppm if the standard were revised.) Since current short-term concentrations in the Chassahowitzka PSD Class I area are estimated to be far below the ambient standard, no reason exists to expect that vegetation species are under stress due to SO_2 exposures. Furthermore, the extremely small increase in SO_2 concentrations predicted to result from RGS emissions will not alter current conditions. Therefore, SO_2 emissions from the RGS project are not expected to create or contribute to adverse impacts on vegetation.

Nitrogen Oxides

With respect to short-term (acute) exposures, data from a variety of experiments on crops and native plants indicate that nitrogen dioxide exposures less than 1,880 $\mu g/m^3$ (1.0 ppm) for one hour have not caused adverse effects (Taylor and Eaton, 1966; Tingey and others, 1971; Taylor and others, 1975; U.S. Environmental Protection Agency, 1982c). Current NO_2 ambient levels at the Chassahowitzka PSD Class I area combined with the minor increase in concentrations due to RGS emissions are expected to be far below this level. Therefore, no acute adverse vegetation impacts are expected to result from RGS NO_x emissions.

Long-term (chronic) exposures to high levels of NO_2 can result in such adverse effects as inhibition of photosynthesis and reduced yield. Ashenden and Mansfield (1978) found that an NO_2 concentration of 207 $\mu g/m^3$ (0.11 ppm) for 103 hours per week over a period of 20 weeks reduced yields of several turf grasses. Other studies (Taylor and others, 1975; U.S. Environmental Protection Agency, 1982c) indicate that yield effects are unlikely to occur in most crops at levels below 470 $\mu g/m^3$ (0.25 ppm). Since these values are far above the national ambient air quality standards and even further above the Chassahowitzka PSD Class I area concentration levels likely to exist after RGS begins operating, no long-term adverse effects on vegetation are expected to result from RGS NO_x emissions.

Ozone

Nitrogen oxides and volatile organic compounds, which are ozone precursors, will be emitted from the RGS facility in significant amounts. However, compared to current ozone precursor emission levels in central Florida (including the metropolitan areas of Tampa-St. Petersburg, Orlando, and the Lakeland area) that could affect the Chassahowitzka PSD Class I area, RGS emissions will be minor. Accordingly, the effect of RGS emissions on Chassahowitzka PSD Class I area ozone concentrations and related vegetation impacts should be negligible.

Other Significant Pollutants

The other significant pollutants that will be emitted from the RGS facility are carbon monoxide, particulate matter, lead, and beryllium. The potential for phytotoxic effects from these emissions at the distance of the Chassahowitzka PSD Class I area is negligible.

SOILS EFFECTS

Sulfur Dioxide

As discussed above, the dominant soils of the Chassahowitzka PSD Class I area are naturally high in sulfur content. The additional sulfur deposition resulting from RGS emissions would be negligible by comparison. In addition, tidal effects and the flushing effect of storms and tributary inflow further reduce the chances of soil sulfur level increases resulting from RGS emissions. Therefore, Chassahowitzka NWA soil composition properties and soil organism makeup should be unaffected by the proposed project.

Other Significant Pollutants

Deposition of other significant pollutants emitted by RGS are not expected to affect the existing soil characteristics of the Chassahowitzka PSD Class I area. This is especially true for lead and beryllium since these metals will be emitted in such small amounts.

WILDLIFE EFFECTS

Sulfur Dioxide

Total levels of sulfur dioxide within the Chassahowitzka PSD Class I area are expected to be well below those levels producing direct adverse toxicological effects on animals. More to the point, as discussed for vegetation, is the incremental effect of RGS emissions. The extremely small increase in concentrations predicted to resulting from RGS SO_2 emissions is highly unlikely to produce an observable effect on wildlife. A similar conclusion can be reached regarding indirect effects on wildlife that might result from damage to vegetation habitat. That is, no adverse impact on wildlife habitat should result from RGS emissions and, consequently, no indirect adverse effect on wildlife.

Other Significant Pollutants

The conclusions for sulfur dioxide also apply to the other significant pollutants.

VISIBILITY EFFECTS

The potential effect of RGS boiler emissions on visibility conditions within the Chassahowitzka PSD Class I area is assessed in Section 7.0 of the permit application. Based on a conservative screening modeling approach, RGS emissions are highly unlikely to produce an adverse visibility impact.

CONCLUSION

Based on this evaluation of air quality related values consisting of effects on vegetation, soils, wildlife, and visibility, significant pollutant emissions from the proposed RGS boiler are not expected to produce adverse impacts within the

Chassahowitzka PSD Class I area. Restated in terms of the PSD Class I adverse impact guidelines developed by the Assistant Secretary for Fish and Wildlife and Parks (see, for example, 57 FR 4465, 2/5/92), the RGS project (1) will not diminish the national significance of the Chassahowitzka NWA, (2) will not impair the quality of the visitor experience, and (3) will not impair the structure and functioning of the ecosystems with the Chassahowitzka NWA.

REFERENCES

Ashenden, T.W., and T.A. Mansfield, 1978. Extreme pollution sensitivity of grasses when SO_2 and NO_2 are present in the atmosphere together. Nature, Vol. 273, p. 142-143.

Taylor, O.C. and F.N. Eaton, 1966. Suppression of plant growth by nitrogen dioxide. Plant Physiology, Vol. 41, p. 132-135.

Taylor, O.C., C.R. Thompson, D.T. Tingey, and R.A. Reinert, 1975. Oxides of nitrogen. In J.B. Mudd and T.T. Kozlowski (eds.), Responses of Plants to Air Pollution, Academic Press, Inc., p. 121- 139.

Tingey. D.T., R.A. Reinert, J.A. Dunning, and W.W. Heck, 1971. Vegetation injury form the interaction of nitrogen dioxide and sulfur dioxide. Phytopathology, Vol. 61, p. 1506-1511.

U.S. Department of Agriculture, 1991a. Survey of Citrus County, Florida. Soil Conservation Service in cooperation with University of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Stations and Soil Science Department.

U.S. Department of Agriculture, 1991b. Survey of Hernando County, Florida. Soil Conservation Service in cooperation with University of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Stations and Soil Science Department.

U.S. Environmental Protection Agency, 1982a. Air quality criteria for particulate matter and sulfur dioxides (three volumes). Office of Research and Development, EPA-600/8-82-029af-cf.

U.S. Environmental Protection Agency, 1982b. Review of the national ambient air quality standards for sulfur oxides: assessment of scientific and technical information; OAQPS staff paper. Office of Air Quality Planning and Standards, EPA-450/5-82-007.

U.S. Environmental Protection Agency, 1982c. Air quality criteria for oxides of nitrogen; final report. Environmental Criteria and Assessment Office.

Class I Impact Analysis of the Ridge Generating Station and Background PSD Sources at the Chassahowitzka National Wilderness Area in Florida

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Final Report

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1. INTRODUCTION

The proposed Ridge Generating Station (RGS) is located near the city of Lakeland, Florida between Orlando and Tampa. Initial modeling of the RGS conducted by Dames & Moore with the Industrial Source Complex Short Term (ISCST) model predicted maximum 24-hour and 3-hour average SO_2 concentrations at receptors in the Chassahowitzka National Wilderness Area PSD Class I area due to the RGS which were greater than the 24-hour and 3-hour SO_2 significance limits of 0.07 $\mu g/m^3$ and 0.48 $\mu g/m^3$, respectively, proposed by the National Park Service.

The Chassahowitzka Class I area is located a minimum of 100 km to the northwest of the RGS along the Gulf of Mexico coast of Florida. The limitations of straight-line trajectory models such as ISCST which assume steady-state meteorological conditions over the entire travel path of plume are well known. Over source-receptor distances of 10-50 km, the spatial and temporal variability in transport winds and other meteorological fields can have a significant effect in determining plume trajectories and dispersion rates. In addition, as distance increases, chemical transformation and pollutant removal mechanisms become increasingly important for reactive and soluble pollutants such as SO_2.

The MESOPUFF II model (Scire et al., 1984a) is a Lagrangian variable-trajectory puff superposition model suitable for transport distances beyond the range of conventional steady-state Gaussian plume models (i.e., beyond about 10 to 50 km). MESOPUFF II is listed in Appendix B and Supplement B (draft) of the *Guideline on Air Quality Models (Revised)* (EPA, 1986 and EPA, 1991) as a model which may be applied on a case-by-case basis for long-range transport problems. In the current study, MESOPUFF II was used to obtain more refined estimates of short-term average SO_2 concentrations at the Chassahowitzka Class I area due to emissions from the RGS and other background increment-consuming and increment-expanding PSD sources in the area.

2. OVERVIEW OF MESOPUFF II

As illustrated in Figure 1, the MESOPUFF II model is one element of a modeling package which includes components for processing meteorological data and postprocessing predicted concentration results. The various programs in the modeling system are:

READ56/READ62 reads and processes twice-daily upper air wind and temperature data. READ62 is a modified version of READ56 which accommodates the new TDF-6200 upper air data format used by the National Climatic Data Center (NCDC). READ62 was used in the current study.

MESOPAC II is the meteorological model which computes time-varying and space-varying fields of meteorological variables (e.g., transport winds, mixing heights). The fields produced by MESOPAC II include hourly, gridded winds at two levels: a lower layer representing flow within the atmospheric boundary layer and an upper layer representing flow above the boundary layer.

MESOPUFF II is the Gaussian dispersion modeling component of the modeling system. MESOPUFF II contains modules accounting for plume transport, diffusion, chemical transformation, wet removal, and dry deposition. In the current analysis, wet removal effects were not considered.

MESOFILE II is a postprocessing program which time averages the concentrations produced by MESOPUFF II. It was used to compute 3-hour and 24-hour averaged SO_2 concentrations at discrete receptors in the Chassahowitzka Class I area.

2.1 Program Modifications

Several modifications were made to the MESOPUFF II model in order to accommodate its use on a 486 PC computer with a large number of sources and

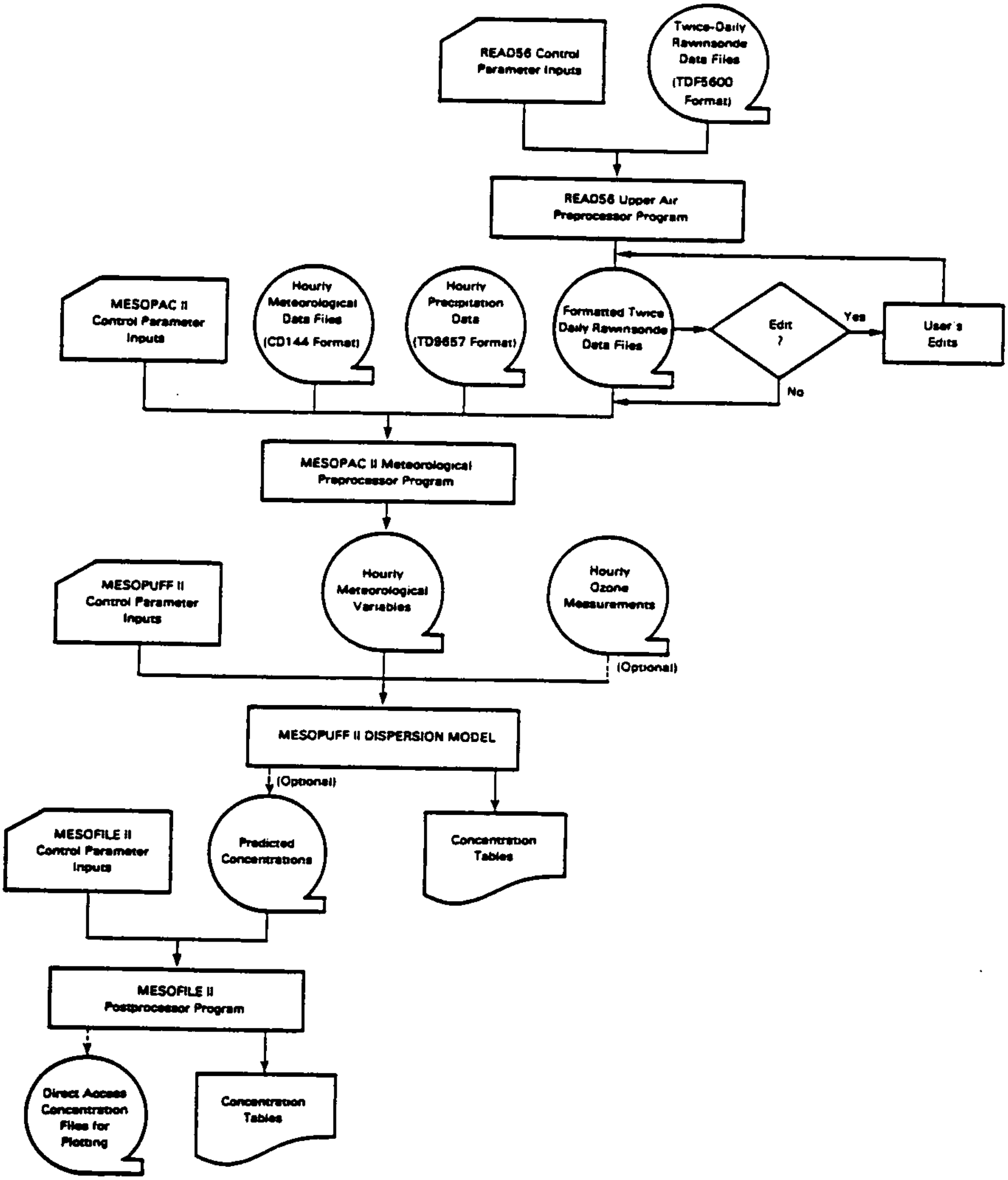

Figure 1. Major Components of the MESOPUFF II Modeling Package.

to avoid computational problems associated with divide by zero errors for variables with no minimum values.

- The dimensions of all arrays relating to the maximum number of puffs were increased from 500 to 8,000.

- Fortran subroutines to compute the error function (ERF) and the difference of two error functions (ERFDIF) were implemented into the MESOPUFF II sampling routine (SAMPLE).

- Small, minimum values were assigned to certain variables which were used in the denominator of equations and which otherwise were allowed to have zero values. These changes were made to avoid divide by zero runtime errors.
  -- SUBR. PRISE - replaced the variable "U" in the denominator of the unstable plume rise equation with the variable "UU", which has a minimum value assigned to it.
  -- SUBR. DEPVEL - set a minimum value of $1x10^{-30}$ for the surface friction velocity (u_*).
  -- MAIN program - set a minimum value of 1 meter for the absolute value of the Monin-Obukhov length (L).

- Several minor modifications were made to the output format to improve the readability of the output listing.

A call to the Lahey Fortran UNDERO subroutine was added to all programs in order to properly treat very small numbers (i.e., $< \sim 10^{-38}$). In addition, the location in the code of the list file write statements in SUBR. ADD2 of the MESOFILE II postprocessor were moved from outside the time loop to within the time loop. This change corrected an error which prevented all except the last time period to be printed in the output list file.

The MESOPAC II program was modified to restrict mixing heights to a maximum height of 3000 m. This change is necessary because the model requires that the mixed-layer height not exceed the height of the 700-mb level when the default wind options are used.

3. TECHNICAL APPROACH

The purpose of the current study was to develop more refined estimates of the maximum 3-hour and 24-hour SO_2 concentrations due to emissions from the RGS at the Chassahowitzka National Wilderness Area and, during periods for which the RGS contributions were predicted to be above proposed NPS "significance limits", to assess the cumulative net impact of emissions from other PSD sources in the region. The study was designed to assess whether emissions from the RGS will cause or contribute to an exceedance of the PSD Class I increment at the Chassahowitzka Class I area.

The RGS and other background PSD sources were modeled with MESOPUFF II for the one year period, 1986. The year selected was based on previous modeling with ISCST for the five year period (1982-1986) conducted by Dames & Moore. The year 1986 was predicted by ISCST to have the highest 24-hour contributions from RGS at the Class I area. (The 24-hour averaging period is the limiting averaging period in this case.)

The approach used with MESOPUFF II was to first model emissions from the RGS alone in order to determine those time periods when the RGS contribution at any receptors within the Chassahowitzka Class I area were above the proposed NPS 3-hour and 24-hour SO_2 significance limits of 0.48 $\mu g/m^3$ and 0.07 $\mu g/m^3$, respectively. A total of 82 other background PSD sources were also modeled with MESOPUFF II for the one year period. During periods when the RGS contribution exceeded the significance limits at a particular receptor, the net predicted contribution of background PSD sources were added to the RGS concentration in order to determine the total cumulative impact for comparison to Class I PSD increment standards. The sources modeled with MESOPUFF II are located at distances of 20 km or more from the Class I area receptors. An additional source located closer to the Class I area was modeled with ISCST.

As indicated in Figure 1, several steps are involved in performing the modeling. In Section 3.1, the development of the meteorological grid and preparation of the meteorological data fields are described. Section 3.2 describes the technical options and model inputs used in the MESOPUFF II simulations.

3.1 Meteorological Data Processing

Meteorological Grid System

A meteorological grid of 25 x 30 grid cells with a 10 km grid size was developed for the MESOPUFF II modeling. The domain allows the RGS source, the Chassahowitzka Class I area, and all of the background sources to be included within the modeling region with a buffer zone of at least three grid cells (30 km) from any source or receptor to the nearest boundary. The meteorological grid is shown in Figure 2.

Meteorological Data

Meteorological data from all the Class I National Weather Surface (NWS) stations within the modeling domain were used in the MESOPAC II modeling. The four surface meteorological stations used were Tampa, Orlando, Gainesville, and Daytona Beach. These stations all include hourly surface observations. Twice-daily upper air data from Tampa were also used. Figure 2 shows the location of the meteorological stations (TAMP, ORLD, GAIN, and DAYT) along with the RGS and receptors within the Class I area (X). Meteorological station information is summarized in Table 1.

The 1986 surface data from the Tampa station was obtained in CD144 format. The data from the other surface stations were downloaded from the U.S. EPA modeling bulletin board. Because MESOPAC II requires two parameters (station pressure, relative humidity) which are in the CD144-type records but not in the compressed EPA bulletin board format, the values of station pressure and relative humidity from Tampa were used throughout the grid. This was accomplished by substituting the Tampa pressure and relative humidity values into the appropriate blank fields in the Orlando, Gainesville, and Daytona Beach data records. MESOPUFF II is only weakly sensitive to station pressure and relative humidity, so this approach is considered appropriate for the domain of interest in the current application.

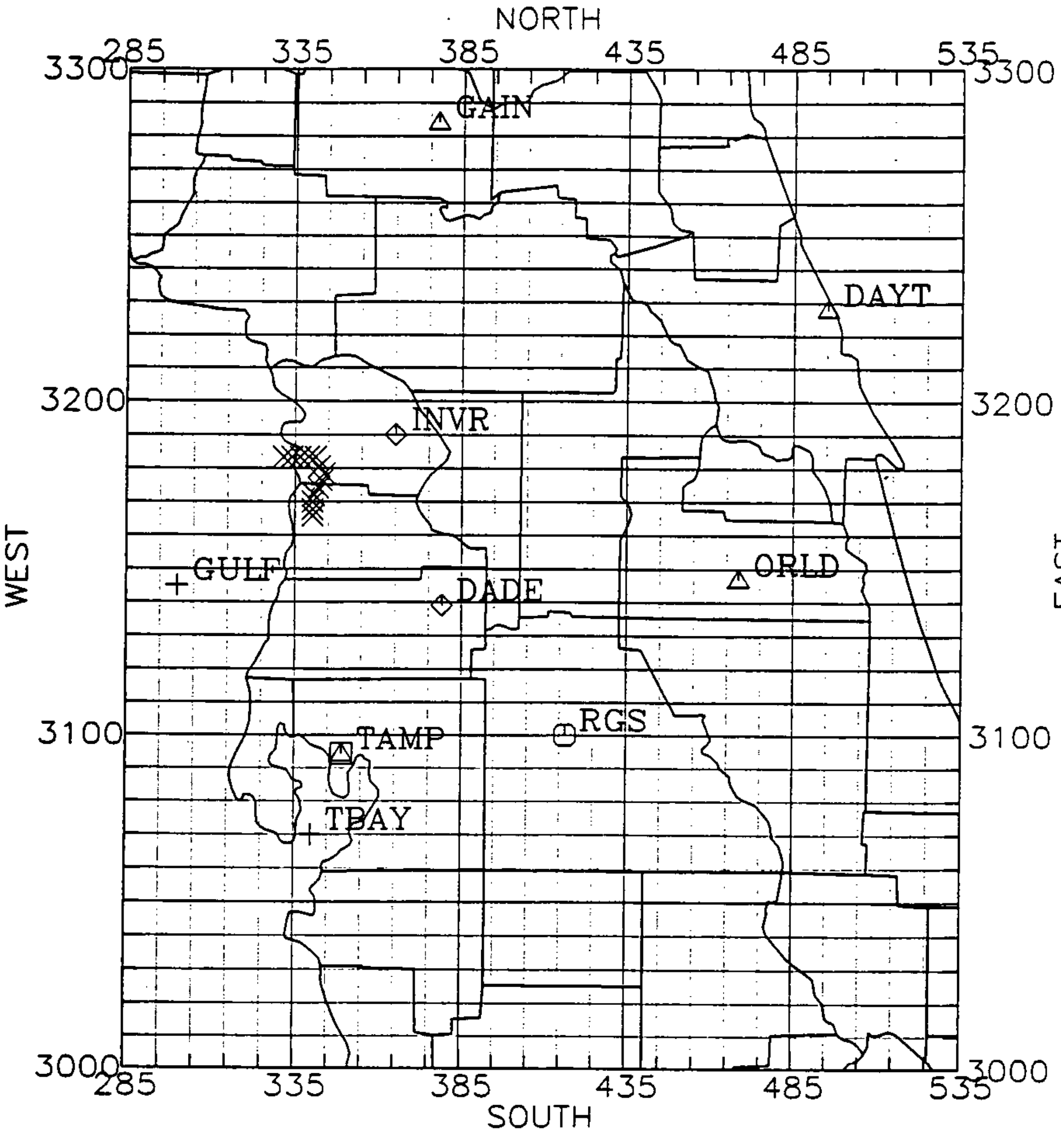

Figure 2. Meteorological Grid System (25 x 30) used in the MESOPUFF II modeling. Grid size is 10 km. (Meteorological stations: TAMP = Tampa, ORLD = Orlando, GAIN = Gainesville, DAYT = Daytona Beach; RGS = Ridge Generating Station; X = Chassohowitzka Class I area receptors).

Table 1

Meteorological Station Data

Station Name	Type	Station ID	Meteorological Grid Coordinate* X	Y	Latitude (deg.)	Longitude (deg.)
Tampa	surface	12842	7.40	10.50	27.97	82.53
Orlando	surface	12815	19.40	15.70	28.45	81.32
Gainesville	surface	12816	10.20	29.40	29.68	82.27
Daytona	surface	12834	22.00	23.80	29.18	81.05
Tampa	upper air	12842	7.40	10.50	27.97	82.53

* Meteorological grid coordinate (1,1) corresponds to UTM coordinate (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

The upper air data from Tampa were obtained from the NCDC in TDF-6200 data format. READ62 was executed using the following missing data control options: LHT = T, LTEMP = F, LWD = F, LWS = F. These options will eliminate a pressure level if the height field is missing, but retain the level if the temperature, wind speed, or wind direction is missing. Missing values of temperature or winds were interpolated from valid values in adjacent levels in order to provide a complete data set. The data from the surface to the 500 mb pressure level were extracted from the TDF-6200 data file by READ62.

READ62 identifies periods with missing or duplicate sounding data. Duplicate records were eliminated. Missing soundings were replaced by substituting the previous day's soundings at the same time of day (i.e., 00:00 GMT or 12:00 GMT).

Land Use Data

An estimation of the dominant land use type of each grid cell is one of the input fields required by the MESOPAC II model. The land use data for the grid shown in Figure 2 was based on the Geographic Information Systems (GIS) land cover data base provided as part of the ARM3 model (Morris et al., 1988). The GIS land use file has a resolution of roughly 35 km x 35 km. The land use data are specified in terms of a fractional coverage for each of ten land use categories.

The land use data are extracted from the archive using the ARM3 PRELND program. The user specifies the origin and size of the region. The grid origin used was UTM (x,y) = (285000, 3040000) meters, with a grid size of 10 km. MESOPAC II requires the specification of the dominant land use type in each grid cell, rather than fractional coverage of the cell for each land use category. Therefore, the land use category with the highest percentage of coverage in each cell was selected. The coastal areas and lakes were reset to water, if necessary, using map information so that the smaller scale features blurred by the lower resolution GIS data were not lost.

Because the GIS land use categories do not exactly correspond to those used in MESOPUFF II, the GIS categories were assigned to the most similar

MESOPUFF II categories based on the surface roughness characteristics. Table 2 illustrates the mapping of the GIS categories into the MESOPUFF II categories. For example, the GIS "agricultural/rangeland" category was mapped into the MESOPUFF II "cropland/grazing" category rather than the "irrigated crops" category because of a better match of the roughness length. Figure 3 contains the gridded MESOPUFF II land use categories used in the modeling.

MESOPAC II Model Options

The default model options were used for all of the technical options in MESOPAC II. These included the use of mixed-layer averaged winds for the lower-layer wind field, and mixing height to 700 mb averaged winds for the upper layer wind field. The model's mixing height constants, cloud-induced radiation reduction factors, and heat flux constants were set to the default values as described in the MESOPUFF II User's Guide.

The output file of gridded meteorological fields for a full year run of MESOPAC II for the 25x30 grid described above would require about 250 megabytes of disk storage. In order to reduce the size of this file and allow the modeling to be conducted simultaneously on multiple computers, the modeling was split into two six-month runs. The second run contained a four-day overlap period with the first in order to eliminate model initialization effects. Thus, the runs were for Julian days 1-181, and days 178-365, respectively. The MESOPUFF II results for Days 178-181 of the second run were discarded.

3.2 MESOPUFF II Dispersion Modeling

Technical Options

A number of important physical and chemical processes affect pollutants traveling over distance scales of tens of kilometers which are generally not important (and therefore not usually considered) in modeling applications for

Table 2

Mapping of ARM3 GIS Land Use Categories into MESOPUFF II Land Use Categories

GIS		MESOPUFF II		
Category	Roughness Length (m)	Category	Roughness Length (m)	Category Number
Urban	1.00	Urban	1.00	11
Agriculture	0.25	Crop/pasture	0.20	1
Rangeland	0.03	Grazing land	0.10	6
Forest - deci.	1.00	Grazed forest	0.90	4
Forest - coni.	1.00	Ungrazed forest	1.00	5
Swamp/forest	1.00	Ungrazed forest	1.00	5
Water	0.0002	Water	0.0001	12
Swamp	0.10	Swamp	0.20	9
Agric./rangeland	0.25	Cropland/grazing	0.30	2
Snow	0.005	-	-	-
-	-	Irrigated crops	0.05	3
-	-	Open woodland	0.20	7
-	-	Desert shrubland	0.30	8
-	-	Marshland	0.50	10

30	5	5	5	5	5	1	1	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12
29	5	5	5	5	5	1	1	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12
28	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12
27	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12
26	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12
25	5	5	5	5	5	5	5	5	5	1	1	1	5	5	5	5	5	5	5	5	12	12	12	12	12
24	12	5	5	5	5	5	5	5	5	1	1	1	5	5	5	5	5	5	5	5	5	12	12	12	12
23	12	12	12	12	5	5	5	5	5	1	1	1	5	5	5	5	5	5	5	5	5	5	12	12	12
22	12	12	12	12	5	5	5	5	5	1	1	1	5	5	5	5	5	5	5	5	5	5	12	12	12
21	12	12	12	12	5	5	5	5	5	1	1	1	1	1	1	1	1	5	5	5	5	5	5	12	12
20	12	12	12	12	12	5	5	5	5	1	1	1	1	1	1	1	1	5	5	5	5	5	5	12	12
19	12	12	12	12	12	5	5	5	5	5	5	5	1	1	1	1	1	5	5	5	5	5	5	12	12
18	12	12	12	12	12	5	5	5	5	5	5	5	1	1	1	1	1	5	5	5	5	5	5	12	12
17	12	12	12	12	12	5	5	5	5	1	1	1	1	1	1	1	1	5	5	5	5	5	9	12	12
16	12	12	12	12	12	5	5	5	5	1	1	1	1	1	1	1	1	5	5	5	5	5	9	12	12
15	12	12	12	12	12	5	5	1	1	5	5	5	5	5	12	12	12	5	5	6	6	6	5	5	12
14	12	12	12	12	5	5	5	1	1	5	5	5	5	5	12	12	12	5	5	6	6	6	5	5	12
13	12	12	12	12	5	5	5	1	1	1	1	1	1	1	5	5	5	12	12	1	1	1	1	1	12
12	12	12	12	12	5	5	5	1	1	1	1	1	12	12	1	1	1	6	6	6	6	6	1	1	12
11	12	12	12	12	5	5	5	1	1	1	1	1	12	12	1	1	1	6	6	6	6	6	1	1	1
10	12	12	12	5	12	12	5	5	5	5	5	5	5	5	1	1	1	6	6	6	6	6	1	1	1
9	12	12	12	5	5	12	12	12	5	5	5	5	5	5	1	1	1	6	6	6	6	6	1	1	1
8	12	12	12	12	5	12	12	1	1	1	1	1	1	1	1	1	1	5	5	1	1	1	6	6	6
7	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1	5	5	1	1	1	6	6	6
6	12	12	12	12	12	12	6	6	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	12	12	12	12	12	6	6	6	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1	6	6	1	1	1	1	1	1
1	12	12	12	12	12	12	12	6	6	6	6	6	1	1	1	1	1	6	6	1	1	1	1	1	1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Figure 3. Gridded MESOPUFF II land use categories for the 25x30 meteorological grid (1 = crop, 5 = forest, 6 = grazing land, 9 = swamp, 12 = water).

small source-receptor distances (i.e., < 10 km). These include gas and aqueous phase transformation of SO_2 into sulfate, dry deposition, and wet scavenging processes. In addition, the spatial and temporal variability in the meteorological fields is usually an important factor affecting concentration estimates at mesoscale distances. MESOPUFF II was developed specifically for transport distances greater than 10 km, and therefore has specific modules to parameterize these effects.

In the current application, the RGS and background PSD sources of SO_2 were modeled for the 1986 annual period. The recommendations contained in the MESOPUFF II User's Guide were used in the modeling with three exceptions. First, wet removal processes were not considered. This assumption is conservative in the sense that during wet periods, significant removal of SO_2 actually occurs. By neglecting this process, the modeling results obtained during periods with precipitation will tend to be overestimated, other factors being equal, than if it were considered. The decision to not include wet removal was based on the preference of the NPS.

The second change was to use a cross-over distance of 10 km instead of 100 km for the use of the time-dependent dispersion equations of Heffter (1965). The 10 km cross-over distance has been recommended by the model authors for several years, and in fact was used in the model evaluation study of MESOPUFF II conducted by the Argonne National Laboratory (ANL). The use of the 10 km cross-over distance was noted by ANL as one of the main factors leading to the superior performance of MESOPUFF II over some of the other models tested in the ANL study. Included in Appendix A are additional comments regarding this issue which were submitted to EPA in response to the request for public comments on the proposed Supplement B revisions to the EPA modeling guidelines.

The third change was the use of two-layer mode for deposition instead of the three-layer mode. This change was the result of sensitivity tests with and without deposition, which produced inconsistent results when the three-layer model was used. It is believed that the vertical dilution term in the three-layer model should be modified to account for the 10-meter surface layer. The two-layer deposition mode produced reasonable and consistent results as compared to the sensitivity run without deposition, and therefore it was used for the current application.

Appendix B contains a listing of a portion of a MESOPUFF II list file which shows the model options selected and values for the various input variables. The listing shown is for a run with the RGS source for the January to June time period. Sources located between 20 and 50 km from the Class I area were modeled with a minimum sampling rate of 8 per hour. Sources greater than 50 km from the Class I area (including the RGS source) used a minimum sampling rate of 2 per hour. As discussed in the MESOPUFF II technical report (Scire et al., 1984b), more frequent sampling is required as the source-receptor distance decreases (see Table 3). These values of the sampling rate should provide a good representation of the plumes for all sources modeled, including those as close as 20 km from the Class I area.

Although wet removal processes were not considered in the modeling analysis, the dry deposition and chemical transformation mechanisms of the model were invoked. This is an especially reasonable procedure in this case since the great majority of sources modeled (including nearly all of the larger sources) are located more than 50 km from the Class I area.

Receptor Locations

Thirteen discrete receptors in the Class I area were used in the modeling analysis. The coordinates of each receptor are listed in Table 4. These receptors were specified by the Florida DER.

Source Data

The stack coordinates, emission parameters, and stack parameters for each of the sources included in the MESOPUFF II modeling are shown in Tables 5a and 5b. The RGS is Source 1 in Table 5a. The background PSD source inventory was specified by the Florida DER. It consists of 63 increment-consuming PSD sources (Table 5a) and 19 increment-expanding sources (Table 5b). The increment-expanding sources are baseline sources which have stopped operations or reduced emissions. Their contribution was subtracted from that of the increment-consuming sources on a receptor-by-receptor and

Table 3

Comparison of MESOPUFF II Concentrations with Straight-Line Gaussian Plume Results as a Function of Source-Receptor Distance and Puff Sampling Rate (N)

(from Scire et al., 1984b)

(Wind Speed = 5 m/s, D Stability, Mixing Height = 1000 m, Uniform Vertical Distribution)

Distance (km)	σ_y (m)	Straight-Line Gaussian Eqn.	MESOPUFF II Sampling Algorithm N=1	N=2	N=4	N=8	N=16
10	518	1.54	1.69	1.09	1.33	1.51	1.55
20	966	0.83	0.59	0.72	0.81	0.83	0.83
30	1,392	0.57	0.63	0.54	0.59	0.57	0.57
40	1,803	0.44	0.39	0.44	0.45	0.44	0.44
50	2,203	0.36	0.41	0.37	0.36	0.36	0.36

Table 4

Meteorological Grid Coordinates of Receptors in the Chassahowitzka National Wildlife Refuge Class I Area

Receptor	Meteorological Grid Coordinates* X	Y
1	6.53	17.57
2	6.53	17.77
3	6.53	17.98
4	6.57	18.19
5	6.70	18.40
6	6.80	18.62
7	6.87	18.83
8	6.74	19.06
9	6.61	19.34
10	6.40	19.34
11	6.15	19.34
12	5.90	19.34
13	5.65	19.34

* Meteorological grid coordinate (1,1) corresponds to UTM coordinate (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

Table 5a

Increment-Consuming PSD Sources Modeled with MESOPUFF II

SOURCE	METEOROLOGICAL* GRID COORDINATES X	Y	STACK HT (m)	DIAMETER (m)	EXIT VEL. (m/s)	TEMP. (deg K)	SO2 EMISSION RATE (g/s)
1	14.17	11.04	99.06	3.05	14.54	349.80	13.78
2	19.25	20.72	15.24	4.21	56.21	819.80	466.40
3	17.13	13.60	15.24	4.21	56.21	819.80	310.90
4	17.13	13.60	15.24	7.04	32.07	880.80	276.10
5	11.30	12.60	60.35	2.44	17.77	353.00	54.60
6	11.30	12.60	60.35	2.44	17.77	353.00	54.60
7	8.69	8.50	149.40	7.32	19.81	342.20	654.70
8	20.85	16.06	167.60	5.80	21.60	325.70	105.40
9	20.85	16.06	167.60	5.80	23.50	324.20	242.40
10	18.51	13.93	18.30	3.66	38.00	422.00	32.10
11	12.98	6.74	22.90	4.88	23.90	389.00	277.60
12	13.35	11.58	76.20	4.88	19.70	350.00	500.10
13	9.32	10.27	50.00	1.80	18.30	491.00	21.40
14	6.03	9.44	49.10	2.74	27.72	522.00	62.24
15	10.83	14.58	12.30	0.40	9.20	466.20	0.20
16	13.42	11.28	30.48	5.79	28.22	783.20	29.11
17	12.16	8.89	61.00	2.60	15.31	350.00	182.85
18	12.16	8.89	60.70	2.60	15.31	350.00	121.90
19	12.16	8.89	36.60	1.83	20.15	319.10	5.54
20	11.06	14.90	30.48	3.35	17.13	384.30	5.04
21	15.90	20.88	30.48	3.35	17.13	384.30	5.04
22	13.35	9.30	9.10	0.70	22.50	450.00	4.30
23	13.35	9.30	67.10	2.40	9.80	351.00	52.90
24	8.68	9.83	30.00	0.61	20.00	375.00	21.02
25	12.34	9.42	45.70	2.30	10.30	352.00	42.00
26	13.45	8.95	30.48	2.29	9.27	355.00	67.16
27	13.45	8.95	45.72	2.44	9.65	355.00	41.96
28	11.46	7.79	38.10	2.90	10.13	339.00	18.40
29	11.46	7.79	38.10	2.44	18.40	346.00	21.17
30	12.16	8.86	60.70	2.60	15.55	350.00	63.00

*Meteorological grid coordinate (1,1) corresponds to UTM coordinates (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

(Continued)

Table 5a

Increment Consuming PSD Sources Modeled with MESOPUFF II

(Concluded)

SOURCE	METEOROLOGICAL* GRID COORDINATES X	Y	STACK HT (m)	DIAMETER (m)	EXIT VEL. (m/s)	TEMP. (deg K)	SO2 EMISSION RATE (g/s)
31	12.18	8.94	52.40	2.40	13.00	322.00	3.78
32	12.18	8.94	52.40	2.40	7.10	319.00	5.36
33	12.15	8.92	36.60	1.80	20.80	319.00	5.54
34	12.15	8.86	60.70	2.60	15.55	350.00	63.00
35	12.15	8.88	61.00	2.50	16.71	350.00	189.00
36	13.17	9.52	61.00	2.13	12.20	360.00	35.70
37	14.11	7.86	53.40	2.59	15.91	355.00	63.00
38	14.11	7.86	53.40	2.59	15.91	355.00	63.00
39	13.47	9.60	61.00	2.80	7.30	346.00	73.60
40	13.45	9.65	61.00	1.52	28.40	347.00	72.00
41	8.84	9.24	45.70	2.29	9.20	355.00	36.75
42	11.98	7.77	8.20	0.41	7.57	505.00	0.60
43	11.99	7.98	30.50	1.82	7.26	334.00	16.35
44	11.45	7.80	38.10	2.44	15.20	339.00	13.40
45	13.97	9.03	13.70	1.22	40.40	330.00	30.64
46	12.33	9.43	25.90	2.29	15.20	339.00	2.44
47	11.53	13.94	6.10	1.38	21.00	422.00	3.54
48	13.25	8.13	45.73	1.60	39.06	350.00	113.50
49	8.50	17.24	97.60	4.88	23.23	442.00	98.40
50	7.21	14.92	83.82	3.05	15.70	394.30	14.10
51	5.92	21.45	182.90	6.90	21.00	398.00	1008.80
52	5.92	21.45	182.90	6.90	21.00	398.00	1008.00
53	8.64	17.84	8.50	1.08	10.95	357.40	2.25
54	8.49	17.24	12.20	1.37	10.58	377.00	2.25
55	10.72	17.61	9.14	0.61	4.57	478.00	2.99
56	11.17	16.58	10.67	1.83	8.99	327.00	0.82
57	8.48	17.49	7.62	1.83	6.29	347.00	2.09
58	6.56	12.92	12.20	3.05	6.47	339.00	0.23
59	8.09	15.37	9.14	1.30	16.00	408.00	3.67
60	5.62	13.45	10.98	0.31	3.88	544.00	0.06
61	5.62	13.45	10.98	0.31	3.88	544.00	0.03
62	5.84	15.10	10.98	0.31	4.00	533.00	0.08
63	5.84	15.10	10.98	0.31	4.00	533.00	0.08
64	6.57	12.95	9.14	1.40	22.30	436.00	7.25

*Meteorological grid coordinate (1,1) corresponds to UTM coordinates (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

Table 5b

Increment-Expanding PSD Sources Modeled with MESOPUFF II

SOURCE	METEOROLOGICAL* GRID COORDINATES X	Y	STACK HT (m)	DIAMETER (m)	EXIT VEL. (m/s)	TEMP. (deg K)	SO2 EMISSION RATE (g/s)
1	11.30	12.60	60.35	2.44	16.40	353.00	50.40
2	11.30	12.60	60.35	2.44	16.40	353.00	50.40
3	8.69	8.50	149.40	7.32	28.65	422.00	2436.00
4	8.69	8.50	149.40	7.32	14.33	418.00	1218.00
5	5.06	12.67	49.00	1.20	3.60	293.00	52.07
6	12.16	8.89	61.00	2.60	14.28	350.00	170.10
7	13.35	9.30	30.50	1.68	14.60	350.00	110.60
8	12.34	9.42	30.50	1.80	18.90	308.00	15.20
9	13.45	8.95	30.48	1.37	20.18	311.00	54.56
10	12.17	8.89	21.04	2.13	18.56	347.00	34.27
11	12.15	8.88	61.00	2.50	11.14	350.00	146.00
12	13.17	9.52	51.00	2.13	9.90	356.00	257.60
13	14.12	7.87	29.00	3.02	6.77	314.00	78.80
14	13.47	9.60	45.70	1.40	16.50	352.00	216.00
15	8.84	7.24	22.60	1.52	19.50	322.00	196.30
16	8.84	9.24	45.70	2.29	9.20	355.00	50.71
17	13.25	8.13	45.73	1.60	26.40	350.00	75.60
18	5.92	21.45	152.00	4.57	42.10	422.00	314.00
19	5.92	21.45	153.00	4.88	42.10	422.00	1859.00

*Meteorological grid coordinate (1,1) corresponds to UTM coordinates (x,y) = (285000, 3040000). One meteorological grid unit = 10 km.

hour-by-hour basis in the MESOFILE II postprocessing step of the analysis. Thus, the total net concentration for a particular time period can be either positive or negative, depending on the relative contribution of the various sources.

4. MESOPUFF II MODELING RESULTS

3-Hour SO_2 Concentrations

The peak predicted 3-hour SO_2 concentration predicted by MESOPUFF II due to emissions from the RGS was 0.26 $\mu g/m^3$ on Day 343 for the hours 03:00-0:600 LST. Because this value is less than the proposed 3-hour SO_2 significance level of 0.48 $\mu g/m^3$, a cumulative impact analysis with background PSD sources was not necessary.

24-Hour SO_2 Concentrations

MESOPUFF II modeling for the RGS source produced three days with predicted 24-hour SO_2 concentrations at or above the proposed NPS 24-hour significance level of 0.07 $\mu g/m^3$ at one or more of the Class I area receptors. As shown in Table 6, concentrations on Days 282, 332, and 333 exceeded the significance level, with the peak concentration (0.09 $\mu g/m^3$) predicted on Day 332.

Tables 7, 8, and 9 show the concentrations due to RGS and the total net contribution from the 82 background PSD sources located at or beyond 20 km from the Class I area added to the RGS contribution. The highest predicted concentrations at a receptor for which the RGS contribution was significant (i.e., $\geq$ 0.07 $\mu g/m^3$) was 4.67 $\mu g/m^3$.

In order to reach conclusions relating to compliance with the 24-hour PSD Class I increment for SO_2, the contributions of the one source located less than 20 km from the Class I area must be added to the values in Tables 7 to 9. The modeling of the additional source with the ISCST model was conducted by Dames & Moore. The results of that analysis are described in a separate report.

Table 6

Predicted Peak 24-Hour Average SO_2 Concentrations Due to RGS Emissions At or Above the Proposed NPS 24-Hour Significance Threshold of 0.07 $\mu g/m^3$

Day	Receptor	Concentration ($\mu g/m^3$)
282	1	0.08
332	13	0.09
333	13	0.08

Table 7

Predicted 24-Hour Average SO_2 Concentrations on Days when RGS Contributions Exceeded the Proposed NPS Significance Level

Day: 282

Receptor	Contribution from RGS	Contribution from Sources ≥ 20 km from Class I Area (Including RGS)
1	0.075	3.01
2	0.073	3.29
3	0.070	3.59
4	0.067	*
5	0.063	*
6	0.059	*
7	0.055	*
8	0.053	*
9	0.050	*
10	0.052	*
11	0.053	*
12	0.054	*
13	0.055	*

* At this receptor, the RGS contribution is less than the proposed NPS 24-hour significance level of 0.07 $\mu g/m^3$.

Table 8

Predicted 24-Hour Average SO_2 Concentrations on Days when RGS Contributions Exceeded the Proposed NPS Significance Level

Day: 332

Receptor	Contribution from RGS	Contribution from Sources ≥ 20 km from Class I Area (Including RGS)
1	0.088	3.84
2	0.088	3.60
3	0.087	3.80
4	0.086	4.32
5	0.084	4.28
6	0.084	4.30
7	0.084	4.43
8	0.083	4.51
9	0.082	4.62
10	0.083	4.67
11	0.085	4.54
12	0.088	4.38
13	0.091	4.33

Table 9

Predicted 24-Hour Average SO_2 Concentrations on Days when RGS Contributions Exceeded the Proposed NPS Significance Level

Day: 333

Receptor	Contribution from RGS	Contribution from Sources ≥ 20 km from Class I Area (Including RGS)
1	.032	*
2	.031	*
3	.030	*
4	.029	*
5	.026	*
6	.026	*
7	.026	*
8	.028	*
9	.031	*
10	.038	*
11	.050	*
12	.065	*
13	.081	1.22

* At this receptor, the RGS contribution is less than the proposed NPS 24-hour significance level of 0.07 $\mu g/m^3$.

5. REFERENCES

EPA, 1986: Guidance on air quality models (revised). EPA-450/2-78-027R, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 1991: Supplement B to the guideline on air quality models (revised). Draft. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Heffter, J.L., 1965: The variations of horizontal diffusion parameters with time travel periods of one hour or longer. *J. Applied Meteorol.*, **4**, 153-156.

Policastro, A.J., M. Wastag, L. Coke, R.A. Carhart and W.E. Dunn, 1986: Evaluation of short-term long-range transport models (Draft final report). U.S. Environmental Protection Agency, Research Triangle Park, NC.

Scire, J.S., F.W. Lurmann, A. Bass and S.R. Hanna, 1984a: User's guide to the MESOPUFF II model and related processor programs. EPA-600/8-84-013, U.S. Environmental Protection Agency, REsearch Triangle Park, NC.

Scire, J.S., F.W. Lurmann, A. Bass and S.R. Hanna, 1984b: Development of the MESOPUFF II dispersion model. EPA-600/3-84-057. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Appendix A

Comments on the use of MESOPUFF II

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May 3, 1991

Air Docket (LE-131), Room M-1500
Waterside Mall
Attention: Docket A-88-04
U.S. Environmental Protection Agency
401 M Street SW
Washington, DC 20460

Dear Sir:

I am writing in response to the Federal Register Notice (AD-FRL-3908-3, Docket No. A-88-04, Monday February 25, 1991) requesting comments on the proposed revisions to the "Guideline on Air Quality Models (Revised)" and Supplement B to the Guideline. In particular, my comments relate to the EPA recommendations regarding the use of the MESOPUFF II dispersion model (Scire et al., 1984).

Supplement B notes that MESOPUFF II, listed in Appendix B of the Guidelines, may be applied on a case-by-case basis when long range transport estimates are needed. It is also noted that information on applying this model is contained in the EPA document "A Modeling Protocol for Applying MESOPUFF-II to Long-Range Problems" (Docket No. A-88-04, II-I-11).

The following changes are recommended to the EPA MESOPUFF II modeling protocol.

- MESOPUFF II contains a input parameter, TMDEP, which controls the distance at which the functions used to compute dispersion coefficients are switched from the distance-dependent equations of Turner to the time-dependent functions of Heffter (1965). The default value for this parameter is set at 100 km, indicating that the time-dependent functions are used at greater distances. However, in our review of the model evaluation protocol prepared by Argonne National Laboratory (ANL) in their evaluation of long-range transport models, we suggested that a value of 10 km be used for TMDEP. The model evaluation work done by ANL was based on a 10 km value for TMDEP. ANL concluded that "the use of 10 km as the transition distance between the use of the Turner curves and Heffter formula for lateral dispersion definitely improved concentration predictions" (page 6-7, Policastro et al., 1986). They also noted that a main cause of the under-prediction of lateral spreading by some of the other models evaluated was due to the use of the distance-dependent curves out to 50-100 km. They concluded that "the more correct distance is about 10 km" (page 6-3). Therefore, it is recommended that the EPA modeling protocol for MESOPUFF II be modified to recommend that a value of 10 km be used for TMDEP.

- The EPA modeling protocol recommends that MESOPUFF II be run for pollutants such as SO_2 with the chemical transformation and pollutant removal algorithms turned off. However, over source-receptor distances of 50 to 300 kilometers, these processes can have a very significant effect on the predicted concentrations. Wet deposition of SO_2 is a particularly efficient removal mechanism. For example, studies of observed scavenging ratios indicate typical removal rates of 10-20 *per hour* or higher for modest precipitation rates of only 1-2 mm/hr. (At an average transport speed of 5 m/s, over 16 hours is required to travel 300 km).

  Current EPA modeling guidelines allow consideration of SO_2 transformation in straight-line Gaussian models on even smaller spatial scales than those for which MESOPUFF II would be applied. For example, the modeling guidelines recommend a pollutant half life of 4 hours for SO_2 modeling in urban areas). Therefore, some allowance for chemical conversion and removal is consistent with current guidance and is justifiable on technical grounds. Although first-level screening analyses with removal and chemical conversion switched off is appropriate, it is suggested that more refined screening modeling with MESOPUFF II which accounts for SO_2 transformation and removal should be allowed.

- The modeling protocol recommends the use of MESOPUFF II at source-receptor distances greater than 50 km. It should be noted that the puff model can reproduce a straight-line Gaussian model results under steady-state conditions with the appropriate choice of puff release parameters at distances much less than 50 km (Table 9 in the MESOPUFF II report shows nearly identical results down to 10 km with N=16). Therefore, it is not so much an issue of when does the puff model become valid as when the straight-line, steady-state assumptions in conventional models become not appropriate. The straight-line Gaussian model is more efficient computationally over short distances, but because there are many flow situations when non-steady-state conditions occur over spatial scales less than 50 km, the use of the puff model may be justified.

The modeling protocol recommends application of MESOPUFF II for a full year period for small numbers of sources. Recent advances in the computational speed of advanced PCs and workstations have made large multi-source or multi-year simulations with the MESOPUFF II model practical. For example, the state agency in Massachusetts sponsored a study to simulate nearly 200 point and area sources of SO_2 for a full year with only modest computational resources. Similar studies have been performed in other states, including Minnesota and Maryland.

Thank you for the opportunity to comment on these issues.

Sincerely,

Joseph S. Scire
Chief Executive Officer

cc: J. Tikvart

References

Heffter, J.L., 1965: The variations of horizontal diffusion parameters with time travel periods of one hour or longer. *J. Applied Meteorol.*, 4, 153-156.

Policastro, A.J., M. Wastag, L. Coke, R.A. Carhart, and W.E. Dunn, 1986: Evaluation of short-term long-range transport models (Draft final report). U.S. Environmental Protection Agency, Research Triangle Park, NC.

Scire, J.S., F.W. Lurmann, A. Bass, S.R. Hanna, 1984: User's guide to the MESOPUFF II model and related processor programs. EPA-600/8-84-013. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Scire J.S., F.W. Lurmann, A. Bass, S.R. Hanna, 1984: Development of the MESOPUFF II dispersion model. EPA-600/3-84-057. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Appendix B

MESOPUFF II Output List File

(RGS Source, January - June, 1986)

MESOPUFF - VERSION 2.0 (DATED 85360)

MESOPUFF VERSION 2.0

****

MESOPUFF II - RGS - 1/1/86 - 6/30/86 w/dry dep and Chem

GENERAL RUN INFORMATION:

YEAR OF RUN (NSYR) = 86
JULIAN DAY OF START OF RUN (NSDAY) = 1
HOUR OF START OF RUN (NSHR) = 0
LENGTH OF RUN (NADVTS) = 4344 (HOURS)
NUMBER OF POINT SOURCES (NPTS) = 1
NUMBER OF AREA (URBAN) SOURCES (NAREAS) = 0
NUMBER OF NONGRIDDED RECEPTORS (NREC) = 13
NUMBER OF POLLUTANT SPECIES (NSPEC) = 1

COMPUTATIONAL VARIABLES:

CONCENTRATION AVERAGING TIME (IAVG) = 1 (HOUR(S))
PUFF RELEASE RATE (NPUF) = 4 (PUFFS/HOUR)
MINIMUM SAMPLING RATE (NSAMAD) = 2 (SAMPLES/HOUR)
SAMPLING RATE VARIED WITH WIND SPEED ? (LVSAMP) = T
SAMPLING RATE WIND SPEED INTERVAL (WSAMP) = 2.00 (M/S)
CONCENTRATIONS CALCULATED AT SAMPLING GRID POINTS ? (LSGRID) = F
PUFFS YOUNGER THAN "AGEMIN" SECONDS ARE NOT SAMPLED (AGEMIN) = 900. (SECONDS)

GRID INFORMATION:

BEGINNING OF COMPUTATIONAL GRID IN X-DIRECTION (IASTAR) = 1
END OF COMPUTATIONAL GRID IN X-DIRECTION (IASTOP) = 25
BEGINNING OF COMPUTATIONAL GRID IN Y-DIRECTION (JASTAR) = 1
END OF COMPUTATIONAL GRID IN Y-DIRECTION (JASTOP) = 30
BEGINNING OF SAMPLING GRID IN X-DIRECTION (ISASTR) = 1
END OF SAMPLING GRID IN X-DIRECTION (ISASTP) = 25
BEGINNING OF SAMPLING GRID IN Y-DIRECTION (JSASTR) = 1
END OF SAMPLING GRID IN Y-DIRECTION (JSASTP) = 30
SAMPLING GRID SPACING FACTOR (MESHDN) = 1

TECHNICAL OPTIONS:

GAUSSIAN VERTICAL CONCENTRATION DISTRIBUTION ? (LGAUSS) = T
CHEMICAL PROCESSES MODELED ? (LCHEM) = T
DRY DEPOSITION MODELED ? (LDRY) = T
WET REMOVAL MODELED ? (LWET) = F
3 VERTICAL LAYERS ? (L3VL) = F

OUTPUT OPTIONS:

CONCENTRATIONS STORED ON TAPE ? (LTAPE) = T
CONCENTRATIONS PRINTED ? (LPRINT) = T
PRINT INTERVAL (IPRINF) = 24
PUFF PARAMETERS PRINTED EACH SAMPLING STEP ? (LDB) = F
TIME STEPS FOR WHICH PUFF PARAMETERS PRINTED (NN1,NN2) = 0, 0

DEFAULT OVERRIDE OPTIONS (0=NO,1=YES)

USER INPUT SIGY, SIGZ VARIABLES (IOPTS(1)) = 1
USER INPUT VERTICAL DIFFUSIVITY CONSTANTS (IOPTS(2)) = 0
USER INPUT DRY DEP. SO2 CANOPY RESISTANCES (IOPTS(3)) = 0
USER INPUT OTHER DRY DEP. CONSTANTS (IOPTS(4)) = 0
USER INPUT WET REMOVAL CONSTANTS (IOPTS(5)) = 0
USER INPUT CHEMICAL TRANSFORMATION VARIABLES (IOPTS(6)) = 0

SIGY, SIGZ VARIABLES:

AY =	0.36000	0.25000	0.19000	0.13000	0.09600	0.06300
BY =	0.90000	0.90000	0.90000	0.90000	0.90000	0.90000
AZ =	0.00023	0.05800	0.11000	0.57000	0.85000	0.77000
BZ =	2.10000	1.09000	0.91000	0.58000	0.47000	0.42000
AZT (IN M) =	5.00000	3.87300	2.73900	1.87100	1.22500	0.70700

TMDEP = 10000. (M)

STABILITY CLASS USED IN SIGY, SIGZ CALCULATIONS FOR PUFFS ABOVE BOUNDARY LAYER (JSUP) = 5
(0 = BOUNDARY LAYER STABILITY CLASS, 5 = E STABILITY, 6 = F STABILITY)

VERTICAL DIFFUSIVITY CONSTANTS:

CON1K = 0.010 (M**2/S)
CON2K = 0.100 (M**2/S)

LAND USE CATEGORY	SO2 CANOPY RESISTANCE (S/M)			
	A,B,C	D	E	F
1	100.00	300.00	1000.00	0.00
2	100.00	300.00	1000.00	0.00
3	100.00	300.00	1000.00	0.00
4	100.00	300.00	1000.00	0.00
5	100.00	300.00	1000.00	0.00
6	100.00	300.00	1000.00	0.00
7	100.00	300.00	1000.00	0.00
8	200.00	500.00	1000.00	1000.00
9	50.00	75.00	100.00	0.00
10	75.00	300.00	1000.00	0.00
11	1000.00	1000.00	1000.00	0.00
12	0.00	0.00	0.00	0.00

DRY DEPOSITION CONSTANTS:

CANOPY RESISTANCE FOR NOX IN S/M (RCNOX) = 130.00 (A,B,C) 500.00 (D) 1500.00 (E) 1500.00 (F)
SURFACE RESISTANCE CONSTANT FOR GASES (RSGCON) = 2.60
SURFACE RESISTANCE FOR PARTICLES (RSPART) = 1000.00 (S/M)

****

```
CHEMICAL TRANSFORMATION VARIABLES:
    SOX TRANSFORMATION METHOD FLAG (MSOX) =  2
        0 - NO TRANSFORMATION
        1 - USER SPECIFIED
        2 - ERT THEORETICAL EQUATION
        3 - GILLANI EQUATION
        4 - HENRY EQUATION FOR ST. LOUIS
        5 - HENRY EQUATION FOR LOS ANGELES
    NOX TRANSFORMATION METHOD FLAG (MNOX) =  2
        0 - NO TRANSFORMATION
        1 - USER SPECIFIED
        2 - ERT THEORETICAL EQUATION
    OZONE INPUT METHOD FLAG (MO3) =  0
        0 - DEFAULT OZONE VALUE USED
        1 - HOURLY OZONE VALUES READ
    DEFAULT BACKGROUND OZONE (CO3B) =   80.0 (PPB)
    TOTAL AMMONIA CONCENTRATION (CTNH3) =   10.0 (PPB)
    NIGHTTIME TRANSFORMATION RATES:
        SO2 LOSS RATE (RNITE(1)) =   0.2 (%/HOUR)
        NOX LOSS RATE (RNITE(2)) =   2.0 (%/HOUR)
        TOTAL NO3 FORMATION RATE (RNITE(3)) =   2.0 (%/HOUR)
```

MESOPUFF VERSION 2.0

****

POINT SOURCE DATA

SOURCE	GRID COORDINATES X	GRID COORDINATES Y	STACK HT (M)	DIAMETER (M)	EXIT VEL. (M/S)	TEMP. (DEG K)	EMISSION RATES (G/S) SO2	SO4	NOX	HNO3	NO3
1	14.17	11.04	99.06	3.05	14.54	349.80	13.78	0.00	0.00	0.00	0.00

NONGRIDDED RECEPTOR LOCATIONS

RECEPTOR	X (GRID UNITS)	Y (GRID UNITS)
1	6.530	17.570
2	6.530	17.770
3	6.530	17.980
4	6.570	18.190
5	6.700	18.400
6	6.800	18.620
7	6.870	18.830
8	6.740	19.060
9	6.610	19.340
10	6.400	19.340
11	6.150	19.340
12	5.900	19.340
13	5.650	19.340

INFORMATION READ FROM METEOROLOGICAL DATA FILE:

YEAR OF METEOROLOGICAL DATA = 86
METEOROLOGICAL DATA BEGINS ON JULIAN DAY 1
NUMBER OF HOURS OF METEOROLOGICAL DATA = 4345
METEOROLOGICAL GRID SIZE IN X (WEST-EAST) DIRECTION = 25
METEOROLOGICAL GRID SIZE IN Y (SOUTH-NORTH) DIRECTION = 30
METEOROLOGICAL GRID SPACING = 10000.0 (M)
BASE TIME ZONE = 5 (E.S.T.)
VON KARMAN CONSTANT = 0.40
CODE FOR LOWER-LEVEL WIND FIELD (ILWF) = 2
CODE FOR UPPER-LEVEL WIND FIELD (IUWF) = 4
NUMBER OF STATIONS USED IN CONSTRUCTION OF METEOROLOGICAL DATA FIELDS
SURFACE: 4
RAWINSONDE: 1

STATION TYPE	GRID COORDINATES X (GRID UNITS)	Y (GRID UNITS)
SURFACE	7.40	10.50
SURFACE	19.40	15.70
SURFACE	10.20	29.40
SURFACE	22.00	23.80
RAWINSONDE	7.40	10.50