Appendix A-3

Modeling Protocol
ENVIRON submitted an air quality modeling protocol on May 8, 2009. That protocol follows this introduction.

However, before the Federal Land Managers (FLMs) had responded to the protocol, two relevant documents were posted on EPA's SCRAM website1 on May 27, 2009. They include a Clearinghouse memorandum on “CALPUFF modeling protocol for BART” (Fox 2009) and a draft “Reassessment of IWAQM Phase 2 Recommendations” (IWAQM 2009). These two documents changed the methodology for running CALMET, and spelled out a series of CALMET setting to be used for PSD air quality modeling analyses.

When the FLMs responded to the May 8 protocol, they asked us to comply with the May 27 guidance. ENVIRON developed a sample CALMET and CALPUFF input file that were accepted by the FLMs. In an email on July 8, 2009, EPA's Nancy Helm confirmed to EFSEC Siting Specialist Jim LaSpina that ENVIRON’s CALMET input file of July 2, 2009 was acceptable, and that ENVIRON had federal clearance to begin modeling. That email is included below.

On August 31, 2009, another memo was posted on EPA’s SCRAM website that again changed the methodology for running CALMET, and spelled out a different series of CALMET setting to be used for PSD analyses. These settings reversed the May 27 guidance, and use essentially the same settings as the VISTAS BART modeling protocol. Because the Grays Harbor Energy project had already received federal clearance to begin modeling on July 2, ENVIRON did not revise our modeling procedures to comply with the August 31 guidance.

The May 8 modeling protocol that follows has not been revised to account for the changes ENVIRON made to comply with the May 27 documents. Instead, we refer the reader to the CALMET and CALPUFF input files in the enclosed compact disk.

July 8, 2008 E-mail from Nancy Helm:

Jim,

That is correct. With NPS approval of this modeling protocol Environ has federal clearance to begin modeling. Also note John's second sentence: In the future the FLMs will follow the revised EPA IWAQM guidance and require MMS data generated in the "hindcast" and not "forecast" mode.

Thanks, everyone, for your work on this.

Nancy Helm
Manager, Federal & Delegated Air Programs
US Environmental Protection Agency
1200 Sixth Avenue
Suite 900, AWT-107
Seattle, WA 98101
206 553-6908  fax 206 553-0110

1 http://www.epa.gov/tn/ scram/

Thank you all for your help on this matter in these regulatorily challenging times!

Since EPA deferred to NPS in this matter, I assume Environ has federal clearance to begin its modeling?

-----Original Message-----
From: John_Notar@nps.gov [mailto:John_Notar@nps.gov]
Sent: Wednesday, July 08, 2009 12:56 PM
To: LaSpina, Jim (CTED)
Cc: bbrashers@Environcorp.com; Dee_Morse@nps.gov; Eric Hansen; Posner, Stephen (CTED); tim_Allen@fws.gov; John_Notar@nps.gov; Bowman, Clint (ECY); John_Vimont@nps.gov
Importance: High

Jim: the National Park Service accepts the version of the CALMET input file we received from Bart Brashers and ENVIRON on July 2, 2009 for the Grays Harbor project. In the future the FLMs will follow the revised EPA IWAQM guidance and require MM5 data generated in the "hindcast" and not "forecast" mode.

thanks
John Notar

John Notar
National Park Service
Air Resources Division
12795 W. Alameda Pkwy.
Lakewood, CO 80228
Phone: 303-969-2079
Fax: 303-969-2822
E-Mail: john_notar@nps.gov
Hello John, Dee, Tim,

Please advise EFSEC as to the status of your review of Grays Harbor Energy's proposed air modeling materials/data that Environ recently submitted to you. They'd like to begin modeling ASAP.

If there is a holdup or problem with the materials, please inform EFSEC at your earliest convenience so that we can work with the applicant to address any deficiencies. Also, please inform us if there are any further concerns about the evolving federal air modeling policies.

Thanks very much for any clarification you can provide in this matter,
Jim La Spina EFSEC Siting Specialist
Modeling Protocol in Support of a Combined Notice of Construction and Prevention of Significant Deterioration Permit Application for Installation of Two Power Generation Units Modifying an Existing Major Stationary Source

Prepared for:
Grays Harbor Energy, LLC
Elma, Washington

Prepared by:
ENVIRON International Corporation
Lynnwood, Washington

Date:
May 8, 2009

Project Number:
29-22706A
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Appendix B  Example CALMET Input File
Appendix C  Example CALPUFF Input File
Appendix D  Example CALPOST Input File
Modeling Protocol in Support of an NOC/PSD Permit Application to Install Two Power Generation Units

Modeling Protocol in Support of a Combined Notice of Construction and Prevention of Significant Deterioration Permit Application for Installation of Two Power Generation Units Modifying an Existing Major Stationary Source

Grays Harbor Energy, LLC
Elma, Washington

1 Introduction

The Grays Harbor Energy Center, owned and operated by Grays Harbor Energy LLC, currently consists of two combined-cycle combustion turbines and a steam turbine generator with a nominal electrical generation capacity of 530 megawatts (MW) and a peak output of 650 MW. Grays Harbor Energy, LLC (GHE) proposes to add two similar combustion turbines and a steam turbine (referred to as Units 3 and 4), effectively doubling the maximum generation potential of the facility. GHE is a wholly-owned subsidiary of Invenergy Thermal, LLC. Washington’s Energy Facility Site Evaluation Council (EFSEC) has jurisdiction over the approval of the requested modification.

This air quality dispersion modeling protocol was prepared by ENVIRON International Corporation (ENVIRON) on behalf of GHE as a preliminary step in preparing the air quality permit application needed to modify the Grays Harbor Energy Center. The permit application will be included as part of the Request for Amendment of the Site Certification Agreement to be submitted to EFSEC.

This modeling protocol identifies how the combined Notice of Construction and Prevention of Significant Deterioration (PSD) permit application (hereafter simply referred to as the PSD application) will evaluate compliance with applicable ambient air quality standards, PSD increments, air quality related values, and toxic air pollutant criteria. A modeling protocol provides interested parties an opportunity to review the proposed procedures with the objective of reaching consensus on the approach in advance of the actual analysis. This protocol will describe the proposed modification, summarize the parameters used to represent emission sources in the simulations, discuss the selection of the dispersion models used in the analyses as well as model inputs and options, and present the approach used to prepare the meteorological data.

ENVIRON and GHE acknowledge that a modeling protocol dated June 23, 2008 was previously submitted by Cascade Environmental Management. That protocol was reviewed by the Olympic Region Clean Air Agency (ORCAA), the U.S. Environmental Protection Agency (USEPA), and federal land managers (FLMs). In January 2009, ENVIRON was retained to replace Cascade Environmental Management in preparing the air quality sections of the SCA Amendment Request to EFSEC. ENVIRON reviewed written comments on the 2008 protocol and, where appropriate, has addressed them in this revised modeling protocol. In some cases,
the comments directed certain issues to be addressed in the permit application rather than the modeling protocol, and those comments will be addressed in the EFSEC submittal.

The primary difference between this protocol and the initial protocol is that ENVIRON believes this modification should be evaluated as a modification to an existing major stationary source. We acknowledge that a previous owner, Duke Energy, filed a request in 2001 to amend its Site Certification Agreement authorizing construction of two additional combined cycle units, what Duke referred to as "Phase 2." Duke's proposal was to allow two separate and individually-financed power plants (each consisting of two combustion turbines with one steam turbine in a 2-on-1 configuration) on the same site. A PSD permit application for the second plant was included in the request as Section 6.1 of the Application for Amendment to the Site Certification Agreement. We acknowledge that Duke's proposal was very similar to what is being proposed now by GHE.

Less than a year later, however, Duke Energy requested that EFSEC postpone its review of the proposed amendment, and never asked EFSEC to resume processing of the amendment request. Although construction of the two-unit project began in September 2001, it was suspended in September 2002 with the project roughly 56 percent completed.

Invenergy purchased the partially completed project in 2005 and re-started construction in 2007. The facility became operational in April 2008. Today, EFSEC's web site characterizes the Grays Harbor Energy facility as follows:

"The Satsop Combustion Turbine Project consists of two combustion turbine generators on a "two on one" configuration with a single steam turbine generator. The Project will produce a nominal output of approximately 530 megawatts per year, with a maximum annual output of approximately 650 megawatts. The Project is a 20-acre site within the Satsop Redevelopment Park in Grays Harbor County. The entire 20-acre site was previously developed, including grading and surfacing with gravel and asphalt, and used as an equipment and material laydown area during construction of WNP-3 and WNP-5.

The Site Certification Agreement for the Satsop Nuclear Project (WNP 3/5) site was amended in 1996 to allow for construction of a 450 MW gas turbine. The nuclear power projects were removed from the Site Certificate in 1999. In April, 2001 the Site Certificate was amended again to allow the current 650 MW gas turbine project. Construction started on the combustion turbine project in September 2001 but was suspended in September 2002 at approximately 56% complete.

In April 2005 the Site Certification Agreement was amended to reflect the sale of the project to Grays Harbor Energy LLC (a subsidiary of Invenergy Inc.) from Duke Energy. Construction was restarted in February 2007 with commercial operation starting in April 25, 2008."

The existing EFSEC approval is for two combustion turbines; a four turbine project has never been approved. We acknowledge that a previous owner of a partially completed project
proposed what it called a second "phase" in November of 2001, during the peak of a major energy crisis, but the project application was placed on hold and never acted on. Four years later, GHE purchased a partially constructed facility designed and approved for two units. The four combustion turbine proposal in 2001 was four years prior to any involvement by GHE. In February 2005, GHE purchased a partially constructed two combustion turbine plant with the intent to complete the construction and make the plant operational, which it achieved in April 2008.

The proposed addition of Units 3 and 4 triggers PSD review because the addition constitutes a modification of the existing source that increases annual emissions by amounts that exceed the Significant Emission Rates established in the PSD program. Our position that the modification is the addition of two combustion turbines to an existing major source does not circumvent the PSD process. Rather, presenting our proposal in this manner more clearly characterizes what is actually happening at an existing, operating power plant.

ENVIRON presents a modeling protocol that is consistent with how major modifications to existing major stationary sources are evaluated in the PSD permit process. However, because both EFSEC and USEPA have expressed an interest in understanding how emissions from all four combustion turbines will affect air quality in Class I areas, this protocol also addresses how the cumulative effects of those emissions will be evaluated.¹

¹ ENVIRON discussed and reached agreement for this approach with EFSEC (Robert Burmark, Jim LaSpina, and Stephen Posner) and with EPA (Nancy Helms) in mid-April 2009.
2 Modification Description

2.1 Physical Description

2.1.1 Location
The Grays Harbor Energy Center facility is located in the Chehalis River Valley approximately 6 kilometers (km) or 4 miles south-southwest of Elma, Washington, at 123° 28’ 44” West longitude and 46° 58’ 8” North latitude. The Chehalis River Valley is a narrow plain between the Olympic Mountains to the north and the Willapa Hills to the south. Figure 2-1 displays the topography in the vicinity of the facility and the location of the near-field analysis modeling domain.

The Grays Harbor Energy Center is in Grays Harbor County, which is designated as attainment or unclassifiable for all criteria pollutants, and is located in Universal Transverse Mercator (UTM) Zone 10.

2.1.2 Equipment Description
The proposed modification consists of the following equipment:

- Two General Electric GE 7FA combustion turbines each with a nominal maximum heat input rating of between 1,735 and 1,780 million British thermal units per hour (MMBtu/hr), depending on the unit selected, and each yoked to an electrical generator with a nominal gross output of 175 MW;
- One heat recovery steam generator (HRSG) and supplementary duct burner per turbine (each with a nominal maximum heat input rate of 505 MMBtu/hr);
- One steam turbine generator (STG) unit with a nominal gross output rating of 300 MW, powered by steam produced in the HRSGs;
- One natural gas-fired auxiliary boiler with a nominal heat input rating of less than 30 MMBtu/hr;
- One forced draft/evaporative cooling tower;
- One emergency diesel engine generator; and
- One diesel engine emergency fire water pump.

2.2 Short-Term Normal Operation Emission Rates
In order to determine the potential air quality impacts associated with a major source modification such as that proposed by GHE and the regulations that would apply to the modification, the types and quantities of emitted air pollutants must be identified. Pollutant
emissions are determined by the physical and operational characteristics of the facility. The pollutant emission rates presented in this protocol are based on preliminary assumptions and equipment specifications, and may change before the permit application is submitted.

2.2.1 Power Generation Units
The two proposed combustion turbine generators (CTGs) and duct burners would combust only natural gas. The hot exhaust gases exiting the CTG combustor flow to the expander turbine, which drives the generator to produce electricity and also turns the air compressor section of the combustion turbine. Hot exhaust gas from the expander is ducted through the HRSG to generate high-energy steam that is used to produce additional electricity in the STG. Steam generated by the HRSG may be supported by duct burners depending upon the situation. Following heat recovery, the cooled CTG exhaust gas is discharged to the atmosphere through the HRSG stacks. Selective catalytic reduction (SCR) control equipment for removal of oxides of nitrogen (NOX) emissions and an oxidation catalyst for control of carbon monoxide (CO) and volatile organic compounds (VOCs) would be located within the HRSG.

To evaluate air quality implications of the range of operating conditions, we will examine four potential operating modes:

1) 100 percent combustion turbine load with duct burners
2) 100 percent combustion turbine load without duct burners
3) 60 percent combustion turbine load without duct burners
4) Combustion turbine startup/shutdown

Table 2-1 presents short-term emission rates for each combustion turbine operating mode. Although operation with duct burners typically produces the highest overall facility emissions, the modeling analyses will consider all three scenarios because predicted ground level concentrations are affected by exhaust gas characteristics (flow rate and temperature) as well as emission rates.
Table 2-1. Preliminary Combustion Turbine Short-Term Emission Rates

<table>
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<tr>
<th>Operating Mode</th>
<th>NOx</th>
<th>CO</th>
<th>SO2</th>
<th>SO2</th>
<th>PM10</th>
<th>VOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% load w/duct firing</td>
<td>20.0</td>
<td>12.2</td>
<td>14.2</td>
<td>13.1</td>
<td>19.0</td>
<td>3.48</td>
</tr>
<tr>
<td>100% load</td>
<td>15.9</td>
<td>9.7</td>
<td>10.9</td>
<td>5.0</td>
<td>19.0</td>
<td>2.76</td>
</tr>
<tr>
<td>60% load</td>
<td>11.3</td>
<td>6.9</td>
<td>7.8</td>
<td>3.6</td>
<td>19.0</td>
<td>5.88</td>
</tr>
<tr>
<td>Maximum</td>
<td>20.0</td>
<td>12.2</td>
<td>14.2</td>
<td>13.1</td>
<td>19.0</td>
<td>5.88</td>
</tr>
</tbody>
</table>

1 Pounds per hour per combustion turbine/HRSG unit. Values represent worst-case emission rates from performance data developed for three ambient temperature/relative humidity scenarios (20 °F/30%, 59 °F/60%, and 90 °F/60%).

2 Based on a maximum hourly average sulfur content of 2.07 gr/100 scf of natural gas, which is based on sulfur content data provided by the natural gas supplier collected between October 1, 2007 and September 30, 2008.

3 Based on a maximum daily average sulfur content of 1.91 gr/100 scf of natural gas, which is based on sulfur content data provided by the natural gas supplier collected between November 1, 2006 and September 30, 2008.

4 Filterable PM2.5 emissions are equal to the filterable portion of PM10 emissions, which was assumed to be 25 percent of total PM10 emissions, consistent with guidance found at [http://www.nature.nps.gov/air/permits/ect/ectGasFiredCT.cfm](http://www.nature.nps.gov/air/permits/ect/ectGasFiredCT.cfm)

NOX and CO emissions are based on proposed emission limits of 2 parts per million by volume, dry (ppmvd) at 15 percent O₂, 3-hour and 1-hour averages, respectively. SO2 emissions are based on mass balance calculations using the concentration of sulfur in the natural gas passing through Williams Northwest Pipeline Sumas station in Washington. Recent data (from the 4th quarter of 2007 through the 3rd quarter of 2008) reveal 24-hour, 3-hour, and 1-hour levels of 2.13, 2.34, and 2.36 grains sulfur per 100 cubic feet (gr/100 cf), respectively, based on the 99th percentile sulfur concentration for those averaging periods. The annual average concentration during the same measurement period was 1.07 gr/100 cf. Particulate matter (PM) and VOC emissions are based on data provided by GE.

The proposed modification also has the potential to emit non-criteria air pollutants that are regulated at the federal level by the CAA Section 112 and at the state level by Ecology under Chapter 173-460 WAC. Some of these pollutants are deemed “hazardous air pollutants” (HAPs) under the CAA Section 112; others are defined as TAPs under Chapter 173-460 WAC.

Table 2-2 identifies TAPs expected to be emitted by the combustion turbines based on emission factors from Section 3.1 of USEPA’s AP-42 emission factor document (Stationary Gas Turbines). Emission factors in Section 1.4 (Natural Gas Combustion) of AP-42 were used to estimate duct burner TAP and HAP emission rates. Ammonia slip emissions are based on a proposed permit limit of 5 ppmvd at 15 percent O₂. Sulfuric acid (H2SO4) emissions were based on an assumed 33 percent conversion of SO2. Table 2-2 presents the maximum total TAP and HAP emissions from a single combustion turbine under full load operation with duct burning.
Table 2-2. Combustion Turbine TAP & HAP Emission Rates

<table>
<thead>
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<th>Compound</th>
<th>CAS #</th>
<th>Emission Factors (lb/MMBtu)</th>
<th>Duct Burner (lb/MMscf)</th>
<th>Maximum Emission Rate (lb/hr)</th>
<th>(ton/yr)</th>
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<tr>
<td>Acetaldehyde</td>
<td>75-07-0</td>
<td>0.00004</td>
<td>--</td>
<td>0.0758</td>
<td>0.332</td>
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<tr>
<td>Acrolein</td>
<td>107-02-8</td>
<td>0.0000064</td>
<td>--</td>
<td>0.0121</td>
<td>0.0531</td>
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<tr>
<td>Ammonia</td>
<td>7664-41-7</td>
<td>0.009064627</td>
<td>--</td>
<td>17.2</td>
<td>75.2</td>
</tr>
<tr>
<td>Arsenic</td>
<td>7440-38-2</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.000109</td>
<td>0.000476</td>
</tr>
<tr>
<td>Barium</td>
<td>7440-39-3</td>
<td>--</td>
<td>0.0044</td>
<td>0.00239</td>
<td>0.0105</td>
</tr>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td>0.000012</td>
<td>0.0021</td>
<td>0.0239</td>
<td>0.105</td>
</tr>
<tr>
<td>Beryllium</td>
<td>7440-41-7</td>
<td>--</td>
<td>0.000012</td>
<td>0.00000652</td>
<td>0.000285</td>
</tr>
<tr>
<td>1,3-Butadiene</td>
<td>106-99-0</td>
<td>0.00000043</td>
<td>--</td>
<td>0.000814</td>
<td>0.00357</td>
</tr>
<tr>
<td>Butane</td>
<td>106-97-8</td>
<td>--</td>
<td>2.1</td>
<td>1.14</td>
<td>4.99</td>
</tr>
<tr>
<td>Cadmium</td>
<td>7440-43-9</td>
<td>--</td>
<td>0.0011</td>
<td>0.000597</td>
<td>0.00262</td>
</tr>
<tr>
<td>Chromium, total</td>
<td>7440-47-3</td>
<td>--</td>
<td>0.0014</td>
<td>0.00076</td>
<td>0.00333</td>
</tr>
<tr>
<td>Chromium, hexavalent</td>
<td>18540-29-9</td>
<td>--</td>
<td>0.0007</td>
<td>0.00038</td>
<td>0.00166</td>
</tr>
<tr>
<td>Cobalt</td>
<td>7440-48-4</td>
<td>--</td>
<td>0.000084</td>
<td>0.0000456</td>
<td>0.002</td>
</tr>
<tr>
<td>Copper</td>
<td>7440-50-8</td>
<td>--</td>
<td>0.00085</td>
<td>0.000462</td>
<td>0.00202</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>100-41-4</td>
<td>0.000032</td>
<td>--</td>
<td>0.0606</td>
<td>0.265</td>
</tr>
<tr>
<td>Formaldehyde¹</td>
<td>50-00-0</td>
<td>0.0001065</td>
<td>0.01125</td>
<td>0.208</td>
<td>0.91</td>
</tr>
<tr>
<td>Hexane</td>
<td>110-54-3</td>
<td>--</td>
<td>1.8</td>
<td>0.977</td>
<td>4.28</td>
</tr>
<tr>
<td>Manganese</td>
<td>7439-96-5</td>
<td>--</td>
<td>0.0038</td>
<td>0.00206</td>
<td>0.00904</td>
</tr>
<tr>
<td>Mercury</td>
<td>7439-97-6</td>
<td>--</td>
<td>0.0026</td>
<td>0.00141</td>
<td>0.00618</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>7439-98-7</td>
<td>--</td>
<td>0.0011</td>
<td>0.000597</td>
<td>0.00262</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>91-20-3</td>
<td>0.0000013</td>
<td>0.00061</td>
<td>0.00279</td>
<td>0.0122</td>
</tr>
<tr>
<td>Nickel</td>
<td>7440-02-0</td>
<td>--</td>
<td>0.0021</td>
<td>0.00114</td>
<td>0.00499</td>
</tr>
<tr>
<td>Pentane</td>
<td>109-66-0</td>
<td>--</td>
<td>2.6</td>
<td>1.41</td>
<td>6.18</td>
</tr>
<tr>
<td>Polynuclear Hydrocarbons</td>
<td>PAH</td>
<td>0.0000022</td>
<td>0.0000096</td>
<td>0.00417</td>
<td>0.0183</td>
</tr>
<tr>
<td>Polycyclic Organic Matter</td>
<td>POM</td>
<td>0.0000022</td>
<td>0.0000882</td>
<td>0.00422</td>
<td>0.0185</td>
</tr>
<tr>
<td>Propylene Oxide</td>
<td>75-56-9</td>
<td>0.000029</td>
<td>--</td>
<td>0.0549</td>
<td>0.241</td>
</tr>
<tr>
<td>Selenium</td>
<td>7784-49-2</td>
<td>--</td>
<td>0.000024</td>
<td>0.000013</td>
<td>0.000571</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>7664-93-9</td>
<td>--</td>
<td>--</td>
<td>3.9</td>
<td>17.1</td>
</tr>
<tr>
<td>Toluene</td>
<td>108-88-3</td>
<td>0.00013</td>
<td>0.0034</td>
<td>0.248</td>
<td>1.09</td>
</tr>
<tr>
<td>Vanadium</td>
<td>7440-62-2</td>
<td>--</td>
<td>0.0023</td>
<td>0.00125</td>
<td>0.00547</td>
</tr>
<tr>
<td>Xylenes</td>
<td>1330-20-7</td>
<td>0.000064</td>
<td>--</td>
<td>0.121</td>
<td>0.531</td>
</tr>
</tbody>
</table>

¹ The formaldehyde emission factors were reduced by 85% to reflect control provided by the oxidation catalyst. See page 7 of AP-42 Section 3.1.

2.2.2 Auxiliary Boiler

The auxiliary boiler will combust only natural gas and will be used to generate steam to reduce the duration of the startup period for the CTGs and STG. Although the boiler is unlikely to operate when a combustion turbine is operating, the modeling of the continuous operation “base load” scenario includes boiler emissions for a 24-hour period. Criteria pollutant emissions summarized in Table 2-3 are based on the use of ultra-low-NOx burners to achieve 9 ppmvd NOx at 3 percent O2, and good combustion control to achieve 50 ppmvd CO at 3 percent O2.
SO₂ emissions are based on a mass balance calculation similar to that used to calculate emissions from the CTGs. PM₁₀ and VOC emissions are based on factors from Section 1.4 of AP-42.

### Table 2-3. Auxiliary Boiler Criteria Pollutant Emission Rates

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emission Factor (lb/MMBtu)</th>
<th>Short-Term Emission Rate (lb/hr)</th>
<th>Annual Emission Rate¹ (ton/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOₓ</td>
<td>0.011</td>
<td>0.3223</td>
<td>4.60E-05</td>
</tr>
<tr>
<td>CO</td>
<td>0.037</td>
<td>1.0841</td>
<td>1.55E-04</td>
</tr>
<tr>
<td>SO₂²</td>
<td>0.0066</td>
<td>0.192925</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>0.0065</td>
<td>0.19129</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>0.0059</td>
<td>0.174123</td>
<td>--</td>
</tr>
<tr>
<td>PM₁₀³</td>
<td>0.005</td>
<td>0.1465</td>
<td>2.09E-05</td>
</tr>
<tr>
<td>VOC</td>
<td>0.004</td>
<td>0.1172</td>
<td>1.67E-05</td>
</tr>
</tbody>
</table>

¹ Based on 2,500 hours of operation per year
² Assumed natural gas sulfur contents in grains per 100 standard cubic feet: 2.36 (1-hr average), 2.34 (3-hr average, and 2.13 (24-hr average)
³ PM₂.₅ emissions are assumed to be equal to the filterable portion of PM₁₀ emissions which is based on the fraction provided in USEPA's AP-42 Section 1.4.

Auxiliary boiler TAP emissions were calculated based on natural gas-fired boiler emission factors from Section 1.4 of AP-42 and the maximum rated boiler heat input (29.3 MMBtu/hr). Maximum annual emissions were based on a maximum of 2,500 hours of operation per year. Table 2-4 presents the TAP and HAP emissions for the auxiliary boiler.

### Table 2-4. Auxiliary Boiler TAP & HAP Emission Rates

<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS #</th>
<th>Emission Factor (lb/MMscf)</th>
<th>Short-Term Emission Rate (lb/hr)</th>
<th>Annual Emission Rate¹ (ton/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>7440-38-2</td>
<td>2.00E-04</td>
<td>5.72E-06</td>
<td>7.15E-06</td>
</tr>
<tr>
<td>Barium</td>
<td>7440-39-3</td>
<td>4.40E-03</td>
<td>1.26E-04</td>
<td>1.57E-04</td>
</tr>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td>2.10E-03</td>
<td>6.01E-05</td>
<td>7.51E-05</td>
</tr>
<tr>
<td>Beryllium</td>
<td>7440-41-7</td>
<td>1.20E-05</td>
<td>3.43E-07</td>
<td>4.29E-07</td>
</tr>
<tr>
<td>Butane</td>
<td>106-97-8</td>
<td>2.10E+00</td>
<td>6.01E-02</td>
<td>7.51E-02</td>
</tr>
<tr>
<td>Cadmium</td>
<td>7440-43-9</td>
<td>1.10E-03</td>
<td>3.15E-05</td>
<td>3.93E-05</td>
</tr>
<tr>
<td>Chromium, Total</td>
<td>7440-47-3</td>
<td>1.40E-03</td>
<td>4.10E-05</td>
<td>5.01E-05</td>
</tr>
<tr>
<td>Chromium, Hexavalent</td>
<td>18540-29-9</td>
<td>7.00E-04</td>
<td>2.00E-05</td>
<td>2.50E-05</td>
</tr>
<tr>
<td>Cobalt</td>
<td>7440-48-4</td>
<td>8.40E-05</td>
<td>2.40E-06</td>
<td>3.00E-06</td>
</tr>
<tr>
<td>Copper</td>
<td>7440-50-8</td>
<td>8.50E-04</td>
<td>2.43E-05</td>
<td>3.04E-05</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>7440-47-3</td>
<td>7.50E-02</td>
<td>2.15E-03</td>
<td>2.68E-03</td>
</tr>
<tr>
<td>Hexane</td>
<td>110-54-3</td>
<td>1.80E+00</td>
<td>5.15E-02</td>
<td>6.44E-02</td>
</tr>
<tr>
<td>Manganese</td>
<td>7439-96-5</td>
<td>3.80E-04</td>
<td>1.09E-05</td>
<td>1.36E-05</td>
</tr>
<tr>
<td>Mercury</td>
<td>7439-97-6</td>
<td>2.60E-04</td>
<td>7.44E-06</td>
<td>9.30E-06</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>7439-98-7</td>
<td>1.10E-03</td>
<td>3.15E-05</td>
<td>3.93E-05</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>91-20-3</td>
<td>6.10E-04</td>
<td>1.75E-05</td>
<td>2.18E-05</td>
</tr>
</tbody>
</table>
2.2.3 Emergency Diesel Engines

Diesel-fueled engines will be used to provide emergency power and pressurized water for fire protection during a power outage. The engines will meet the emission standards prescribed by 40 CFR Part 60 Subpart IIII (Standards of Performance for Stationary Compression Ignition Internal Combustion Engines). Ordinarily, the engine will operate only a few hours per month for testing, and Subpart IIII limits non-emergency operation to 100 hours per year. In the modeling analyses, it is assumed that the engine is tested in the one hour scenario, but operates only one hour in the 3-hour, 8-hour, and 24-operating scenarios. Annual emissions are estimated based on 100 hours of operation over the course of a year. Hourly and annual criteria pollutant emissions are presented in Table 2-5.

Table 2-5. Emergency Diesel Engine Criteria Pollutant Emission Rates

<table>
<thead>
<tr>
<th>Emergency Generator</th>
<th>Units</th>
<th>NOₓ ¹</th>
<th>CO ²</th>
<th>SO₂ ²</th>
<th>PM₁₀ ³</th>
<th>VOC ¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission Factor</td>
<td>g/kW-hr</td>
<td>4.0</td>
<td>3.5</td>
<td>0.0074</td>
<td>0.20</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>lb/hp-hr</td>
<td>0.0066</td>
<td>0.0058</td>
<td>0.00001</td>
<td>0.00033</td>
<td>0.0066</td>
</tr>
<tr>
<td>Emission Rate</td>
<td>lb/hr</td>
<td>3.95</td>
<td>3.45</td>
<td>0.00728</td>
<td>0.197</td>
<td>3.95</td>
</tr>
<tr>
<td></td>
<td>ton/yr ⁵</td>
<td>0.197</td>
<td>0.173</td>
<td>0.00036</td>
<td>0.00987</td>
<td>0.197</td>
</tr>
<tr>
<td>Emergency Fire Water Pump</td>
<td>Units</td>
<td>NOₓ ¹</td>
<td>CO ²</td>
<td>SO₂ ²</td>
<td>PM₁₀ ³</td>
<td>VOC ¹</td>
</tr>
<tr>
<td>Emission Factor</td>
<td>g/kW-hr</td>
<td>3.0</td>
<td>2.6</td>
<td>0.0074</td>
<td>0.15</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>lb/hp-hr</td>
<td>0.0049</td>
<td>0.0043</td>
<td>0.00001</td>
<td>0.00066</td>
<td>0.0049</td>
</tr>
<tr>
<td>Emission Rate</td>
<td>lb/hr</td>
<td>1.36</td>
<td>1.18</td>
<td>0.00334</td>
<td>0.181</td>
<td>1.36</td>
</tr>
<tr>
<td></td>
<td>ton/yr ⁵</td>
<td>0.0678</td>
<td>0.0588</td>
<td>0.00016</td>
<td>0.00905</td>
<td>0.0678</td>
</tr>
</tbody>
</table>

¹ Conservatively assumed both NOₓ and VOC emissions equal the Subpart IIII limit on the sum of NOₓ and VOC emissions.

² SO₂ based on AP-42 Section 3.4, Table 3.4-1 and fuel sulfur content of 0.05% by weight (8.09e-3 × %S).

³ PM₂.₅ emissions are equal to the filterable portion of PM₁₀, which was calculated using a ratio of emission factors from Table 3.4-2 in USEPA’s AP-42, Section 3.4.

⁴ 40 CFR Part 60.4202(a)(2) Subpart IIII (except SO₂, see note 2)
Modeling Protocol in Support of an NOC/PSD Permit Application to Install Two Power Generation Units

5 Based on 100 hours per year of maintenance operation per engine.

The emergency diesel engine TAP and HAP emission rates presented in Table 2-6 were calculated based on the emission standards in Subpart III. Maximum annual emissions were based on the 100 hour per year limit of non-emergency operation imposed by Subpart III.

### Table 2-6. Emergency Diesel Engine TAP & HAP Emission Rates

<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS #</th>
<th>Emission Factor¹ (lb/MMBtu)</th>
<th>Emergency Generator</th>
<th>Fire Water Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Short-term (lb/hr)</td>
<td>Annual² (ton/yr)</td>
<td>Short-term (lb/hr)</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>75-07-0</td>
<td>7.67E-04</td>
<td>1.17E-03</td>
<td>5.85E-05</td>
</tr>
<tr>
<td>Acrolein</td>
<td>107-02-8</td>
<td>9.25E-05</td>
<td>1.41E-04</td>
<td>7.06E-06</td>
</tr>
<tr>
<td>1,3-Butadiene</td>
<td>106-99-0</td>
<td>3.91E-05</td>
<td>5.97E-05</td>
<td>2.98E-06</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>50-00-0</td>
<td>1.18E-03</td>
<td>1.80E-03</td>
<td>9.00E-05</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>91-20-3</td>
<td>8.48E-05</td>
<td>1.29E-04</td>
<td>6.47E-06</td>
</tr>
<tr>
<td>Propylene</td>
<td>115-07-1</td>
<td>2.58E-04</td>
<td>3.94E-04</td>
<td>1.97E-05</td>
</tr>
<tr>
<td>Polyaromatic Hydrocarbons³</td>
<td>PAH</td>
<td>4.51E-06</td>
<td>6.88E-06</td>
<td>3.44E-07</td>
</tr>
<tr>
<td>Polycyclic Organic Matter⁴</td>
<td>POM</td>
<td>8.31E-05</td>
<td>1.27E-04</td>
<td>6.34E-06</td>
</tr>
<tr>
<td>Toluene</td>
<td>108-88-3</td>
<td>4.09E-04</td>
<td>6.24E-04</td>
<td>3.12E-05</td>
</tr>
<tr>
<td>Xylenes</td>
<td>1330-20-7</td>
<td>2.85E-04</td>
<td>4.35E-04</td>
<td>2.17E-05</td>
</tr>
</tbody>
</table>

¹ Emission factors from USEPA AP-42 Section 3.3 Small Diesel Engines (<600hp)
² Maximum annual emission based on 100 hr/yr normal maintenance operation per engine.
³ Washington State PAHs determined by WAC 173-460-50
⁴ For the CAA112 requirements, all Polyaromatic Hydrocarbons (PAH) will be considered Polycyclic Organic Matter (POM)

### 2.2.4 Cooling Towers

A cooling tower would be installed and operated to condense steam so that the water can be recycled. These cooling towers release water droplets that contain naturally-occurring dissolved solids from the water supply, and are concentrated in the cooling process.

The cooling tower is configured in two parallel sets of 5 cells. The quantity of water released as droplets to the air (the drift rate) is based on 0.0005 percent of the water recirculation rate, and reflects the use of very high efficiency drift eliminators. The total dissolved solids (TDS) content of the drift is the maximum value estimated from local water quality measurement data water concentrated 12 times by the water recirculation cycles. PM emissions from the cooling tower displayed in Table 2-7 are based on the assumption that water throughput is maximized in all cooling tower cells. The cooling towers are not expected to emit any TAPs.
Table 2-7. Cooling Tower Particulate Matter Emission Rates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water circulation rate</td>
<td>MMlb/hr</td>
<td>87.6</td>
</tr>
<tr>
<td>Maximum dissolved solids(^1)</td>
<td>ppmw</td>
<td>1,800</td>
</tr>
<tr>
<td>Drift as fraction of circulating water</td>
<td>%</td>
<td>0.0005</td>
</tr>
<tr>
<td>Short-term PM(_{10}) emission rate(^2)(^4)</td>
<td>lb/hr</td>
<td>0.79</td>
</tr>
<tr>
<td>Annual PM(_{10}) emission rate(^3)(^4)</td>
<td>ton/yr</td>
<td>3.5</td>
</tr>
</tbody>
</table>

\(^1\) Maximum expected total dissolved solids (TDS) in makeup water = 150 parts per million by weight (ppmw); maximum expected TDS in circulating cooling water at twelve cycles = 12 x 150 = 1800 ppmw

\(^2\) Example calculation: \((87.6 \times 10^6 \text{ lb/hr}) \times (0.000005 \text{ lb drift/lb water}) \times (1800 \text{ lb PM}/10^6 \text{ lb drift}) = 0.79 \text{ lb/hr}\)

\(^3\) Based on continuous operation \((8,760 \text{ hr/yr})\)

\(^4\) PM\(_{2.5}\) emissions are equal to filterable PM\(_{10}\) emissions, which were assumed to be 100 percent of total PM\(_{10}\) emissions.

2.2.5 Short-Term Emission Rate Summary

Short-term maximum criteria pollutant emission rates for operation are summarized in Table 2-8. This table presents emissions for three combustion turbines operating scenarios, and maximum operation for the cooling tower, auxiliary boiler, and emergency diesel engines. In practice, it is unlikely that these units would all operate simultaneously at their maximum capacity.

Table 2-8. Maximum Proposed Short-Term Criteria Pollutant Emission Rate Increases\(^1\)

<table>
<thead>
<tr>
<th>Source</th>
<th>NO(_x)</th>
<th>CO</th>
<th>SO(_2)</th>
<th>PM(_{10})</th>
<th>PM(_{2.5})(^2)</th>
<th>VOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion Turbines w/Duct Firing(^3)</td>
<td>40.0</td>
<td>24.4</td>
<td>28.3</td>
<td>38.0</td>
<td>9.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Combustion Turbines @ 100% Load(^3)</td>
<td>31.7</td>
<td>19.3</td>
<td>21.9</td>
<td>38.0</td>
<td>9.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Combustion Turbines @ 60% Load(^3)</td>
<td>22.5</td>
<td>13.7</td>
<td>15.6</td>
<td>38.0</td>
<td>9.5</td>
<td>11.8</td>
</tr>
<tr>
<td>Auxiliary Boiler</td>
<td>0.32</td>
<td>1.1</td>
<td>0.17</td>
<td>0.15</td>
<td>0.04</td>
<td>0.12</td>
</tr>
<tr>
<td>Emergency Diesel Generator</td>
<td>0.16</td>
<td>3.5</td>
<td>0.0073</td>
<td>0.0082</td>
<td>0.0069</td>
<td>3.9</td>
</tr>
<tr>
<td>Emergency Diesel Fire Pump</td>
<td>0.057</td>
<td>1.2</td>
<td>0.0033</td>
<td>0.0075</td>
<td>0.0063</td>
<td>1.4</td>
</tr>
<tr>
<td>Cooling Tower</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>0.8</td>
<td>0.8</td>
<td>--</td>
</tr>
<tr>
<td>100% Load w/Duct Firing Total</td>
<td>40.6</td>
<td>30.1</td>
<td>28.5</td>
<td>39.0</td>
<td>10.3</td>
<td>12.4</td>
</tr>
<tr>
<td>100% Load Total</td>
<td>32.3</td>
<td>25.0</td>
<td>22.1</td>
<td>39.0</td>
<td>10.3</td>
<td>10.9</td>
</tr>
<tr>
<td>60% Load Total</td>
<td>23.1</td>
<td>19.4</td>
<td>15.7</td>
<td>39.0</td>
<td>10.3</td>
<td>17.2</td>
</tr>
<tr>
<td>Worst Case Total</td>
<td>40.6</td>
<td>30.1</td>
<td>28.5</td>
<td>39.0</td>
<td>10.3</td>
<td>17.2</td>
</tr>
</tbody>
</table>

\(^1\) All emission rates are in pounds per hour, averaged over one hour.

\(^2\) Filterable PM\(_{2.5}\).

\(^3\) Combined emission rate for both units.
2.3 Annual Average Normal Operation Emission Rates

Annual emissions (typically expressed as tons per year or tpy) depend on how many hours each unit operates and the unit’s operating rate during those periods. Table 2-9 presents annual emissions assuming the combustion turbines operate every hour of the year in the operating mode with the highest emission rates; these occur when the CTGs are operating at 100 percent load with duct burners for all pollutants except VOCs, which are highest when the CTGs operate at 60 percent load. In consideration of the potential operating mode with frequent startups and shutdowns, annual average emission rates that incorporate a daily startup/operation/shutdown sequence will be developed.

Table 2-9. Criteria Pollutant Annual Emission Rates for Continuous Operation

<table>
<thead>
<tr>
<th>Source</th>
<th>(\text{NO}_x^1)</th>
<th>(\text{CO}^1)</th>
<th>(\text{SO}_2^1)</th>
<th>(\text{PM}_{10}^1)</th>
<th>(\text{VOC}^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion Turbines(^2) w/Duct Firing</td>
<td>175</td>
<td>107</td>
<td>64.1</td>
<td>144</td>
<td>30.5</td>
</tr>
<tr>
<td>Combustion Turbines @ 100% Load(^2)</td>
<td>139</td>
<td>84.6</td>
<td>24.8</td>
<td>127</td>
<td>24.2</td>
</tr>
<tr>
<td>Combustion Turbines(^2) @ 60% Load</td>
<td>98.8</td>
<td>60.1</td>
<td>17.6</td>
<td>90.5</td>
<td>51.5</td>
</tr>
<tr>
<td>Auxiliary Boiler(^3)</td>
<td>0.40</td>
<td>1.4</td>
<td>0.24</td>
<td>0.18</td>
<td>0.15</td>
</tr>
<tr>
<td>Emergency Diesel Generator(^4)</td>
<td>0.0082</td>
<td>0.17</td>
<td>0.00036</td>
<td>0.00041</td>
<td>0.20</td>
</tr>
<tr>
<td>Emergency Diesel Fire Pump(^4)</td>
<td>0.0028</td>
<td>0.059</td>
<td>0.00017</td>
<td>0.00038</td>
<td>0.068</td>
</tr>
<tr>
<td>Cooling Towers(^5)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>7.7</td>
<td>--</td>
</tr>
<tr>
<td>100% Load w/Duct Firing Total</td>
<td>176</td>
<td>108</td>
<td>64.3</td>
<td>152</td>
<td>30.9</td>
</tr>
<tr>
<td>100% Load Total</td>
<td>139</td>
<td>86</td>
<td>25.0</td>
<td>135</td>
<td>24.6</td>
</tr>
<tr>
<td>60% Load Total</td>
<td>99</td>
<td>61.7</td>
<td>17.9</td>
<td>98.4</td>
<td>51.9</td>
</tr>
<tr>
<td>Maximum Facility-wide Emissions</td>
<td>176</td>
<td>108</td>
<td>64.3</td>
<td>152</td>
<td>51.9</td>
</tr>
</tbody>
</table>

\(^1\) Emission rates are in tons per year
\(^2\) Combined emission rates for both units
\(^3\) 2,500 hours per year
\(^4\) Maximum of 100 hours per year of maintenance/testing operation
\(^5\) Total for 10 cooling tower cells

Auxiliary boiler emissions are based on full load operation for 2,500 hours per year. Although GHE intends to test the emergency diesel engines only a few hours per month, the annual emission scenario assumes it is operated 100 hours per year at its maximum capacity rating. Annual \(\text{PM}_{10}\) emissions from the cooling towers are based on the assumption that the water flow rate is maximized in each cell every hour of the year. In practice, water flow may be reduced as outdoor temperatures drop or when the combustion turbine load decrease. Consequently, this assumption provides a conservative estimate of cooling tower emissions.

2.4 Startup Emission Rates

Emissions of some pollutants are higher during startup than during normal operations because combustion is not yet optimized or because control equipment is not functional under all operating conditions. Like automobile engines, combustion turbines emit more carbon...
monoxide during startup because combustion is optimized for a warm engine and the typical higher loads (usually 60 percent load or greater). Combustion turbine NOX emissions are also higher during startup, in part because the SCR is not effective at low exhaust gas temperatures.

The duration of a combustion turbine startup event and the total pollutant emissions from the event depend on the extent of the downtime preceding the event. Startup times and emissions provided by the turbine manufacturer are shown in Table 2-10. Modeling simulations will be developed for cases where a pollutant emission rate exceeds that of one of the normal operating scenarios. Because stack parameters vary throughout a startup or shutdown event, modeling simulations were developed using stack parameters from every available operating scenario. In all cases, the operational scenario that generates maximum pollutant emissions will be assume for the balance of the averaging periods (in all cases, this is 100 percent load with duct firing). At this point, only the short-term NOX and CO emission rates exceed the corresponding normal operation emission rates. For both the 1- and 8-hour average CO concentrations, emissions based on a warm start followed by normal operation will be included in the startup modeling simulation. Because there is no short-term ambient NOX standard, no short-term NOX startup modeling will be developed.²

Table 2-10. Combustion Turbine Startup and Shutdown Duration and Emission Rates

<table>
<thead>
<tr>
<th>Mode¹</th>
<th>Time² (min)</th>
<th>NOX</th>
<th>CO</th>
<th>SO2⁴</th>
<th>Emissions per Event³ (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NOX</td>
</tr>
<tr>
<td>Cold Start</td>
<td>241</td>
<td>520</td>
<td>1,300</td>
<td>7.3</td>
<td>22.0</td>
</tr>
<tr>
<td>Warm Start</td>
<td>124</td>
<td>275</td>
<td>1,900</td>
<td>6.4</td>
<td>13.2</td>
</tr>
<tr>
<td>Hot Start</td>
<td>83</td>
<td>175</td>
<td>800</td>
<td>5.5</td>
<td>10.1</td>
</tr>
<tr>
<td>Shutdown</td>
<td>30</td>
<td>100</td>
<td>650</td>
<td>7.7</td>
<td>3.8</td>
</tr>
</tbody>
</table>

¹ Startup mode definitions: Cold Start is more than 72 hours since shutdown, Warm Start is approximately 48 hours since shutdown, and Cold Start is less than 8 hours since shutdown.

² Time for both turbines to reach 100 % load for startup (first turbine will reach 100% load 20-30 minutes before the second), and to go from 100% load to no operation for shutdown.

³ Emissions are for both turbines, combined.

⁴ SO2 emissions were not provided by the turbine manufacturer. Based on analysis of continuous emissions monitor system (CEMS) data collected from the existing Units 1 & 2 during startup and shutdown events, it was estimated that the average emission rate during a cold start event is approximately 50% of hourly 100% load normal operation emission rate, 58.5% during a warm start event, 67% during a hot start event, and 70% during shutdown.

² The 24-hour average NOX emission rate reflecting startup and shutdown emissions will be included in the worst-case AQRV analysis of visibility impacts.
Annual average NO\textsubscript{X}, SO\textsubscript{2}, and PM\textsubscript{10} emission rates (filterable PM\textsubscript{2.5} was assumed to be 25 percent of PM\textsubscript{10}) reflecting startup and shutdown emission rates have been developed for three startup scenarios: cold startup, warm startup, and hot startup. The normal operation annual average emission rates assume no startups or shutdowns; to bound the universe of reasonable possibilities each of the three startup scenarios was assumed to occur as often as possible, followed by 16 hours of operation (100 percent load with duct firing), and a shutdown. The cycle starts again following the minimum amount of non-operational time prior to startup that defines the scenario (i.e., 72 hours for cold start, 10 hours for warm start, and 0 hours for hot start) and repeats throughout the year. At this point, preliminary emission rate calculations indicate that only annual average NO\textsubscript{X} exceeds the corresponding normal operation emission rate.

2.5 Unit 1, Unit 2, and Related Source Emission Rates

The discussion above described emissions from sources related to the proposed new Unit 3 and Unit 4. In addition to air quality simulations with these sources, EFSEC and USEPA requested that potential air quality impacts to Class I areas also include emissions from the existing facility (referred to as Unit 1 and Unit 2). PSD regulations do not require these cumulative impact simulations to assess the ambient standards and/or the PSD increments unless screening criteria are exceeded due to emissions from the new sources. However, at the request of USEPA and EFSEC, simulations will be performed with both existing and proposed GHEC sources to provide data to the Federal Land Managers even if the screening criteria are not exceeded. Table 2-10 and Table 2-11 show the maximum permitted daily and annual emissions from the existing Unit 1 and Unit 2 sources that will be used in the simulations for Class I areas.

<table>
<thead>
<tr>
<th>Source</th>
<th>NO\textsubscript{X}</th>
<th>SO\textsubscript{2}</th>
<th>PM\textsubscript{10}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion Turbines w/Duct Firing(^2)</td>
<td>34.8</td>
<td>39.6</td>
<td>45.2</td>
</tr>
<tr>
<td>Auxiliary Boiler</td>
<td>1.03</td>
<td>0.07</td>
<td>0.29</td>
</tr>
<tr>
<td>Emergency Diesel Generator(^3)</td>
<td>7.05</td>
<td>0.27</td>
<td>0.11</td>
</tr>
<tr>
<td>Emergency Diesel Fire Pump(^4)</td>
<td>4.2</td>
<td>0.11</td>
<td>0.24</td>
</tr>
<tr>
<td>Cooling Towers</td>
<td>--</td>
<td>--</td>
<td>1.02</td>
</tr>
</tbody>
</table>

\(^1\) All emission rates are in pounds per hour.
\(^2\) Combined emission rate for both units.
\(^3\) Emergency generator emissions based on 500 kilowatt (kW) engine rating, but actual nameplate is 400 kW. Emergency generator NO\textsubscript{X} emission rates include NO\textsubscript{X} and NMOC (as limited by 40 CFR 89.112)
\(^4\) Fire water pump emissions based on 205 kW engine rating (275 hp) and corresponding emission factors from 40 CFR 89.112 (2002 engine). SO\textsubscript{2} emissions based on AP-42 section 3.4, Table 3.4-1 and sulfur content of 0.05 percent by weight.
Table 2-11. Maximum Permitted Unit 1, Unit 2, and Related Source Annual Emission Rates

<table>
<thead>
<tr>
<th>Source</th>
<th>NO\textsubscript{X}</th>
<th>SO\textsubscript{2}</th>
<th>PM\textsubscript{10}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion Turbines w/Duct Firing\textsuperscript{3}</td>
<td>243.4</td>
<td>58.0</td>
<td>198.0</td>
</tr>
<tr>
<td>Auxiliary Boiler</td>
<td>1.3</td>
<td>0.106</td>
<td>0.4</td>
</tr>
<tr>
<td>Emergency Diesel Generator\textsuperscript{4}</td>
<td>1.76</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>Emergency Diesel Fire Pump\textsuperscript{5}</td>
<td>1.04</td>
<td>0.028</td>
<td>0.061</td>
</tr>
<tr>
<td>Cooling Towers</td>
<td>--</td>
<td>--</td>
<td>4.5</td>
</tr>
</tbody>
</table>

\textsuperscript{1} All emission rates are in tons per year.

\textsuperscript{2} Based on recent sulfur analysis of pipeline natural gas in the Pacific Northwest, annual average SO\textsubscript{2} emissions from the combustion turbines, duct burners, and auxiliary boiler will be based on a gas sulfur content of 1.0 gr/100 scf, rather than the 0.5 gr/100 scf that was assumed when the current annual permit limits were calculated.

\textsuperscript{3} Combined emission rate for both units.

\textsuperscript{4} Emergency generator emissions based on 500 kilowatt (kW) engine rating, but actual nameplate is 400 kW. Emergency generator NO\textsubscript{X} emission rates include NO\textsubscript{X} and NMOC (as limited by 40 CFR 89.112).

\textsuperscript{5} Fire water pump emissions based on 205 kW engine rating (275 hp) and corresponding emission factors from 40 CFR 89.112 (2002 engine). SO\textsubscript{2} emissions based on AP-42 section 3.4, Table 3.4-1 and sulfur content of 0.05 percent by weight. Annual emissions based on 500 hours of operation per year.
3 Air Quality Impact Analysis Methodology

3.1 Model Selection
As of November 9, 2005, AERMOD became the model recommended by the USEPA’s Guideline on Air Quality Models (codified as Appendix W to 40 CFR Part 51) as the preferred dispersion model for complex source configurations and for sources subject to building downwash. The latest version of the USEPA regulatory model AERMOD (Version 07026) will be used for the dispersion modeling analysis.

3.2 Model Input Data

3.2.1 Emission Rates
The short-term and annual emission rates calculated for modification sources as described in the previous section will be included in the modeling simulations. Simulations will be developed for four operating power generation unit scenarios (100 percent load with duct firing, 100 percent load, 60 percent load, and startup/shutdown). In addition, emission rates for each of the four scenarios at three different ambient temperature and relative humidity combinations (20 °F/30%, 59 °F/60%, and 90 °F/60%) will be modeled. If facility-wide modeling becomes necessary to assess compliance with ambient standards and increments in the area surrounding the facility, the emission rates summarized in Table 2-10 and Table 2-11 will be used for existing sources at the facility.

3.2.2 Elevation Data and Receptor Network
Several receptor grids will be used in the dispersion modeling simulations. The modeling domain shown in Figure 3-1 is 10 km-by-10 km. Initially, receptors will be placed 500 meters apart covering the entire modeling domain, with a 50 km-by-50 km nested receptor grid with 200 m spacing, and a 2 km-by-2 km nested grid with 50-m spacing. The nested grids will be located such that Grays Harbor Energy Center is the center of each grid, and receptors will be located at 25-m intervals along the fenceline of the facility. Nested 25-m spacing grids will be placed around the locations of the initially-predicted maximum concentrations to more fully resolve the magnitude and location of the predicted maximum concentration.

Terrain elevations and hill height scale values for the receptors shown in Figure 3-1 will be calculated using the AERMAP preprocessor (Version 09040) with 7.5-minute United States Geological Survey digital elevation model (DEM) quadrangles (Elma, Montesano, Prices Peak, and South Elma) obtained from the internet (http://www.mapmart.com). These data have a horizontal spatial resolution of about 10 m. Terrain heights surrounding the facility indicate that some receptors are likely to be located in “complex terrain” (i.e., above plume height).
3.2.3 Meteorological Data

A representative one-year meteorological dataset (May 20, 2002 – May 19, 2003) for the AERMOD dispersion model was prepared for the Satsop, Washington area using available surface meteorological data, upper air meteorological data, and the AERMOD meteorological preprocessor AERMET (Version 06341). This section describes the data and procedures used to generate the meteorological data set.

Surface Data Processing

A meteorological station located in Satsop, Washington was operated by MFG, Inc. for Duke Energy North America from May 2002 until May 2003. The Satsop meteorological station collected hourly wind speed, wind direction, solar radiation, differential temperature (delta-T), lateral wind turbulence (sigma-theta), vertical wind turbulence (sigma-w), temperature, relative humidity, station pressure, and precipitation (the annual data report is provided in Appendix A). The sensors employed and the audit procedures used meet USEPA requirements for meteorological data to support PSD permits. The Satsop station collected the necessary data for the regulatory dispersion model AERMOD. Table 3-1 presents the Satsop data recovery for all meteorological variables.

Table 3-1. Satsop Meteorological Site Data Recovery (May 20, 2002 – May 19, 2003)

<table>
<thead>
<tr>
<th>Meteorological Parameter</th>
<th>Data Recovery (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 m Temperature</td>
<td>72.03</td>
</tr>
<tr>
<td>10 m Wind Speed</td>
<td>99.18</td>
</tr>
<tr>
<td>10 m Wind Direction</td>
<td>96.87</td>
</tr>
<tr>
<td>10 m Sigma-Theta</td>
<td>96.11</td>
</tr>
<tr>
<td>10 m Sigma-W</td>
<td>78.95</td>
</tr>
<tr>
<td>10 m Temperature</td>
<td>90.92</td>
</tr>
<tr>
<td>30 m Wind Speed</td>
<td>99.37</td>
</tr>
<tr>
<td>30 m Wind Direction</td>
<td>99.37</td>
</tr>
<tr>
<td>30 m Sigma-Theta</td>
<td>99.12</td>
</tr>
<tr>
<td>30 m Sigma-W</td>
<td>78.98</td>
</tr>
<tr>
<td>30 m Temperature</td>
<td>86.32</td>
</tr>
<tr>
<td>60 m Wind Speed</td>
<td>99.37</td>
</tr>
<tr>
<td>60 m Wind Direction</td>
<td>99.37</td>
</tr>
<tr>
<td>60 m Sigma-Theta</td>
<td>99.37</td>
</tr>
<tr>
<td>60 m Sigma-W</td>
<td>79.00</td>
</tr>
<tr>
<td>60 m Temperature</td>
<td>99.34</td>
</tr>
<tr>
<td>60 m Relative Humidity</td>
<td>99.37</td>
</tr>
<tr>
<td>Vertical Temperature Difference (10 m – 2 m)</td>
<td>71.85</td>
</tr>
<tr>
<td>Vertical Temperature Difference (30 m – 10 m)</td>
<td>86.11</td>
</tr>
<tr>
<td>Vertical Temperature Difference (60 m – 10 m)</td>
<td>90.30</td>
</tr>
<tr>
<td>Solar Radiation</td>
<td>99.36</td>
</tr>
<tr>
<td>Station Pressure</td>
<td>99.33</td>
</tr>
<tr>
<td>Precipitation</td>
<td>99.37</td>
</tr>
</tbody>
</table>
The Satsop meteorological data includes the following variables at 10 m, 30 m, and 60 m above ground level: wind speed, wind direction, sigma-theta, sigma-w, temperature, and relative humidity. The Satsop meteorological data also included 2 m temperature, station pressure, solar radiation, temperature difference (10 m minus 2 m), temperature difference (30 m minus 10 m), temperature difference (60 m minus 10 m), and precipitation.

To prevent AERMET and AERMOD from developing unrealistic vertical turbulence profiles, Sigma-w values from the Satsop meteorological site were invalidated for any hour and level with a horizontal wind speed less than one meter per second. Figures 3-2 through 3-4 show sigma-w/horizontal wind speed versus horizontal wind speed at each meteorological sensor level (10 m, 30 m, and 60 m). As the figures show, sigma-w values at horizontal wind speeds less than one meter per second are uncharacteristic. Vertical wind velocities are less than the vertical anemometer threshold when horizontal wind speeds are less than about one meter.

The Satsop meteorological data were processed through AERMET as onsite data. Missing onsite meteorological data were supplemented by surface observations from the National Weather Service (NWS) station in Hoquiam, Washington (approximately 34 km west of Satsop).

Windrose plots presenting wind speed and wind direction data for the one year period at all three vertical observation levels are shown in Figures 3-5 through 3-7. The windroses show that the winds are predominantly from the west to south-southwest directions at all three vertical levels and from the east-northeast direction with increasing frequency at the 30 m and the 60 m heights. The wind flow patterns generally follow the Chehalis River valley. The average 10 m wind speed is 2.1 meters per second (m/s) and calm conditions occur less than three percent of the time. Overall, the average wind speed increases and the calm conditions decrease from 10 m to 60 m.

**Upper Air Data Processing**

Upper air data from the NWS site in Quillayute, Washington were used for the one-year meteorological dataset. The Quillayute upper air data were collected from the National Oceanic and Atmospheric Administration (NOAA) Forecast Systems Laboratory Radiosonde Database (http://raob.fsl.noaa.gov).

**Land Use Data Processing**

Surface parameters including the surface roughness length, albedo, and Bowen ratio were determined for the area surrounding the Satsop meteorological tower using the AERMET preprocessor, AERSURFACE (Version 08009), and the USGS 1992 National Land Cover (NLCD92) land-use data set (http://landcover.usgs.gov/natlandcover.php). The NLCD92 data set used in the analysis has a 30 m mesh size and 21 land-use categories. Seasonal surface parameters were determined using AERSURFACE according to USEPA guidance.3

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3 The AERMOD Implementation Guide (USEPA, 2008) and the AERSURFACE User's Guide (EPA-454/B-08-001,
Seasonal albedo and Bowen ratio values were based on averaging over a 10 km-by-10 km region centered on the Satsop meteorological tower site. An unweighted arithmetic average was used for calculating seasonal albedo; and an unweighted geometric average was used for calculating seasonal Bowen ratio. Seasonal surface roughness values were calculated for twelve 30 degree sectors within one kilometer of the Satsop meteorological tower location. An inverse-distance weighted geometric average was used to calculate seasonal surface roughness length values for each of the twelve sectors.

NLCD92 data combines transportation land-use (roadways and airport runways) into the same category as commercial and industrial land-use (industrial parks). Surface roughness values for roadways are much lower than values for an industrial parks or commercial areas with multiple buildings and structures. The AERSURFACE input file requires the user to state whether the meteorological site is located at an airport or not: the Satsop meteorological tower is not located at an airport.

AERSURFACE also requires the user to provide additional climatological information about the meteorological site and surrounding area. ENVIRON used historic Elma, Washington climate information to provide AERSURFACE with the required climatological information. The AERSURFACE user must answer the following questions:

- **Is the site located in an arid region?** NLCD92 data includes two land-use categories (shrubland and bare rock/sand/clay) to describe both desert and non-arid regions in the United States. Surface parameters for an arid region would include higher albedo and Bowen ratio values but lower surface roughness values compared to bare rock/sand/clay land-use. The Satsop meteorological tower site is not located in an arid region.

- **Is the site surface moisture dry, average, or wet?** AERSURFACE includes three sets of Bowen ratio values (dry, average, and wet) depending on the surface moisture of the site for the years modeled relative to a long term average. Annual average precipitation for the Elma/Satsop area during 2002 – 2003 is considered average compared to the last 30 years of precipitation records for the area.

- **Does the site experience continuous snow cover for most of the winter months (December, January, and February)?** AERSURFACE contains two sets of seasonal surface parameters values depending on the snow cover at the site. Surface parameters for continuous snow cover include lower Bowen ratio and surface roughness length values but higher albedo values compared to the surface parameters for winter months with no continuous snow cover. Annual average total snowfall for the Elma/Satsop area is approximately 6.4 inches, with an average snow depth during January, December, and February of approximately zero inches, indicating no continuous snow cover.

January 2008).
The land-use processing domain and NLCD92 land-use categories are shown in Figure 3-8. Table 3-2 presents the AERSURFACE calculated seasonal albedo, Bowen ratio, and surface roughness length values for the Satsop meteorological site.

### Table 3-2. Satsop Meteorological Site AERSURFACE Parameter Summary

<table>
<thead>
<tr>
<th>Sector</th>
<th>Winter</th>
<th></th>
<th></th>
<th>Spring</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Albedo</td>
<td>Bowen Ratio</td>
<td>Surface Roughness Length (m)</td>
<td>Albedo</td>
<td>Bowen Ratio</td>
<td>Surface Roughness Length (m)</td>
</tr>
<tr>
<td>1</td>
<td>0.16</td>
<td>0.86</td>
<td>0.222</td>
<td>0.15</td>
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<table>
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<th>Sector</th>
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<th></th>
<th>Autumn</th>
<th></th>
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<tr>
<td></td>
<td>Albedo</td>
<td>Bowen Ratio</td>
<td>Surface Roughness Length (m)</td>
<td>Albedo</td>
<td>Bowen Ratio</td>
<td>Surface Roughness Length (m)</td>
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<td>0.356</td>
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<td>0.409</td>
<td>0.16</td>
<td>0.86</td>
<td>0.409</td>
</tr>
</tbody>
</table>

**AERMET Processing**
The USEPA meteorological program AERMET was used to combine the Satsop data (missing data substituted with Hoquiam NWS data) with Quillayute NWS upper air soundings to derive the necessary meteorological variables for AERMOD. When surface temperature difference data was available, the Bulk-Richardson option was used to estimate dispersion variables and surface energy fluxes during nocturnal periods.

### 3.2.4 Emission Source Release Parameters

Figure 3-9 shows the locations of emission sources that will be included in the modeling analysis, as well as significant structures that could potentially influence emissions from the point sources. A summary of the release parameters that will be used to represent the point sources in the simulations is presented in Table 3-3.

#### Table 3-3. Point Source Release Parameters

<table>
<thead>
<tr>
<th>Source</th>
<th>Number of Sources</th>
<th>Stack Base Elev. (m)</th>
<th>Stack Height (m)</th>
<th>Exhaust Temp. (K)</th>
<th>Exit Velocity (m/s)</th>
<th>Stack Diam. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT @ 100% Load w/Duct Burner</td>
<td>2</td>
<td>93</td>
<td>54.9</td>
<td>348 – 345</td>
<td>20.5 – 17.7</td>
<td>5.49</td>
</tr>
<tr>
<td>CT @ 100% Load</td>
<td>2</td>
<td>93</td>
<td>54.9</td>
<td>356 – 353</td>
<td>20.8 – 18.0</td>
<td>5.49</td>
</tr>
<tr>
<td>CT @ 60% Load</td>
<td>2</td>
<td>93</td>
<td>54.9</td>
<td>349 – 344</td>
<td>14.1 – 13.2</td>
<td>5.49</td>
</tr>
<tr>
<td>Auxiliary Boiler</td>
<td>1</td>
<td>94</td>
<td>14.9</td>
<td>477</td>
<td>20.8</td>
<td>0.54</td>
</tr>
<tr>
<td>Emergency Diesel Generator</td>
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<td>94</td>
<td>4.0</td>
<td>761</td>
<td>94.6</td>
<td>0.15</td>
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<tr>
<td>Emergency Diesel Fire Water Pump</td>
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<td>829</td>
<td>72.7</td>
<td>0.13</td>
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<tr>
<td>Cooling Tower</td>
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<td>92</td>
<td>15.8</td>
<td>312</td>
<td>5.4</td>
<td>12.98</td>
</tr>
</tbody>
</table>

1 Exhaust temperatures and exit velocities vary with the assumed power generation unit ambient temperature; the values show are the maximum and minimum used.

In addition to release parameters, the building dimensions and facility configuration were provided to AERMOD to assess potential downwash effects. Wind-direction-specific building profiles were prepared for the model using USEPA’s Building Profile Input Program for the PRIME algorithm (BPIP-PRIME). The facility layout and building elevations provided by GHE will be used to prepare data for BPIP-PRIME, which provides the necessary input data for AERMOD. Figure 3-9 shows the configuration of significant structures that were used to develop the BPIP-PRIME input files, and Table 3-4 presents the heights of the significant structures that will be included in the simulations.
Table 3-4. Heights and Elevations of Significant On-Site Structures

<table>
<thead>
<tr>
<th>Structure</th>
<th>Base Elevation (m)</th>
<th>Height Above Grade (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia Tank</td>
<td>93</td>
<td>7.9</td>
</tr>
<tr>
<td>Combustion Turbine #1</td>
<td>93</td>
<td>7.9</td>
</tr>
<tr>
<td>Combustion Turbine #2</td>
<td>93</td>
<td>7.9</td>
</tr>
<tr>
<td>Combustion Turbine #3</td>
<td>93</td>
<td>7.9</td>
</tr>
<tr>
<td>Combustion Turbine #4</td>
<td>93</td>
<td>7.9</td>
</tr>
<tr>
<td>Cooling Tower #1</td>
<td>93</td>
<td>15.9</td>
</tr>
<tr>
<td>Cooling Tower #2</td>
<td>93</td>
<td>15.9</td>
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<tr>
<td>De-mineralized Water Tank</td>
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<tr>
<td>Gas Conditioning Building</td>
<td>93</td>
<td>5.5</td>
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<tr>
<td>HRSG #1</td>
<td>93</td>
<td>24.4</td>
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<tr>
<td>HRSG #2</td>
<td>93</td>
<td>24.4</td>
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<td>HRSG #3</td>
<td>93</td>
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<tr>
<td>HRSG #4</td>
<td>93</td>
<td>24.4</td>
</tr>
<tr>
<td>Inlet Air Filter #1</td>
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<td>22.3</td>
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<td>Inlet Air Filter #4</td>
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<td>Raw Water Tank</td>
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<td>Steam Turbine #1</td>
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<tr>
<td>Steam Turbine #2</td>
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<td>14.0</td>
</tr>
<tr>
<td>Warehouse/Maintenance Building</td>
<td>93</td>
<td>7.6</td>
</tr>
</tbody>
</table>

3.3 Regulatory Thresholds and Standards

Criteria pollutants expected to increase as a result of the modification, as well as any TAPs exceeding the small quantity emission rates (SQERs) established in WAC 173-460, will be included in modification-only analyses to obtain the maximum predicted concentration increases for each pollutant using averaging periods appropriate for the ambient standard or TAP class. For criteria pollutants, the maximum concentration increase will be compared to the applicable significant impact levels (SILs – WAC 173-400-113(3)).

Facility-wide modeling will be developed for each PSD criteria pollutant predicted to exceed the SIL, and the design concentration calculated by the model, using the appropriate averaging period, will be added to the appropriate background concentration to assess compliance with the Washington or national ambient air quality standards (WAAQS or NAAQS). Criteria pollutants exceeding a non-PSD SIL (e.g., one-hour average SO2) will be combined with a background concentration to evaluate compliance with the ambient standard. The maximum net TAP concentrations will be compared to the applicable acceptable source impact levels (ASILs) in WAC 173-460 to determine whether or not additional analyses are required to demonstrate compliance.
4 Air Quality Related Value Analysis Methodology

PSD regulations require an assessment of a project or modification’s impacts on Air Quality Related Values (AQRVs) in Class I areas. AQRVs include regional visibility or haze; the effects of primary and secondary pollutants on sensitive plants; the effects of pollutant deposition on soils and receiving water bodies; and other effects associated with secondary aerosol formation. Through the PSD program, the Clean Air Act provides special protection for Class I areas. The FLMs for the Class I areas, the National Park Service (NPS), U.S. Fish and Wildlife Service, and U.S. Forest Service (USFS) have the responsibility of ensuring AQRVs in the Class I areas are not adversely affected.

Both long-term and short-term AQRV criteria and PSD increments will be assessed in the Class I modeling analysis. Several simulations will be performed using different sets of emission and source combinations for Unit 3 and Unit 4 related sources. At the request of USEPA and EFSEC, simulations will also be performed using permitted emissions from existing Unit 1, Unit 2, and related sources. The proposed emission cases are as follows:

1. Maximum 24-hour emissions from Unit 3 and Unit 4 sources: Unit 3, Unit 4, Auxiliary Boiler 2, Diesel Generator 2, Fire Pump 2, and Cooling Tower 2. For each source and pollutant (SO₂, NOₓ, and PM₁₀) the maximum short-term emissions will consider multiple load and start-up conditions as discussed in Section 2.

2. Maximum annual emissions from Unit 3 and Unit 4 sources: Unit 3, Unit 4, Auxiliary Boiler 2, Diesel Generator 2, Fire Pump 2, and Cooling Tower 2. For each source and pollutant the maximum annual emissions will consider multiple load and start-up conditions as discussed in Section 2.

3. Case 1 above plus maximum permitted 24-hour emissions from Unit1, Unit 2, Auxiliary Boiler 1, Diesel Generator 1, Fire Pump 1, and Cooling Tower 1.

4. Case 2 above plus maximum permitted annual emissions from Unit1, Unit 2, Auxiliary Boiler 1, Diesel Generator 1, Fire Pump 1, and Cooling Tower 1.

Case 1 and Case 2 will be used for comparisons against screening level criteria. AQRV results for Case 3 and Case 4 will provided for information purposes only at the request of the FLMs.

4.1 Study Domain

PSD guidance requires an analysis of potential impacts to AQRVs in Federal Class I areas within 100 km (62.1 miles) of the project or modification. However, the FLMs generally request analyses of AQRV impacts for additional Class I areas within 200 km (124 miles) of the site. In the Pacific Northwest, the FLMs also request PSD sources disclose potential impacts to the Columbia River Gorge National Scenic Area (CRGNSA). This area is not subject to special protection under the Clean Air Act and model estimates are provided for information purposes only.
The proposed 428 km-by-444 km study domain is shown in Figure 4-1. The proposed domain is a subset of the domain used by the University of Washington (UW) for numerical weather predictions and includes all Class I areas within 200 km of the Grays Harbor Energy Center. Class I areas that will be considered in the analysis are shown in Figure 4-2. We also plan to include the CRGNSA and, at the request of the USFS, the Mt. Hood Wilderness. The closest Class I area is the Olympic National Park, approximately 58 km (36 miles) north of the site. The distances to all areas of interest are listed in Table 4-1.

<table>
<thead>
<tr>
<th>Area of Interest</th>
<th>Distance (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine Lakes Wilderness</td>
<td>147</td>
</tr>
<tr>
<td>Glacier Peak Wilderness</td>
<td>198</td>
</tr>
<tr>
<td>Goat Rocks Wilderness</td>
<td>145</td>
</tr>
<tr>
<td>Mt. Adams Wilderness</td>
<td>158</td>
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<tr>
<td>Mt. Hood Wilderness</td>
<td>208</td>
</tr>
<tr>
<td>Mt. Rainier National Park</td>
<td>115</td>
</tr>
<tr>
<td>Olympic National Park</td>
<td>58</td>
</tr>
<tr>
<td>Columbia River Gorge National Scenic Area</td>
<td>171</td>
</tr>
</tbody>
</table>

4.2 Model Selection

USEPA has adopted the CALPUFF modeling system as the preferred model for long-range transport assessments and for evaluating potential impacts to Class I areas. CALPUFF is included in Appendix A of the USEPA’s Guideline on Air Quality Models (codified as Appendix W to 40 CFR Part 51). Features of the CALPUFF modeling system include the ability to consider: secondary aerosol formation; gaseous and particle deposition; wet and dry deposition processes; and complex three-dimensional wind regimes.

ENVIRON plans to use Version 5.8 of the CALPUFF modeling system; the release date of the versions to be used is June 23, 2007. The CALPUFF modeling system is comprised of three main components: the CALPUFF dispersion model, the CALMET meteorological pre-processor, and the CALPOST post-processor. A number of other utilities provided with the system will also be applied to aid in the preparation of the meteorological/geophysical data and to manipulate the large CALPUFF output files.

Examples of the input files for the three components of the CALPUFF modeling system are included in Appendix B, Appendix C, and Appendix D, for CALMET, CALPUFF, and CALPOST, respectively. The remainder of the protocol discusses some of the more important aspects of the data sets and options that can be viewed in more detail by examination of these appendices.
4.3 Modeling Procedures

The modeling procedures to be used for the Class I area analyses will follow the recommendations of the Interagency Agency Workgroup on Air Quality Modeling (IWAQM) and the FLM Air Quality Related Values Workgroup (FLAG), outlined in the FLAG Phase I Report (December 2000). USEPA endorsed these procedures in advance in the IWAQM Phase II report (December 1998), and reiterated this endorsement in the April 15, 2003 Federal Register notice (Volume 68, Number 72) that adopted CALPUFF as a Guideline model. Regulatory switches recently added as part of the latest Version 5.8 update would also be used. Appendix C shows an example CALPUFF input file for the 2003 simulations.

4.4 PM$_{10}$ Fractions And Species

Data characterizing the chemical composition of the PM$_{10}$ emitted are needed for the AQRV analysis using the CALPUFF modeling system. PM$_{10}$ emission rates must be divided into six species, including: soot or elemental carbon (EC), fine soil particles (PMF), coarse particles (PMC), organic carbon$^4$ (OC), sulfate (SO$_4$), and nitrate (NO$_3$).

Table 4-2 shows the PM$_{10}$ fractions and species emission rates assumed for each Unit 3 and Unit 4 related source in the CALPUFF short-term simulations. Similar techniques will be used divide PM$_{10}$ emissions for the annual and Unit 1 and Unit 2 sources when included in the simulations. Cooling tower emissions are assumed to be entirely PMF. Following NPS guidance for gas-fired turbines$^5$, all of the PM$_{10}$ emissions are assumed to be PM$_{2.5}$ (no PMC emissions). The filterable fraction is assumed to be 25 percent of the PM$_{10}$ emissions and to consist of EC. The remaining condensable fraction is assumed to be ammonium sulfate, based on a 33 percent conversion of the SO$_2$ and OC. To avoid double counting the sulfur emissions from the gas-turbines, SO$_2$ emissions in the simulations will be reduced by the amount assumed to form ammonium sulfate. Ammonium nitrate and PMF emissions are assumed to be negligible.

For the diesel-fired generator, fire pump and auxiliary boiler, we plan to use PM$_{2.5}$/PM$_{10}$ ratios and PM$_{2.5}$ fractions from a database provided by Washington State Department of Ecology (Ecology) for use in Best Available Retrofit Technology (BART) modeling analyses. The PM$_{2.5}$ fractions in the database are based on profiles recommended by the USEPA for the Community Multi-Scale Air Quality (CMAQ) model.$^6$ CMAQ is the preferred regulatory model for PM$_{2.5}$ and regional haze simulations. The CMAQ profile database is indexed by Source Classification Code (SCC). Should updated or more appropriate PM$_{2.5}$/PM$_{10}$ ratios become available following submittal of this protocol, they will be used instead of those described here.

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4 For the purposes of post-processing by CALPOST, the species OC is labeled SOA (secondary organic aerosol) in the CALPUFF input and output files. CALPOST actually looks for “SOA” when calculating extinction. We assume all OC emitted forms SOA.

5 The NPS guidance can be found at http://www.nature.nps.gov/air/permits/ect/ectGasFiredCT.cfm

6 EPA website containing PM speciation by source categories: http://www.epa.gov/ttn/chief/emch/speciation.
### Table 4-2. PM$_{10}$ Fractions and Species

<table>
<thead>
<tr>
<th>Model ID</th>
<th>PM$<em>{2.5}$ to PM$</em>{10}$ Ratio$^1$</th>
<th>PM$_{10}$ Species 24-hour Maximum Emission Rate (lb/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ammonium Sulfate</td>
</tr>
<tr>
<td>Unit 3</td>
<td>1</td>
<td>8.972</td>
</tr>
<tr>
<td>Unit 4</td>
<td>1</td>
<td>8.972</td>
</tr>
<tr>
<td>Aux Boil 2</td>
<td>1</td>
<td>0.029</td>
</tr>
<tr>
<td>Dies. Gen 2</td>
<td>1</td>
<td>0.000</td>
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<tr>
<td>Fire Pump 2</td>
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<td>0.000</td>
</tr>
<tr>
<td>Cooling Towers</td>
<td>1</td>
<td>0.000</td>
</tr>
</tbody>
</table>

$^1$ If updated or more appropriate PM$_{2.5}$/PM$_{10}$ ratios become available, they will be used instead of those presented here.

### 4.5 Meteorological Data

ENVIRON obtained meteorological data sets from the UW’s numerical simulations of Pacific Northwest weather with the Penn State and National Center of Atmospheric Research Mesoscale Model (MM5). The AQRV analysis will use three years of hourly 4-km horizontal mesh size MM5 output data from January 2003 to December 2005. The UW MM5 datasets with a 12-km horizontal mesh size have also been used to assess industrial sources subject to Best Available Retrofit Technology (BART) review, as part the USEPA Regional Haze Rule. For the current analysis we propose to use the 4-km mesh size simulations in order to better resolve the flow in the complex terrain surrounding the Grays Harbor Energy Center in the Chehalis River valley.

CALMET (Version 5.8), the meteorological preprocessor component of the CALPUFF system, will be used to combine the MM5 simulation data, surface observations, terrain elevations, and land use data into the format required by the dispersion modeling component CALPUFF. In addition to specifying the three-dimensional wind field, CALMET also estimates the boundary layer parameters used to characterize diffusion and deposition by the dispersion model.

In 2007, USEPA Region 10, the FLMs, and the state agencies of Washington, Oregon, and Idaho (hereafter the PNW states) issued a template of recommended options for CALMET regulatory analyses.$^7$ ENVIRON proposes to follow the PNW states recommended CALMET input file options with one exception. Based on recent conversations with the FLMs, ENVIRON will also include available upper air sounding data in the preparation of a meteorological database.

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$^7$ Wong, Herman, 2007. *CALMET V5.8 Template.* Email from Herman Wong, EPA Region 10 to Ken Richmond, Geomatrix, August 23, 2007.
Appendix B includes a listing of a sample CALMET input file for January 2003. Major features of the CALMET application and input data preparation are as follows:

- The proposed model domain is a subset of the UW's 4-km mesh size MM5 domain as shown in Figure 4-1. The horizontal mesh size will be 4 km, with each CALMET grid point matched to a MM5 grid point. There will be ten vertical levels, ranging geometrically from the surface to 4,000 m. In order to match the MM5 simulations, a Lambert Conformal Conic (LCC) coordinate system will be used with an origin of 49N, 121W and standard latitudes of 30N and 60N.

- MM5 winds based on a 4-km grid spacing for January 2003 to December 2005 will be used to initialize the three-dimensional wind field predictions. The MM5 data will be processed with the CALMM5 utility for use by CALMET.

- Land use and terrain data will be prepared using the processing tools accompanying the CALPUFF modeling system and the USGS GTOPO30 elevation data sets available on the Internet resulting in 4-km mesh size fields. Figure 4-3 shows the 4-km mesh size terrain to be used in the simulations.

- ENVIRON has constructed surface weather observations for the Pacific Northwest West using the National Center of Atmospheric Research dataset ds472.0. Figure 4-4 shows the surface weather observation stations in and around the proposed modeling domain. The individual stations vary slightly for each of the years (2003-2005). A full listing of the 155 surface stations for 2003 is included in Appendix B.

- Twice daily upper air soundings will be blended with the MM5 data for winds and used for upper air temperatures. The locations of the upper air stations are shown in Figure 4-5. CALMET requires a continuous set of soundings from each upper air site. Missing soundings at each site will be replaced by a MM5 pseudo-sounding from the closest grid point to the station location.

- Buoy observations from the National Data Buoy Center will be used to characterize winds, sea-air temperature differences, and air temperatures over marine areas of the domain. The location of the buoy data sets are shown in Figure 4-6. The buoy data will be processed by the BUOY utility from the CALPUFF modeling system.

- Hourly precipitation data will be obtained from the National Climatic Data Center’s TD-3240 (COOP) dataset and processed with the CALMET utility PMERGE. Sites were selected based on the criteria that the locations must be near or in the model domain and there must be at least a 25 percent data recovery. Using this criteria, historic precipitation data from this dataset are available for between 64 and 68 stations depending upon the year. A full listing of the 66 stations available for 2003 are shown in Appendix B.

- In order to augment the precipitation observations especially in mountainous and marine areas, simulated hourly precipitation using every third grid point of the MM5 4-km domain will also be included in the meteorological data set. Figure 4-7 shows the locations of the combined precipitation data set.
Interpolation options will be selected using the PNW states recommended CALMET options to blend the MM5 initial fields with the surface, precipitation and upper air observations (See Appendix B).

Selected hours of the three-year CALMET/MM5 three-dimensional data set will be examined by extracting data from the CALMET output files and plotting the meteorological fields with the CALDESK software package. Wind vector plots will be examined for different times of year, different times of day, and for all ten vertical levels.

4.6 Receptor Network
The proposed receptor network is plotted in Figure 4-8. The CALPUFF dispersion model simulations will assess AQRVs within each Class I area at discrete receptors obtained from the NPS. Receptors will also be located within the CRGNSA using the locations and elevations provided by USEPA Region 10 for Pacific Northwest BART simulations. In addition to the discrete receptors, a receptor grid with 4-km spacing will also be used throughout the CALPUFF modeling domain for AQRV predictions. The 4-km mesh size receptors will be used to construct plots showing the spatial variation of the calculated parameters throughout the modeling domain. These plots will be used for diagnostic purposes, as well as to develop figures that will be presented in the permit application. Comparisons with AQRV criteria will be based solely on the discrete receptor locations.

4.7 Ammonia and Ozone Background Concentrations
The NOx chemistry in CALPUFF depends on the ambient ammonia concentration to establish the equilibrium between gaseous nitric acid and ammonium nitrate. However, ambient ammonia concentrations are usually not explicitly simulated by CALPUFF and the FLMs recommend an appropriate background concentration be used for ammonia.

The IWAQM Phase II recommendations suggest typical ammonia concentrations are: 10 parts per billion (ppb) for grasslands, 0.5 ppb for forests, and 1 ppb for arid lands during warmer weather. In the current analysis, we propose to use 17 ppb for the background ammonia concentration. This conservative concentration was recommended for Pacific Northwest BART simulations and is based on measurements in southern British Columbia. This relatively high background ensures the conversion of NOX to ammonium nitrate is not limited by a lack of ammonia for the range of NOX concentrations predicted in this study.

Reaction rates in the CALPUFF chemistry algorithms are influenced by background ozone concentrations. In order to conservatively characterize ozone concentrations throughout the domain, ENVIRON proposes to use hourly a background ozone concentration of 60 ppb as recommended by the USFS.

---

8 The NPS receptor database can be obtained at [http://www2.nature.nps.gov/air/Maps/Receptors/index.cfm](http://www2.nature.nps.gov/air/Maps/Receptors/index.cfm)
4.8 Post-Processing Procedures

The CALPUFF modeling system will be used to predict criteria pollutant concentrations, concentrations of PM$_{10}$ species that contribute to regional haze, deposition (wet and dry) fluxes for nitrogen containing pollutant species, and deposition fluxes for sulfur species. For each emission case considered, three annual simulations will be performed in parallel for each of the three years (2003-2005). In order to account for plumes that may remained within the domain at the end of the year, the simulations for 2004 and 2005 will start two days early.

The CALPUFF utility POSTUTIL will be used to manipulate the large CALPUFF output files and calculate a number of the parameters needed to assess AQRVs in the areas of interest. Specifically, POSTUTIL will be used to:

- Adjust the nitric acid/ammonium nitrate equilibrium to account for possible overlapping plumes using the MNITRATE=1 option. Initially the post-processing will be performed without this option. The option may be employed if AQRV criteria related to nitrate formation are exceeded.

- Sum the sulfur and nitrogen portions of the deposited gaseous and particle compounds to estimate the total sulfur and nitrogen deposition fluxes. The nitrogen in the ammonium nitrate and ammonium sulfate, including the portion that might be from the background ammonia, will be incorporated in the total.

- Sum the individual PM$_{10}$ species together after accounting for the differences in molecular weight between the species in the CALPUFF output files and the actual component species of PM$_{10}$.

Following the application of POSTUTIL, the CALPOST post-processor will be used to summarize the modeling results and obtain maximum predicted concentrations of NO$_x$, SO$_2$, and PM$_{10}$ in Class I areas and in the CRGNSA. Table 4-3 summarizes the applicable Class I Significant Impact Levels (SILs) and Class I PSD increments. At this point, there are two sets of Class I SILs, those proposed by USEPA and those recommended by the FLMs. These proposed and recommended SILs were obtained from the Federal Register, Vol. 61, No. 143, p. 38292, July 23, 1996.

Table 4-3. Class I Area Significance Levels and Increments

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>PSD Class I Increment</th>
<th>USEPA SIL $^1$</th>
<th>FLM SIL $^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{10}$</td>
<td>Annual</td>
<td>4</td>
<td>0.2</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>24-hour</td>
<td>8</td>
<td>0.3</td>
<td>0.27</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>Annual</td>
<td>2</td>
<td>0.1</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>24-hour</td>
<td>5</td>
<td>0.2</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>3-hour</td>
<td>25</td>
<td>1</td>
<td>0.48</td>
</tr>
<tr>
<td>NO$_2$</td>
<td>Annual</td>
<td>2.5</td>
<td>0.1</td>
<td>0.03</td>
</tr>
</tbody>
</table>

$^1$ SIL = Significant Impact Level; USEPA proposed and FLM recommended from the Federal Register, Vol. 61, No. 142, p. 38292, July 23, 1996
Figures will be provided to show the spatial variation across the simulation domain of the predicted maximum criteria pollutant concentrations attributable to the proposed modification. These figures will be constructed from the maximum predictions obtained at the 4-km mesh size grid receptors, and will be provided so the FLMs can assess the spatial extent of potential impacts from the Grays Harbor Energy Center.

Predicted annual sulfur and nitrogen deposition fluxes will be used as a measure to assess potential impacts to soils and vegetation in regional Class I areas and the CRGNSA. There are no promulgated standards for evaluation of these incremental impacts to soils and vegetation in Washington. However, the FLMs have established Deposition Analysis Thresholds (DATs) for nitrogen and sulfur of 0.005 kilograms per hectare per year (kg/ha/yr). These “thresholds” are based on natural background deposition estimates culled from various research efforts, a variability factor, and a safety factor that accounts for cumulative effects. The nitrogen and sulfur DATs are not adverse impact thresholds, but are intended as conservative screening criteria that allow the FLMs to identify potential deposition fluxes that require their consideration on a case-by-case basis.

The nitrogen and sulfur deposition flux results of the CALPUFF simulations for each Class I area and the CRGNSA will be compared to the DATs. ENVIRON will construct contour plots showing the spatial variation of the predicted nitrogen and sulfur deposition fluxes over the entire modeling domain.

The potential impacts to regional haze in the areas of interest will be assessed using predictions of the 24-hour change to extinction. The FLMs recommend in the FLAG Phase I Report that a five percent change to extinction be used to indicate a “just perceptible” change to a landscape. CALPOST will be used to calculate both the extinction coefficient attributable to the proposed emission increases as well as the background extinction coefficients. Specifically:

- Extinction coefficients will be calculated using hourly predicted aerosol concentrations, hourly relative humidity, and background aerosol concentrations with CALPOST Method 2 (MVISBK = 2). Relative humidity will be capped at 95 percent (RHMAX=95) and the FLAG relative humidity growth factors will be applied to the hygroscopic aerosols (MFRH=2).
- Default light extinction scattering efficiencies will be used for each aerosol species.
- Background visibility in all Class I areas of interest will be based on the FLAG defaults for the western US by using the hygroscopic (0.6 Mm-1), dry (4.5 Mm-1), and Rayleigh scattering (10.0 Mm-1) portions of the extinction coefficient. These defaults will be applied within CALPOST during post-processing with the following options: BKSO4=0.2, BKSOIL=4.5 and BEXTRAY=10.

9 Guidance on Nitrogen and Sulfur Deposition Analysis Thresholds, available on the FLAG internet site at http://www2.nature.nps.gov/ard/flagfree/NSDATGuidance.htm
A sample CALPOST input file that would be used to summarize the visibility results for 2003 and the Alpine Lakes Wilderness is included in Appendix D.

The current FLAG recommended CALPOST method for extinction coefficients can be very sensitive to hourly relative humidity. High relative humidity in the Pacific Northwest is often associated with precipitation, fog, low overcast and weather related visibility obscuring phenomena. In order to provide the FLMs with further information, extinction coefficients will also be calculated using the 2008 proposed revisions to the FLM FLAG procedures. The revised procedures employ an updated equation for extinction (invoked with MVISCHECK=1) using monthly relatively humidity adjustment factors and background aerosol concentrations recommended by the FLMs for each Class I area. In order to use this method, CALPOST Version 6.221 (Level 080724) will be used to post-process the CALPUFF output files.

The visibility related AQRVs will be summarized for each area of interest in a series of tables showing the number of days the five percent change to extinction was exceeded and showing the extinction budgets for the top eight days in each year of the simulation and any day with a change to extinction greater than 5 percent. Time series plots will be used to display the seasonality of the modeling results and contour plots of the predicted maximum 24-hour extinction coefficients will be used to examine spatial variability.

Figures
Figure 2-1. Modeling Domain for Near-Field Air Quality Impact Analysis
Figure 3-1. Preliminary Near-Field Modeling Receptor Locations
Figure 3-2. Normalized Sigma-W Versus Wind Speed Measured At 10 Meters
Figure 3-3. Normalized Sigma-W Versus Wind Speed Measured At 30 Meters
Figure 3-4. Normalized Sigma-W Versus Wind Speed Measured At 60 Meters
Figure 3-5. Windrose for Satsop, 2002 – 2003, 10 m Level
Figure 3-6. Windrose for Satsop, 2002 – 2003, 30 m Level
Figure 3-7. Windrose for Satsop, 2002 – 2003, 60 m Level
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

Figure 3-8. Satsop Meteorological Station AERMET Land-Use Analysis

NLCD 92 Land-Use Key

- 11: Open Water
- 12: Perennial Ice/Snow
- 21: Low Intensity Residential
- 22: High intensity Residential
- 23: Commercial/Industrial/Transport.
- 31: Bare Rock/Sand/Clay
- 32: Quarries/Strip Mines/Gravel Pits
- 33: Transitional
- 41: Deciduous Forest
- 42: Evergreen Forest
- 43: Mixed Forest
- 51: Shrubland
- 61: Orchards/Vineyards/Other
- 71: Grasslands/Herbaceous
- 81: Pasture/Hay
- 82: Row Crops
- 83: Small Grains
- 84: Fallow
- 85: Urban/Recreational Grasses
- 91: Woody Wetlands
- 92: Emergent Herbaceous Wetlands

Surface Roughness Length AERSURFACE Sectors

Albedo and Bowen Ratio AERSURFACE Domain

UTM East-West (Meters)

UTM North-South (Meters)
Figure 3-9. Significant On-Site Structures and Modeled Sources
Figure 4-1. Modeling Domain for AQRV Analysis
Figure 4-2. Locations of Class I Areas and CRGNSA within AQRV Modeling Domain
Figure 4-3. CALMET 4-Kilometer Mesh-Size Terrain and Grid Points
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

Figure 4-4. Surface Meteorological Stations In and Around the Modeling Domain
Figure 4-5. Upper Air Meteorological Stations in the Pacific Northwest
Figure 4-6. Buoy Meteorological Stations in the Pacific Northwest
Figure 4-7. CO-OP Precipitation Stations and MM5 Pseudo-Stations
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

Figure 4-8. AQRV Analysis Receptors

(●) CLASS I/CRGNSA RECEPTORS
(●) GRIDDED RECEPTORS
Appendix A

Satsop Ambient Air & Meteorological Monitoring
Annual Data Report (Appendices Removed)
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units
Appendix B

Example CALMET Input File
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

GHE Units 3 & 4 CALMET dataset, 107x111x4 km mesh, Jan 2003 4 km MM5
Protocol options after comments from FLMs (larger radii and domain)
ds472.0 surface obs, ndbc&bc buoys, mm5 pseudo & coop prec, upa sites
---------------- Run title (3 lines) -------------------------------

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

INPUT GROUP: 0 -- Input and Output File Names

Subgroup (a)
-------------
Default Name   Type     File Name
-------------- -----------
GEO.DAT        input    ! GEODAT= geo/geo.4km.dat    !
SURF.DAT       input    ! SRFDAT= sfc/pacnw.2003.sfc !
CLOUD.DAT      input    * CLDDAT=             *
PRECIP.DAT     input    ! PRCDAT= prec/prec.2003.dat !
WT.DAT         input    * WTDAT=             *
CALMET.LST     output   ! METLST= calmet.2003.01.out  !
CALMET.DAT     output   ! METDAT= calmet.2003.01.met  !
PACOUT.DAT     output   * PACDAT=            *

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

NUMBER OF UPPER AIR & OVERWATER STATIONS:

  Number of upper air stations (NUSTA) No default    ! NUSTA = 10  !
  Number of overwater met stations      (NOWSTA) No default    ! NOWSTA = 20  !

NUMBER OF PROGNOSTIC and IGF-CALMET FILES:

  Number of MM4/MM5/3D.DAT files       (NM3D) No default    ! NM3D = 1  !
  Number of IGF-CALMET.DAT files       (NIGF) No default    ! NIGF = 0  !

!END!

Subgroup (b)
-------------
Upper air files (one per station)
----------------------------------
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

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<td>! updat=upa/yzt.2003-2006.upa ! END!</td>
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<tr>
<td>UP2.DAT</td>
<td>input</td>
<td>! updat=upa/yly.2003-2006.upa ! END!</td>
</tr>
<tr>
<td>UP3.DAT</td>
<td>input</td>
<td>! updat=upa/mfr.2003-2006.upa ! END!</td>
</tr>
<tr>
<td>UP4.DAT</td>
<td>input</td>
<td>! updat=upa/boi.2003-2006.upa ! END!</td>
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<td>UP5.DAT</td>
<td>input</td>
<td>! updat=upa/sle.2003-2006.upa ! END!</td>
</tr>
<tr>
<td>UP6.DAT</td>
<td>input</td>
<td>! updat=upa/otx.2003-2006.upa ! END!</td>
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Subgroup (c)

Overwater station files (one per station)

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<th>File Name</th>
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<td>input</td>
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<td>! seadat=buoy/46004-0305.dat ! end!</td>
</tr>
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<td>2</td>
<td></td>
<td>! seadat=buoy/46005-0305.dat ! end!</td>
</tr>
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<td></td>
<td>! seadat=buoy/46006-0305.dat ! end!</td>
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<td></td>
<td>! seadat=buoy/46015-0305.dat ! end!</td>
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<td></td>
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<td></td>
<td>! seadat=buoy/46027-0305.dat ! end!</td>
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<td>! seadat=buoy/46029-0305.dat ! end!</td>
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<td>! seadat=buoy/46089-0305.dat ! end!</td>
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<td>! seadat=buoy/46131-0305.dat ! end!</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>! seadat=buoy/46132-0305.dat ! end!</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>* seadat=buoy/46134-0305.dat <em>end</em> leave out Pat Bay too near land and poor data recovery</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>! seadat=buoy/46145-0305.dat ! end!</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>! seadat=buoy/46146-0305.dat ! end!</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>! seadat=buoy/46206-0305.dat ! end!</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>! seadat=buoy/46207-0305.dat ! end!</td>
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Subgroup (d)

MM4/MM5/3D.DAT files (consecutive or overlapping)

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<th>File Name</th>
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<td>MM51.DAT</td>
<td>input</td>
<td>! M3DDAT=../calmm5/monthly/2003.01.4km.m3d ! END!</td>
</tr>
</tbody>
</table>
Subgroup (e)
-------------------------------------------------
IGF-CALMET.DAT files (consecutive or overlapping)
-------------------------------------------------

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<th>File Name</th>
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<td>IGFn.DAT</td>
<td>input</td>
<td>* IGFDAT=CALMET0.DAT *</td>
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Subgroup (f)
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Other file names
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<th>Type</th>
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</thead>
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<td>DIAG.DAT</td>
<td>input</td>
<td>* DIADAT=</td>
</tr>
<tr>
<td>PROG.DAT</td>
<td>input</td>
<td>* PRGDAT=</td>
</tr>
<tr>
<td>TEST.PRT</td>
<td>output</td>
<td>* TSTPRT=</td>
</tr>
<tr>
<td>TEST.OUT</td>
<td>output</td>
<td>* TSTOUT=</td>
</tr>
<tr>
<td>TEST.KIN</td>
<td>output</td>
<td>* TSTKIN=</td>
</tr>
<tr>
<td>TEST.FRD</td>
<td>output</td>
<td>* TSTFRD=</td>
</tr>
<tr>
<td>TEST.SLP</td>
<td>output</td>
<td>* TSTSLP=</td>
</tr>
<tr>
<td>DCST.GRD</td>
<td>output</td>
<td>* DCSTGD=</td>
</tr>
</tbody>
</table>

NOTES: (1) File/path names can be up to 70 characters in length
(2) Subgroups (a) and (f) must have ONE 'END' (surrounded by delimiters) at the end of the group
(3) Subgroups (b) through (e) are included ONLY if the corresponding number of files (NUSTA, NOWSTA, NM3D, NIGF) is not 0, and each must have an 'END' (surround by delimiters) at the end of EACH LINE

!END!

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

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

Starting date: Year (IBYR) -- No default ! IBYR = 2003   !
               Month (IBMO) -- No default ! IBMO = 01   !
               Day (IBDY) -- No default ! IBDY = 01   !
               Hour (IBHR) -- No default ! IBHR = 01   !

Note: IBHR is the time at the END of the first hour of the simulation
      (IBHR=1, the first hour of a day, runs from 00:00 to 01:00)

Base time zone (IBTZ) -- No default ! IBTZ = 8   !
           PST = 08, MST = 07
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

**CST** = 06, **EST** = 05

Length of run (hours) (IRLG) -- No default

| Default: IRLG = 744 |

Run type (IRTYPE) -- Default: 1

| Default: IRTYPE = 1 |

- 0 = Computes wind fields only
- 1 = Computes wind fields and micrometeorological variables ($u^*$, $w^*$, $L$, $z_i$, etc.)

(IRTYPE must be 1 to run CALPUFF or CALGRID)

Compute special data fields required by CALGRID (i.e., 3-D fields of $W$ wind components and temperature) in addition to regular fields?

Default: T

| LCALGRD = T |

(LCALGRD must be T to run CALGRID)

Flag to stop run after SETUP phase (ITEST)

| Default: ITEST = 2 |

(Used to allow checking of the model inputs, files, etc.)

**ITEST** = 1 - STOPS program after SETUP phase

**ITEST** = 2 - Continues with execution of COMPUTATIONAL phase after SETUP

Test options specified to see if they conform to regulatory values? (MREG)

No Default

| MREG = 1 |

0 = NO checks are made

1 = Technical options must conform to USEPA guidance

- **IMIXH** -1 Maul-Carson convective mixing height over land; OCD mixing height overwater
- **ICOARE** 0 OCD deltaT method for overwater fluxes
- **THRESHL** 0.0 Threshold buoyancy flux over land needed to sustain convective mixing height growth

!END!

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

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

Projection for all (X,Y):

Map projection (PMAP)

| Default: UTM | PMAP = LCC |

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

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

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

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

Latitude and Longitude (decimal degrees) of projection origin
(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
(RLAT0) No Default ! RLAT0 = 49.0N !
(RLON0) No Default ! RLON0 = 121.0W !

TTM : RLON0 identifies central (true N/S) meridian of projection
LCC : RLON0 selected for convenience
PS : RLON0 identifies central (grid N/S) meridian of projection
LCC : RLON0 identified latitude of tangent-point of mapping plane
LAZA: RLON0 identifies longitude of tangent-point of mapping plane

Matching parallel(s) of latitude (decimal degrees) for projection
(Used only if PMAP= LCC or PS)
(XLAT1) No Default ! XLAT1 = 30.0N !
(XLAT2) No Default ! XLAT2 = 60.0N !

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

----------

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

Datum-region

The Datum-Region for the coordinates is identified by a character string. Many mapping products currently available use the model of the Earth known as the World Geodetic System 1984 (WGS-84). Other local models may be in use, and their selection in CALMET will make its output consistent with local mapping products. The list of Datum-Regions with official transformation parameters is provided by the National Imagery and Mapping Agency (NIMA).

NIMA Datum - Regions (Examples)

<table>
<thead>
<tr>
<th>Datum</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WGS-84</td>
<td>WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)</td>
</tr>
<tr>
<td>NAS-C</td>
<td>NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)</td>
</tr>
<tr>
<td>NAR-C</td>
<td>NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)</td>
</tr>
<tr>
<td>NWS-84</td>
<td>NWS 6370KM Radius, Sphere</td>
</tr>
<tr>
<td>ESR-S</td>
<td>ESRI REFERENCE 6371KM Radius, Sphere</td>
</tr>
</tbody>
</table>

Datum-region for output coordinates (DATUM) Default: WGS-G ! DATUM = NWS-84 ! *** Same as UW MMS ***

Horizontal grid definition:

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. X grid cells (NX)</td>
<td>No default ! NX = 107 !</td>
</tr>
<tr>
<td>No. Y grid cells (NY)</td>
<td>No default ! NY = 111 !</td>
</tr>
<tr>
<td>Grid spacing (DGRIDKM)</td>
<td>No default ! DGRIDKM = 4. ! Units: km</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>X coordinate (XORIGKM)</td>
<td>No default ! XORIGKM = -344. !</td>
</tr>
<tr>
<td>Y coordinate (YORIGKM)</td>
<td>No default ! YORIGKM = -444. ! Units: km</td>
</tr>
</tbody>
</table>

Vertical grid definition:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of vertical layers (NZ)</td>
<td>No default ! NZ = 10 !</td>
</tr>
</tbody>
</table>
Cell face heights in arbitrary vertical grid (ZFACE(NZ+1))  No defaults Units: m

! ZFACE =0.,20.,40.,65.,120.,200.,400.,700.,1200.,2200.,4000. !

!END!

INPUT GROUP: 3 -- Output Options

DISK OUTPUT OPTION

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

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

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

LINE PRINTER OUTPUT OPTIONS:

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

Print interval
(IPRINF) in hours Default: 1  ! IPRINF = 12 !
(Meteorological fields are printed every 1 hours)

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

Specify which levels of the W wind component to print
(NOTE: W defined at TOP cell face -- 6 values)
(IWOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

(used only if LPRINT=T & LCALGRD=T)

-----------------------------------
Defaults: NZ*0
IWOUT = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 !

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

-----------------------------------
Defaults: NZ*0
ITOUT = 1, 0, 0, 0, 0, 0, 0, 0, 0, 0 !

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

-----------------------
Variable            Print ?
(0 = do not print,
1 = print)
--------        ------------------
! STABILITY      =           1           ! - PGT stability class
! USTAR           =           0           ! - Friction velocity
! MONIN           =           0           ! - Monin-Obukhov length
! MIXHT           =           1           ! - Mixing height
! WSTAR           =           0           ! - Convective velocity scale
! PRECIP          =           1           ! - Precipitation rate
! SENSHEAT        =           0           ! - Sensible heat flux
! CONVZI          =           0           ! - Convective mixing ht.

Testing and debug print options for micrometeorological module

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

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

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

Print distance to land internal variables (LDBCST) Default: F ! LDBCST = F !
(F = Do not print, T = print)
(Output in .GRD file DCST.GRD, defined in input group 0)
Testing and debug print options for wind field module
(all of the following print options control output to
wind field module's output files: TEST.PRT, TEST.OUT,
TEST.KIN, TEST.FRD, and TEST.SLP)

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

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

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

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

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

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

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

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

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

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

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

!END!

-------------------------------------------------------------------------------
INPUT GROUP: 4 -- Meteorological data options
NO OBSERVATION MODE (NOOBS) Default: 0 ! NOOBS = 0 !
0 = Use surface, overwater, and upper air stations
1 = Use surface and overwater stations (no upper air observations)
   Use MM4/MM5/3D for upper air data
2 = No surface, overwater, or upper air observations
   Use MM4/MM5/3D for surface, overwater, and upper air data

NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

Number of surface stations (NSSTA) No default ! NSSTA = 115 !
Number of precipitation stations
(NPSTA=-1: flag for use of MM5/3D precip data)
(NPSTA) No default ! NPSTA = 1398 !

CLOUD DATA OPTIONS

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

FILE FORMATS

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

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

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

!END!

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

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

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

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

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

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

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

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

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

Minimum distance from nearest upper air station to surface station for which extrapolation of surface winds at surface station will be allowed (RMIN2: Set to -1 for IEXTRP = 4 or other situations where all surface stations should be extrapolated)
Default: 4. ! RMIN2 = -1.0 !
Use gridded prognostic wind field model output fields as input to the diagnostic wind field model (IPROG)  Default: 0 ! IPROG = 14 !
(0 = No, [IWFCOD = 0 or 1]
1 = Yes, use CSUMM prog. winds as Step 1 field, [IWFCOD = 0]
2 = Yes, use CSUMM prog. winds as initial guess field [IWFCOD = 1]
3 = Yes, use winds from MM4.DAT file as Step 1 field [IWFCOD = 0]
4 = Yes, use winds from MM4.DAT file as initial guess field [IWFCOD = 1]
5 = Yes, use winds from MM4.DAT file as observations [IWFCOD = 1]
13 = Yes, use winds from MM5/3D.DAT file as Step 1 field [IWFCOD = 0]
14 = Yes, use winds from MM5/3D.DAT file as initial guess field [IWFCOD = 1]
15 = Yes, use winds from MM5/3D.DAT file as observations [IWFCOD = 1]

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

Use coarse CALMET fields as initial guess fields (IGFMET) (overwrites IGF based on prognostic wind fields if any)  Default: 0 ! IGFMET = 0 !

RADIUS OF INFLUENCE PARAMETERS

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

Maximum radius of influence over land in the surface layer (RMAX1)  No default ! RMAX1 = 36. !
Units: km

Maximum radius of influence over land aloft (RMAX2)  No default ! RMAX2 = 36. !
Units: km

Maximum radius of influence over water (RMAX3)  No default ! RMAX3 = 50. !

OTHER WIND FIELD INPUT PARAMETERS

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

Radius of influence of terrain features (TERRAD)  No default ! TERRAD = 8. !
Units: km

Relative weighting of the first guess field and observations in the SURFACE layer (R1)  No default ! R1 = 10. !
(R1 is the distance from an observational station at which the observation and first guess field are
equally weighted)

Relative weighting of the first guess field and observations in the layers ALOFT (R2)
(R2 is applied in the upper layers in the same manner as R1 is used in the surface layer).

Relative weighting parameter of the prognostic wind field data (RPROG)
(Used only if IPROG = 1)

Maximum acceptable divergence in the divergence minimization procedure

Maximum number of iterations in the divergence min. procedure (NITER)

Number of passes in the smoothing procedure (NSMTH(NZ))
NOTE: NZ values must be entered

Maximum number of stations used in each layer for the interpolation of data to a grid point (NINTR2(NZ))
NOTE: NZ values must be entered

Critical Froude number (CRITFN)

Empirical factor controlling the influence of kinematic effects (ALPHA)

Multiplicative scaling factor for extrapolation of surface observations to upper layers (FEXTR2(NZ))
(Used only if IEXTRP = 3 or -3)

BARRIER INFORMATION

Number of barriers to interpolation of the wind fields (NBAR)
Level (1 to NZ) up to which barriers apply (KBAR)
Default: NZ ! KBAR = 10 !

THE FOLLOWING 4 VARIABLES ARE INCLUDED
ONLY IF NBAR > 0
NOTE: NBAR values must be entered for each variable
Units: km

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

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

DIAGNOSTIC MODULE DATA INPUT OPTIONS

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

Surface met. station to use for the surface temperature (ISURFT)
No default ! ISURFT = 98 ! SeaTac
(Must be a value from 1 to NSSTA)
(Used only if IDIOPT1 = 0)

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

Upper air station to use for the domain-scale lapse rate (IUPT)
No default ! IUPT = 8 ! Quillayute
(Must be a value from 1 to NUSTA)
(Used only if IDIOPT2 = 0)

Depth through which the domain-scale lapse rate is computed (ZUPT)
Default: 200. ! ZUPT = 200. !
(Used only if IDIOPT2 = 0) Units: meters
Domain-averaged wind components
(IDIOPT3) Default: 0 ! IDIOPT3 = 0 !
0 = Compute internally from twice-daily upper air observations
1 = Read hourly preprocessed values a data file (DIAG.DAT)

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

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

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

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

LAKE BREEZE INFORMATION

Use Lake Breeze Module (LLBREZE) Default: F ! LLBREZE = F !
Number of lake breeze regions (NBOX) ! NBOX = 0 !
X Grid line 1 defining the region of interest ! XG1 = 0. !
X Grid line 2 defining the region of interest ! XG2 = 0. !
Y Grid line 1 defining the region of interest ! YG1 = 0. !
Y Grid line 2 defining the region of interest ! YG2 = 0. !
X Point defining the coastline (Straight line)
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

(XBCST) (KM) Default: none ! XBCST = 0. !

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

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

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

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

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

!END!

---

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

EMPIRICAL MIXING HEIGHT CONSTANTS

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

SPATIAL AVERAGING OF MIXING HEIGHTS

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

Max. search radius in averaging process (MNMDAV) Default: 1 ! MNMDAV = 1 !
Units: Grid cells

Half-angle of upwind looking cone for averaging (HAFANG) Default: 30. ! HAFANG = 30. !
Layer of winds used in upwind averaging (ILEVZI) 
Default: 1 ! ILEVZI = 1 ! (must be between 1 and NZ)

CONVECTIVE MIXING HEIGHT OPTIONS:
Method to compute the convective mixing height (IMIHXH) 
Default: 1 ! IMIXH = -1 !
1: Maul-Carson for land and water cells
-1: Maul-Carson for land cells only - OCD mixing height overwater
2: Batchvarova and Gryning for land and water cells
-2: Batchvarova and Gryning for land cells only
OCD mixing height overwater

Threshold buoyancy flux required to sustain convective mixing height growth
overland (THRESHL) Default: 0.0 ! THRESHL = 0.0 ! (expressed as a heat flux units: W/m3 per meter of boundary layer)

Threshold buoyancy flux required to sustain convective mixing height growth
overwater (THRESHW) Default: 0.05 ! THRESHW = 0.05 ! (expressed as a heat flux units: W/m3 per meter of boundary layer)

Option for overwater lapse rates used in convective mixing height growth
(ITWPROG) Default: 0 ! ITWPROG = 0 !
0 : use SEA.DAT lapse rates and deltaT (or assume neutral conditions if missing)
1 : use prognostic lapse rates (only if IPROG>2) and SEA.DAT deltaT (or neutral if missing)
2 : use prognostic lapse rates and prognostic delta T (only if iprog>12 and 3D.DAT version# 2.0 or higher)

Land Use category ocean in 3D.DAT datasets 
(ILUOC3D) Default: 16 ! ILUOC3D = 16 !
Note: if 3D.DAT from MM5 version 3.0, iluoc3d = 16
if MM4.DAT, typically iluoc3d = 7

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

Minimum overland mixing height (ZIMIN)  
Default: 50.  ! ZIMIN = 50.  !  
Units: meters

Maximum overland mixing height (ZIMAX)  
Default: 3000.  ! ZIMAX = 3000.  !  
Units: meters

Minimum overwater mixing height (ZIMINW) -- (Not used if observed overwater mixing hts. are used)  
Default: 50.  ! ZIMINW = 50.  !  
Units: meters

Maximum overwater mixing height (ZIMAXW) -- (Not used if observed overwater mixing hts. are used)  
Default: 3000.  ! ZIMAXW = 3000.  !  
Units: meters

OVERWATER SURFACE FLUXES METHOD and PARAMETERS (ICOARE)  
Default: 10      ! ICOARE = 0      !  
0: original deltaT method (OCD)  
10: COARE with no wave parameterization (jwave=0, Charnock)  
11: COARE with wave option jwave=1 (Oost et al.) and default wave properties  
-11: COARE with wave option jwave=1 (Oost et al.) and observed wave properties (must be in SEA.DAT files)  
12: COARE with wave option 2 (Taylor and Yelland) and default wave properties  
-12: COARE with wave option 2 (Taylor and Yelland) and observed wave properties (must be in SEA.DAT files)

Note: When ICOARE=0, similarity wind profile stability PSI functions based on Van Ulden and Holtslag (1985) are substituted for later formulations used with the COARE module, and temperatures used for surface layer parameters are obtained from either the nearest surface station temperature or prognostic model 2D temperatures (if ITPROG=2).

Coastal/Shallow water length scale (DSHELF)  
(for modified z0 in shallow water)  
(COARE fluxes only)  
Default : 0.  ! DSHELF = 0.  !  
units: km

COARE warm layer computation (IWARM)  
1: on - 0: off (must be off if SST measured with IR radiometer)  
Default: 0  
! IWARM = 0  !

COARE cool skin layer computation (ICOOL)  
1: on - 0: off (must be off if SST measured with IR radiometer)  
Default: 0  
! ICOOL = 0  !

TEMPERATURE PARAMETERS
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

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

- 0 = Use Surface and upper air stations (only if NOOBS = 0)
- 1 = Use Surface stations (no upper air observations)
  Use MM5/3D for upper air data (only if NOOBS = 0,1)
- 2 = No surface or upper air observations
  Use MM5/3D for surface and upper air data (only if NOOBS = 0,1,2)

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

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

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

Conduct spatial averaging of temperatures (IAVET)  (0=no, 1=yes)  Default: 1  ! IAVET = 1 !
(will use mixing ht MNMDAV,HAFANG so make sure they are correct)

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

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

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

JWAT1 = 55  !
JWAT2 = 55  !

Precip Interpolation Parameters

Method of interpolation (NFLAGP)  Default: 2  ! NFLAGP = 2 !
(1=1/R, 2=1/R**2, 3=EXP/R**2)

Radius of Influence (SIGMAP)  Default: 100.0  ! SIGMAP = 12. !

pseudo prec mesh size (0.0 => use half dist. btwn nearest stns w & w/out precip when NFLAGP = 3)
Units: km

Minimum Precip. Rate Cutoff (CUTP)  Default: 0.01  ! CUTP = 0.01 !
(values < CUTP = 0.0 mm/hr) Units: mm/hr
INPUT GROUP: 7 -- Surface meteorological station parameters

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

<table>
<thead>
<tr>
<th>Name</th>
<th>ID</th>
<th>X coord. (km)</th>
<th>Y coord. (km)</th>
<th>Time zone</th>
<th>Anem. Ht. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1</td>
<td>'CWCL'</td>
<td>714740</td>
<td>-33.918</td>
<td>8 10.0</td>
<td>!</td>
</tr>
<tr>
<td>SS2</td>
<td>'CWLY'</td>
<td>718910</td>
<td>-40.254</td>
<td>8 10.0</td>
<td>!</td>
</tr>
<tr>
<td>SS3</td>
<td>'CYKA'</td>
<td>718870</td>
<td>37.462</td>
<td>8 10.0</td>
<td>!</td>
</tr>
<tr>
<td>SS4</td>
<td>'CYLW'</td>
<td>712030</td>
<td>111.894</td>
<td>8 10.0</td>
<td>!</td>
</tr>
<tr>
<td>SS5</td>
<td>'CYQL'</td>
<td>718740</td>
<td>570.501</td>
<td>8 10.0</td>
<td>!</td>
</tr>
<tr>
<td>SS6</td>
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Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

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<td>8 10.0</td>
</tr>
<tr>
<td>SS105 = 'KSPB'</td>
<td>175</td>
<td>-137.845</td>
<td>-344.331</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS106 = 'KTCM'</td>
<td>742060</td>
<td>-108.396</td>
<td>-197.813</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS107 = 'KTIIW'</td>
<td>94274</td>
<td>-115.450</td>
<td>-185.111</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS108 = 'KTTD'</td>
<td>24242</td>
<td>-106.013</td>
<td>-369.567</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS109 = 'KTFW'</td>
<td>94178</td>
<td>516.133</td>
<td>-679.030</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS110 = 'KUAO'</td>
<td>726959</td>
<td>-133.863</td>
<td>-401.335</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS111 = 'KUIL'</td>
<td>727970</td>
<td>-255.480</td>
<td>-107.220</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS112 = 'KVUYO'</td>
<td>186</td>
<td>-123.976</td>
<td>-361.815</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS113 = 'KWMC'</td>
<td>725830</td>
<td>260.408</td>
<td>-865.200</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS114 = 'KYYM'</td>
<td>727810</td>
<td>34.388</td>
<td>-261.319</td>
<td>8 10.0</td>
</tr>
<tr>
<td>SS115 = 'KSIY'</td>
<td>725955</td>
<td>-117.790</td>
<td>-774.263</td>
<td>8 10.0</td>
</tr>
</tbody>
</table>

---

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

2. Six digit integer for station ID

!END!

---

INPUT GROUP: 8 -- Upper air meteorological station parameters

----------

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

<table>
<thead>
<tr>
<th>Name</th>
<th>ID</th>
<th>X coord</th>
<th>Y coord</th>
<th>Time zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>US1 = 'YZZ'</td>
<td>25223</td>
<td>-434.681</td>
<td>198.133</td>
<td>8 ! Port Hardy</td>
</tr>
</tbody>
</table>

-------------------
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

---

<table>
<thead>
<tr>
<th>Station</th>
<th>Code</th>
<th>X coord. (km)</th>
<th>Y coord. (km)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>US2 = 'YLW'</td>
<td>94151</td>
<td>112.095</td>
<td>105.490</td>
<td>Kelowna Apt</td>
</tr>
<tr>
<td>US3 = 'MFR'</td>
<td>24225</td>
<td>-148.645</td>
<td>-710.465</td>
<td>Medford</td>
</tr>
<tr>
<td>US4 = 'BOI'</td>
<td>24131</td>
<td>371.767</td>
<td>-572.123</td>
<td>Boise</td>
</tr>
<tr>
<td>US5 = 'SLE'</td>
<td>24232</td>
<td>-153.648</td>
<td>-436.307</td>
<td>Salem</td>
</tr>
<tr>
<td>US6 = 'OTX'</td>
<td>4106</td>
<td>243.587</td>
<td>-136.761</td>
<td>Spokane Intnl Apt</td>
</tr>
<tr>
<td>US7 = 'UIL'</td>
<td>94240</td>
<td>-255.480</td>
<td>-107.220</td>
<td>Quillayute</td>
</tr>
<tr>
<td>US8 = 'TFX'</td>
<td>4102</td>
<td>696.997</td>
<td>-124.670</td>
<td>Great Falls</td>
</tr>
<tr>
<td>US9 = 'LKN'</td>
<td>4105</td>
<td>428.933</td>
<td>-859.514</td>
<td>Elko</td>
</tr>
<tr>
<td>US10 = 'SLC'</td>
<td>24127</td>
<td>735.212</td>
<td>-842.906</td>
<td>Salt Lake City</td>
</tr>
</tbody>
</table>

---

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

2. Five digit integer for station ID

!END!

---

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

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Station</th>
<th>X coord. (km)</th>
<th>Y coord. (km)</th>
<th>Code</th>
</tr>
</thead>
</table>

** 1st line must have "PS1" in (3:5)**

| PS1 | 0001 | 000001 | -333.999 | -446.002 | mm5(I,j): 015083 |
| PS0002 | 0002 | 000002 | -321.997 | -446.003 | mm5(I,j): 018083 |
| PS0003 | 0003 | 000003 | -309.999 | -446.002 | mm5(I,j): 021083 |
| PS0004 | 0004 | 000004 | -298.002 | -445.998 | mm5(I,j): 024083 |
| PS0005 | 0005 | 000005 | -286.001 | -446.003 | mm5(I,j): 027083 |

<< pseudo-stations 6 through 1393 removed for brevity >>

| PS1394 | 1394 | 457473 | -95.521 | -166.410 | |
| PS1395 | 1395 | 457709 | -24.033 | -138.289 | |
| PS1396 | 1396 | 457773 | -60.713 | -156.463 | |
| PS1397 | 1397 | 457781 | -30.157 | -169.233 | |
| PS1398 | 1398 | 458089 | -6.683 | -135.739 | |

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

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

!END!
Appendix C

Example CALPUFF Input File
GHE Unit 3&4, 2003 Met data, 4-km MM5 based winds
24-Hour Max Rates
Gridded & Class I recs, 60 ppb Ozone, 17 ppb NH3

--- Run title (3 lines) ---------

CALPUFF MODEL CONTROL FILE
-------------------------
-----------------------------------------------
INPUT GROUP: 0 -- Input and Output File Names

<table>
<thead>
<tr>
<th>Default Name</th>
<th>Type</th>
<th>File Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =</td>
</tr>
<tr>
<td>ISCMET.DAT</td>
<td>input</td>
<td>ISCDAT =</td>
</tr>
<tr>
<td>PLMMET.DAT</td>
<td>input</td>
<td>PLMDAT =</td>
</tr>
<tr>
<td>PROFILE.DAT</td>
<td>input</td>
<td>PRFDAT =</td>
</tr>
<tr>
<td>SURFACE.DAT</td>
<td>input</td>
<td>SFCDAT =</td>
</tr>
<tr>
<td>RESTARTB.DAT</td>
<td>input</td>
<td>RSTARTB=</td>
</tr>
</tbody>
</table>

CALPUFF.LST output ! PUFLST = ghe.2003.out !
CONC.DAT output ! CONDAT = ghe.2003.con !
DFLX.DAT output * DFDAT = ghe.2003.dry *
WFLX.DAT output * WFDAT = ghe.2003.wet *

VISB.DAT output ! VISDAT = ghe.2003.vis !
TK2D.DAT output * T2DDAT = *
RH2D.DAT output * RHODAT = *
RESTARTE.DAT output * RSTARTE= *

Emission Files

PTEMARB.DAT input * PTDAT = *
VOLEMARB.DAT input * VOLDAT = *
BAEMARB.DAT input * ARDAT = *
LNEMARB.DAT input * LNDAT = *

Other Files

OZONE.DAT input * OZDAT =../ozone/o3.03-05.dat *
VD.DAT input * VDDAT = *
CHEM.DAT input * CHEMDAT= *
H2O2.DAT input * H2O2DAT= *
HILL.DAT input * HILDAT= *
HILLRCT.DAT input * RCTDAT= *
COASTLN.DAT input * CSTDAT= *
FLUXBDY.DAT input * BDYDAT= *
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

<table>
<thead>
<tr>
<th>File Name</th>
<th>Type</th>
<th>File Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCON.DAT</td>
<td>input</td>
<td>BCNDAT=</td>
</tr>
<tr>
<td>DEBUG.DAT</td>
<td>output</td>
<td>DEBUG =</td>
</tr>
<tr>
<td>MASSFLX.DAT</td>
<td>output</td>
<td>FLXDAT=</td>
</tr>
<tr>
<td>MASSBAL.DAT</td>
<td>output</td>
<td>BALDAT= ghe.2003.bal</td>
</tr>
<tr>
<td>FOG.DAT</td>
<td>output</td>
<td>FOGDAT=</td>
</tr>
</tbody>
</table>

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

NOTE: (1) file/path names can be up to 70 characters in length

Provision for multiple input files

<table>
<thead>
<tr>
<th>Number of CALMET.DAT files for run (NMETDAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default: 1</td>
</tr>
<tr>
<td>! NMETDAT = 12 !</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of PTEMARB.DAT files for run (NPTDAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default: 0</td>
</tr>
<tr>
<td>! NPTDAT = 0 !</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of BAEMARB.DAT files for run (NARDAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default: 0</td>
</tr>
<tr>
<td>! NARDAT = 0 !</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of VOLEMARB.DAT files for run (NVOLDAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default: 0</td>
</tr>
<tr>
<td>! NVOLDAT = 0 !</td>
</tr>
</tbody>
</table>

!END!

------------------
Subgroup (0a)
------------------

The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

<table>
<thead>
<tr>
<th>Default Name</th>
<th>Type</th>
<th>File Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.01.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.02.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.03.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.04.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.05.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.06.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.07.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.08.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.09.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.10.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.11.met ! !END!</td>
</tr>
<tr>
<td>CALMET.DAT</td>
<td>input</td>
<td>METDAT =../calmet/calmet.2003.12.met ! !END!</td>
</tr>
</tbody>
</table>
INPUT GROUP: 1 -- General run control parameters

Option to run all periods found in the met. file (METRUN) Default: 0 ! METRUN = 0 !

METRUN = 0 - Run period explicitly defined below
METRUN = 1 - Run all periods in met. file

Starting date: Year (IBYR) -- No default ! IBYR = 2003 !
(used only if Month (IBMO) -- No default ! IBMO = 1 !
METRUN = 0) Day (IBDY) -- No default ! IBDY = 1 !
Hour (IBHR) -- No default ! IBHR = 1 !

Base time zone (XBTZ) -- No default ! XBTZ = 8.0 !
PST = 8., MST = 7.
CST = 6., EST = 5.

Length of run (hours) (IRLG) -- No default ! IRLG = 8760 !

Number of chemical species (NSPEC) Default: 5 ! NSPEC = 9 !

Number of chemical species to be emitted (NSE) Default: 3 ! NSE = 8 !

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

Restart Configuration:

Control flag (MRESTART) Default: 0 ! MRESTART = 0 !

0 = Do not read or write a restart file
1 = Read a restart file at the beginning of the run
2 = Write a restart file during run
3 = Read a restart file at beginning of run and write a restart file during run

Number of periods in Restart output cycle (NRESPD) Default: 0 ! NRESPD = 0 !

0 = File written only at last period
>0 = File updated every NRESPD periods
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

Meteorological Data Format (METFM)

Default: 1 ! METFM = 1 !

- METFM = 1 - CALMET binary file (CALMET.MET)
- METFM = 2 - ISC ASCII file (ISCMET.MET)
- METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
- METFM = 4 - CTDM plus tower file (PROFILE.DAT) and surface parameters file (SURFACE.DAT)
- METFM = 5 - AERMET tower file (PROFILE.DAT) and surface parameters file (SURFACE.DAT)

Meteorological Profile Data Format (MPRFFM)

(used only for METFM = 1, 2, 3)

Default: 1 ! MPRFFM = 1 !

- MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
- MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2

Averaging Time (minutes) (AVET)

Default: 60.0 ! AVET = 60. !

PG Averaging Time (minutes) (PGTIME)

Default: 60.0 ! PGTIME = 60. !

!END!

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

INPUT GROUP: 2 -- Technical options

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

Vertical distribution used in the near field (MGAUSS)

Default: 1 ! MGAUSS = 1 !

- 0 = uniform
- 1 = Gaussian

Terrain adjustment method (MCTADJ)

Default: 3 ! MCTADJ = 3 !

- 0 = no adjustment
- 1 = ISC-type of terrain adjustment
- 2 = simple, CALPUFF-type of terrain adjustment
- 3 = partial plume path adjustment

Subgrid-scale complex terrain flag (MCTSG)

Default: 0 ! MCTSG = 0 !

- 0 = not modeled
- 1 = modeled
Near-field puffs modeled as elongated 0 (MSLUG)  
0 = no  
1 = yes (slug model used)  

Transitional plume rise modeled? (MTRANS)  
0 = no (i.e., final rise only)  
1 = yes (i.e., transitional rise computed)  

Stack tip downwash? (MTIP)  
0 = no (i.e., no stack tip downwash)  
1 = yes (i.e., use stack tip downwash)  

Method used to simulate building downwash? (MBDW)  
1 = ISC method  
2 = PRIME method  

Vertical wind shear modeled above stack top? (MSHEAR)  
0 = no (i.e., vertical wind shear not modeled)  
1 = yes (i.e., vertical wind shear modeled)  

Puff splitting allowed? (MSPLIT)  
0 = no (i.e., puffs not split)  
1 = yes (i.e., puffs are split)  

Chemical mechanism flag (MCHEM)  
0 = chemical transformation not modeled  
1 = transformation rates computed internally (MESOPUFF II scheme)  
2 = user-specified transformation rates used  
3 = transformation rates computed internally (RIVAD/ARM3 scheme)  
4 = secondary organic aerosol formation computed (MESOPUFF II scheme for OH)  

Aqueous phase transformation flag (MAQCHEM)  
(Used only if MCHEM = 1, or 3)  
0 = aqueous phase transformation not modeled  
1 = transformation rates adjusted for aqueous phase reactions  

Wet removal modeled? (MWET)  
0 = no  
1 = yes
Dry deposition modeled? (MDRY)  Default: 1  ! MDRY = 1  !
0 = no
1 = yes
(dry deposition method specified
for each species in Input Group 3)

Gravitational settling (plume tilt)
modeled? (MTILT)  Default: 0  ! MTILT = 0  !
0 = no
1 = yes
(puff center falls at the gravitational
settling velocity for 1 particle species)

Restrictions:
- MDRY = 1
- NSPEC = 1  (must be particle species as well)
- sg = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
  set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)  Default: 3  ! MDISP = 3  !
1 = dispersion coefficients computed from measured values
  of turbulence, sigma v, sigma w
2 = dispersion coefficients from internally calculated
  sigma v, sigma w using micrometeorological variables
  (u*, w*, L, etc.)
3 = PG dispersion coefficients for RURAL areas (computed using
  the ISCST multi-segment approximation) and MP coefficients in
  urban areas
4 = same as 3 except PG coefficients computed using
  the MESOPUFF II eqns.
5 = CTDM sigmas used for stable and neutral conditions.
  For unstable conditions, sigmas are computed as in
  MDISP = 3, described above.  MDISP = 5 assumes that
  measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)  Default: 3  ! MTURBVW = 3  !
1 = use sigma-v or sigma-theta measurements
  from PROFILE.DAT to compute sigma-y
  (valid for METFM = 1, 2, 3, 4, 5)
2 = use sigma-w measurements
  from PROFILE.DAT to compute sigma-z
  (valid for METFM = 1, 2, 3, 4, 5)
3 = use both sigma-(v/theta) and sigma-w
  from PROFILE.DAT to compute sigma-y and sigma-z
  (valid for METFM = 1, 2, 3, 4, 5)
4 = use sigma-theta measurements
  from PLMMET.DAT to compute sigma-y
  (valid only if METFM = 3)
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

Back-up method used to compute dispersion when measured turbulence data are missing (MDISP2) Default: 3 ! MDISP2 = 3 !
(used only if MDISP = 1 or 5)
2 = dispersion coefficients from internally calculated sigma v, sigma w using micrometeorological variables (u*, w*, L, etc.)
3 = PG dispersion coefficients for RURAL areas (computed using the ISCST multi-segment approximation) and MP coefficients in urban areas
4 = same as 3 except PG coefficients computed using the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y (used only if MDISP=1,2 or MDISP2=1,2)
(MTAYLULY) Default: 0 ! MTAYLULY = 0 !
0 = Draxler default 617.284 (s)
1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
10 < Direct user input (s) -- e.g., 306.9

[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence (used only if MDISP=2 or MDISP2=2)
(MTAAUADV) Default: 0 ! MTAAUADV = 0 !
0 = No turbulence advection
1 = Computed (OPTION NOT IMPLEMENTED)
10 < Direct user input (s) -- e.g., 800

Method used to compute turbulence sigma-v & sigma-w using micrometeorological variables (Used only if MDISP = 2 or MDISP2 = 2)
(MTURBB) Default: 1 ! MTURBB = 1 !
1 = Standard CALPUFF subroutines
2 = AERMOD subroutines

PG sigma-y,z adj. for roughness? Default: 0 ! MROUGH = 0 !
(MRROUGH)
0 = no
1 = yes

Partial plume penetration of elevated inversion? Default: 1 ! MPARTL = 1 !
(MPARTL)
0 = no
1 = yes

Strength of temperature inversion provided in PROFILE.DAT extended records? Default: 0 ! MTINV = 0 !
(MTINV)
0 = no (computed from measured/default gradients)
1 = yes

PDF used for dispersion under convective conditions?

Default: 0 ! MPDF = 0 !

(MPDF)
0 = no
1 = yes

Sub-Grid TIBL module used for shore line?

Default: 0 ! MSGTIBL = 0 !

(MSGTIBL)
0 = no
1 = yes

Boundary conditions (concentration) modeled?

Default: 0 ! MBCON = 0 !

(MBCON)
0 = no
1 = yes, using formatted BCON.DAT file
2 = yes, using unformatted CONC.DAT file

Note: MBCON > 0 requires that the last species modeled be 'BCON'. Mass is placed in species BCON when generating boundary condition puffs so that clean air entering the modeling domain can be simulated in the same way as polluted air. Specify zero emission of species BCON for all regular sources.

Individual source contributions saved?

Default: 0 ! MSOURCE = 0 !

(MSOURCE)
0 = no
1 = yes

Analyses of fogging and icing impacts due to emissions from arrays of mechanically-forced cooling towers can be performed using CALPUFF in conjunction with a cooling tower emissions processor (CTEMISS) and its associated postprocessors. Hourly emissions of water vapor and temperature from each cooling tower cell are computed for the current cell configuration and ambient conditions by CTEMISS. CALPUFF models the dispersion of these emissions and provides cloud information in a specialized format for further analysis. Output to FOG.DAT is provided in either 'plume mode' or 'receptor mode' format.

Configure for FOG Model output?

Default: 0 ! MFOG = 0 !

(MFOG)
0 = no
1 = yes  - report results in PLUME Mode format
2 = yes  - report results in RECEPTOR Mode format

Test options specified to see if
they conform to regulatory
values? (MREG)  Default: 1  ! MREG = 1  !

0 = NO checks are made
1 = Technical options must conform to USEPA
  Long Range Transport (LRT) guidance

METFM    1 or 2
AVET     60. (min)
PGETIME  60. (min)
MGAUSS   1
MCTADJ   3
MTRANS   1
MTIP     1
MCHEM    1 or 3 (if modeling SOx, NOx)
MWET     1
MDRY     1
MDISP    2 or 3
MPDF     0 if MDISP=3
         1 if MDISP=2
MROUGH   0
MPARTRL  1
SYTDEP   550. (m)
MHFTSZ   0
SVMIN    0.5 (m/s)

!END!

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

INPUT GROUP: 3a, 3b -- Species list
-----------------------------
-----------------------------
Subgroup (3a)
--------------

The following species are modeled:

! CSPEC =    SO2 !  !END!
! CSPEC =    SO4 !  !END!
! CSPEC =    NOX !  !END!
! CSPEC =   HNO3 !  !END!
! CSPEC =    NO3 !  !END!
! CSPEC =    PMC !  !END!
! CSPEC =    PMF !  !END!
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

! CSPEC = EC ! !END!
! CSPEC = SOA ! !END!

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>MODELED</th>
<th>EMITTED</th>
<th>DEPOSITED</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>(0=NO, 1=YES)</td>
<td>(0=NO, 1=YES)</td>
<td>(0=NO, 1=COMPUTED-GAS)</td>
<td>(0=NONE, 1=1st)</td>
</tr>
<tr>
<td>SO2</td>
<td>1,</td>
<td>1,</td>
<td>1,</td>
<td>0 !</td>
</tr>
<tr>
<td>SO4</td>
<td>1,</td>
<td>1,</td>
<td>2,</td>
<td>0 !</td>
</tr>
<tr>
<td>NOX</td>
<td>1,</td>
<td>1,</td>
<td>1,</td>
<td>0 !</td>
</tr>
<tr>
<td>HNO3</td>
<td>1,</td>
<td>0,</td>
<td>1,</td>
<td>0 !</td>
</tr>
<tr>
<td>NO3</td>
<td>1,</td>
<td>1,</td>
<td>2,</td>
<td>0 !</td>
</tr>
<tr>
<td>PMC</td>
<td>1,</td>
<td>1,</td>
<td>2,</td>
<td>0 !</td>
</tr>
<tr>
<td>PMF</td>
<td>1,</td>
<td>1,</td>
<td>2,</td>
<td>0 !</td>
</tr>
<tr>
<td>EC</td>
<td>1,</td>
<td>1,</td>
<td>2,</td>
<td>0 !</td>
</tr>
<tr>
<td>SOA</td>
<td>1,</td>
<td>1,</td>
<td>2,</td>
<td>0 !</td>
</tr>
</tbody>
</table>

Note: The last species in (3a) must be 'BCON' when using the boundary condition option (MBCON > 0). Species BCON should typically be modeled as inert (no chem transformation or removal).

Subgroup (3b)

The following names are used for Species-Groups in which results for certain species are combined (added) prior to output. The CGRUP name will be used as the species name in output files. Use this feature to model specific particle-size distributions by treating each size-range as a separate species. Order must be consistent with 3(a) above.

INPUT GROUP: 4 -- Map Projection and Grid control parameters

Projection for all (X,Y):

Map projection
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

(PMAP)                      Default: UTM ! PMAP = LCC !

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

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

UTM zone (1 to 60)
(Used only if PMAP=UTM)
(IUTMZN)                   No Default ! IUTMZN = 0 !

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

Latitude and Longitude (decimal degrees) of projection origin
(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
(RLAT0)                   No Default ! RLAT0 = 49.0N !
(RLON0)                   No Default ! RLON0 = 121.0W !

TTM : RLON0 identifies central (true N/S) meridian of projection
     RLAT0 selected for convenience
LCC : RLON0 identifies central (true N/S) meridian of projection
     RLAT0 selected for convenience
PS : RLON0 identifies central (grid N/S) meridian of projection
     RLAT0 selected for convenience
EM : RLON0 identifies central meridian of projection
     RLAT0 is REPLACED by 0.0N (Equator)
LAZA: RLON0 identifies longitude of tangent-point of mapping plane
     RLAT0 identifies latitude of tangent-point of mapping plane

Matching parallel(s) of latitude (decimal degrees) for projection
(Used only if PMAP= LCC or PS)
(XLAT1)                   No Default ! XLAT1 = 30.0N !
(XLAT2)                   No Default ! XLAT2 = 60.0N !

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

----------

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

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

The Datum-Region for the coordinates is identified by a character string. Many mapping products currently available use the model of the Earth known as the World Geodetic System 1984 (WGS-84). Other local models may be in use, and their selection in CALMET will make its output consistent with local mapping products. The list of Datum-Regions with official transformation parameters is provided by the National Imagery and Mapping Agency (NIMA).

NIMA Datum - Regions(Examples)
---------------------------------
WGS-84 WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
NAS-C NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
NAR-C NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
NWS-84 NWS 6370KM Radius, Sphere
ESR-S ESRI REFERENCE 6371KM Radius, Sphere

Datum-region for output coordinates
(DATUM)  Default: WGS-84   ! DATUM = NWS-84 !

METEOROLOGICAL Grid:

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

No. X grid cells (NX)  No default   ! NX = 107 !
No. Y grid cells (NY)  No default   ! NY = 111 !
No. vertical layers (NZ)  No default   ! NZ = 10 !
Grid spacing (DGRIDKM)  No default   ! DGRIDKM = 4. !
Units: km

Cell face heights
(ZFACE(nz+1))  No defaults
Units: m
! ZFACE =0.,20.,40.,65.,120.,200.,400.,700.,1200.,2200.,4000. !

Reference Coordinates
of SOUTHWEST corner of grid cell(1, 1):

X coordinate (XORIGKM)  No default   ! XORIGKM = -344. !
Y coordinate (YORIGKM)  No default   ! YORIGKM = -444. !
Units: km
COMPUTATIONAL Grid:

The computational grid is identical to or a subset of the MET. grid. The lower left (LL) corner of the computational grid is at grid point (IBCOMP, JBCOMP) of the MET. grid. The upper right (UR) corner of the computational grid is at grid point (IECOMP, JECOMP) of the MET. grid. The grid spacing of the computational grid is the same as the MET. grid.

X index of LL corner (IBCOMP) No default ! IBCOMP = 1 !
(1 <= IBCOMP <= NX)

Y index of LL corner (JBCOMP) No default ! JBCOMP = 1 !
(1 <= JBCOMP <= NY)

X index of UR corner (IECOMP) No default ! IECOMP = 107 !
(1 <= IECOMP <= NX)

Y index of UR corner (JECOMP) No default ! JECOMP = 111 !
(1 <= JECOMP <= NY)

SAMPLING Grid (GRIDDED RECEPTORS):

The lower left (LL) corner of the sampling grid is at grid point (IBSAMP, JBSAMP) of the MET. grid. The upper right (UR) corner of the sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid. The sampling grid must be identical to or a subset of the computational grid. It may be a nested grid inside the computational grid. The grid spacing of the sampling grid is DGRIDKM/MESHDN.

Logical flag indicating if gridded receptors are used (LSAMP) Default: T ! LSAMP = T !
(T=yes, F=no)

X index of LL corner (IBSAMP) No default ! IBSAMP = 1 !
(IBCOMP <= IBSAMP <= IECOMP)

Y index of LL corner (JBSAMP) No default ! JBSAMP = 1 !
(JBCOMP <= JBSAMP <= JECOMP)

X index of UR corner (IESAMP) No default ! IESAMP = 107 !
(IBCOMP <= IESAMP <= IECOMP)

Y index of UR corner (JESAMP) No default ! JESAMP = 111 !
(JBCOMP <= JESAMP <= JECOMP)
Nesting factor of the sampling grid (MESHDN) Default: 1 ! MESHDN = 1 !
(MESHDN is an integer >= 1)

END!

INPUT GROUP: 5 -- Output Options
----------

<table>
<thead>
<tr>
<th>FILE</th>
<th>DEFAULT VALUE</th>
<th>VALUE THIS RUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrations (ICON)</td>
<td>1</td>
<td>ICON = 1 !</td>
</tr>
<tr>
<td>Dry Fluxes (IDRY)</td>
<td>1</td>
<td>IDRY = 0 !</td>
</tr>
<tr>
<td>Wet Fluxes (IWET)</td>
<td>1</td>
<td>IWET = 0 !</td>
</tr>
<tr>
<td>2D Temperature (IT2D)</td>
<td>0</td>
<td>IT2D = 0 !</td>
</tr>
<tr>
<td>2D Density (IRHO)</td>
<td>0</td>
<td>IRHO = 0 !</td>
</tr>
<tr>
<td>Relative Humidity (IVIS)</td>
<td>1</td>
<td>IVIS = 1 !</td>
</tr>
</tbody>
</table>

(RH file is required for VISIBILITY analyses)

Use data compression option in output file?
(LCOMPRS) Default: T ! LCOMPRS = T !

* 0 = Do not create file, 1 = create file

QA PLOT FILE OUTPUT OPTION:

Create a standard series of output files (e.g. locations of sources, receptors, grids ...) suitable for plotting?
(IQAPLOT) Default: 1 ! IQAPLOT = 1 !
0 = no
1 = yes

DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

Mass flux across specified boundaries for selected species reported hourly?
(IMFLX) Default: 0 ! IMFLX = 0 !
0 = no
1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames are specified in Input Group 0)

Mass balance for each species
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

---

reported hourly?

(IMBAL) Default: 0 ! IMBAL = 1 !  
0 = no  
1 = yes (MASSBAL.DAT filename is specified in Input Group 0)

LINE PRINTER OUTPUT OPTIONS:

Print concentrations (ICPRT) Default: 0 ! ICPRT = 0 !  
Print dry fluxes (IDPRT) Default: 0 ! IDPRT = 0 !  
Print wet fluxes (IWPRRT) Default: 0 ! IWPRRT = 0 !

(0 = Do not print, 1 = Print)

Concentration print interval (ICFRQ) in hours Default: 1 ! ICFRQ = 24 !  
Dry flux print interval (IDFRQ) in hours Default: 1 ! IDFRQ = 1 !  
Wet flux print interval (IWFRQ) in hours Default: 1 ! IWFRQ = 1 !

Units for Line Printer Output (IPRTU) Default: 1 ! IPRTU = 1 !

<table>
<thead>
<tr>
<th>for Concentration</th>
<th>for Deposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = g/m**3</td>
<td>g/m**2/s</td>
</tr>
<tr>
<td>2 = mg/m**3</td>
<td>mg/m**2/s</td>
</tr>
<tr>
<td>3 = ug/m**3</td>
<td>ug/m**2/s</td>
</tr>
<tr>
<td>4 = ng/m**3</td>
<td>ng/m**2/s</td>
</tr>
<tr>
<td>5 = Odour Units</td>
<td></td>
</tr>
</tbody>
</table>

Messages tracking progress of run written to the screen ?

(IMESG) Default: 2 ! IMESG = 2 !  
0 = no  
1 = yes (advection step, puff ID)  
2 = yes (YYYYJJJJHH, # old puffs, # emitted puffs)

SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

| SPECIES 
<table>
<thead>
<tr>
<th>GROUP</th>
<th>PRINTED?</th>
<th>SAVED ON DISK?</th>
<th>PRINTED?</th>
<th>SAVED ON DISK?</th>
<th>PRINTED?</th>
<th>SAVED ON DISK?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>---------</td>
<td>--------------</td>
<td>----------</td>
<td>--------------</td>
<td>----------</td>
<td>--------------</td>
</tr>
<tr>
<td>!</td>
<td>SO2 =</td>
<td>0,</td>
<td>1,</td>
<td>0,</td>
<td>0,</td>
<td>0,</td>
</tr>
<tr>
<td>!</td>
<td>NOX =</td>
<td>0,</td>
<td>1,</td>
<td>0,</td>
<td>0,</td>
<td>0,</td>
</tr>
</tbody>
</table>
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

! 

HNO3 = 0, 1, 0, 0, 0, 0, 0, 0 !
SO4 = 0, 1, 0, 0, 0, 0, 0, 0 !
NO3 = 0, 1, 0, 0, 0, 0, 0, 0 !
PMC = 0, 1, 0, 0, 0, 0, 0, 0 !
PMF = 0, 1, 0, 0, 0, 0, 0, 0 !
EC = 0, 1, 0, 0, 0, 0, 0, 0 !
SOA = 0, 1, 0, 0, 0, 0, 0, 0 !

Note: Species BCON (for MBCON > 0) does not need to be saved on disk.

OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

Logical for debug output
(LDEBUG) Default: F ! LDEBUG = F !
First puff to track
(IPFDEB) Default: 1 ! IPFDEB = 1 !
Number of puffs to track
(NPFDEB) Default: 1 ! NPFDEB = 10 !
Met. period to start output
(NN1) Default: 1 ! NN1 = 10 !
Met. period to end output
(NN2) Default: 10 ! NN2 = 10 !

END!

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

INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-----------------------------------------------

Subgroup (6a)
---------------
Number of terrain features (NHILL) Default: 0 ! NHILL = 0 !
Number of special complex terrain receptors (NCTREC) Default: 0 ! NCTREC = 0 !
Terrain and CTSG Receptor data for CTSG hills input in CTDM format?

(MHILL)

1 = Hill and Receptor data created by CTDM processors & read from HILL.DAT and HILLRCT.DAT files
2 = Hill data created by OPTHILL & input below in Subgroup (6b);
   Receptor data in Subgroup (6c)

Factor to convert horizontal dimensions to meters (MHILL=1)

Factor to convert vertical dimensions to meters (MHILL=1)

X-origin of CTDM system relative to CALPUFF coordinate system, in Kilometers (MHILL=1)

Y-origin of CTDM system relative to CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

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

Subgroup (6b)

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

1 **

HILL information

<table>
<thead>
<tr>
<th>NO.</th>
<th>XC</th>
<th>YC</th>
<th>THETAH</th>
<th>ZGRID</th>
<th>RELIEF</th>
<th>EXPO 1</th>
<th>EXPO 2</th>
<th>SCALE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(km)</td>
<td>(km)</td>
<td>(deg.)</td>
<td>(m)</td>
<td>(m)</td>
<td>(m)</td>
<td>(m)</td>
<td>(m)</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
<td>------</td>
<td>--------</td>
<td>-------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
</tr>
</tbody>
</table>

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

Subgroup (6c)

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

COMPLEX TERRAIN RECEPTOR INFORMATION

<table>
<thead>
<tr>
<th>XRCT</th>
<th>YRCT</th>
<th>ZRCT</th>
<th>XHH</th>
</tr>
</thead>
<tbody>
<tr>
<td>(km)</td>
<td>(km)</td>
<td>(m)</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
</tbody>
</table>
Description of Complex Terrain Variables:
XC, YC = Coordinates of center of hill
THETAH = Orientation of major axis of hill (clockwise from North)
ZGRID = Height of the grid above mean sea level
RELIEF = Height of the crest of the hill above the grid elevation
EXPO 1 = Hill-shape exponent for the major axis
EXPO 2 = Hill-shape exponent for the minor axis
SCALE 1 = Horizontal length scale along the major axis
SCALE 2 = Horizontal length scale along the minor axis
AMAX = Maximum allowed axis length for the major axis
BMAX = Maximum allowed axis length for the major axis
XRCT, YRCT = Coordinates of the complex terrain receptors
ZRCT = Height of the ground (MSL) at the complex terrain receptor
XHH = Hill number associated with each complex terrain receptor
(NOTE: MUST BE ENTERED AS A REAL NUMBER)

**
NOTE: DATA for each hill and CTSG receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
------------

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>DIFFUSIVITY</th>
<th>ALPHA STAR</th>
<th>REACTIVITY</th>
<th>MESOPHYLL RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HENRY'S LAW COEFFICIENT</td>
<td>(cm**2/s)</td>
<td>(s/cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAME</td>
<td>(dimensionless)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>----------------</td>
<td>--------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO2 = 0.1509,</td>
<td>1000.,</td>
<td>8.,</td>
<td>0.,</td>
<td>0.04 !</td>
</tr>
<tr>
<td>NOX = 0.1656,</td>
<td>1.,</td>
<td>8.,</td>
<td>5.,</td>
<td>3.5 !</td>
</tr>
<tr>
<td>HNO3 = 0.1628,</td>
<td>1.,</td>
<td>18.,</td>
<td>0.,</td>
<td>0.00000008</td>
</tr>
</tbody>
</table>

!END!

INPUT GROUP: 8 -- Size parameters for dry deposition of particles
-------------
For SINGLE SPECIES, the mean and standard deviation are used to compute a deposition velocity for NINT (see group 9) size-ranges, and these are then averaged to obtain a mean deposition velocity.

For GROUPED SPECIES, the size distribution should be explicitly specified (by the 'species' in the group), and the standard deviation for each should be entered as 0. The model will then use the deposition velocity for the stated mean diameter.

<table>
<thead>
<tr>
<th>SPECIES NAME</th>
<th>GEOMETRIC MASS MEAN DIAMETER (microns)</th>
<th>GEOMETRIC STANDARD DEVIATION (microns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>! SO4 =</td>
<td>0.48,</td>
<td>2.0</td>
</tr>
<tr>
<td>! NO3 =</td>
<td>0.48,</td>
<td>2.0</td>
</tr>
<tr>
<td>! SOA =</td>
<td>0.48,</td>
<td>2.0</td>
</tr>
<tr>
<td>! PMF =</td>
<td>0.48,</td>
<td>2.0</td>
</tr>
<tr>
<td>! PMC =</td>
<td>5.0,</td>
<td>1.5</td>
</tr>
<tr>
<td>! EC =</td>
<td>0.48,</td>
<td>2.0</td>
</tr>
</tbody>
</table>

INPUT GROUP: 9 -- Miscellaneous dry deposition parameters

Reference cuticle resistance (s/cm) (RCUTR) Default: 30 ! RCUTR = 30.0 !
Reference ground resistance (s/cm) (RGR) Default: 10 ! RGR = 10.0 !
Reference pollutant reactivity (REACTR) Default: 8 ! REACTR = 8.0 !

Number of particle-size intervals used to evaluate effective particle deposition velocity (NINT) Default: 9 ! NINT = 9 !

Vegetation state in unirrigated areas (IVEG) Default: 1 ! IVEG = 1 !
IVEG=1 for active and unstressed vegetation
IVEG=2 for active and stressed vegetation
IVEG=3 for inactive vegetation

!END!
INPUT GROUP: 10 -- Wet Deposition Parameters

Scavenging Coefficient -- Units: (sec)**(-1)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Liquid Precip.</th>
<th>Frozen Precip.</th>
</tr>
</thead>
<tbody>
<tr>
<td>! SO2 =</td>
<td>3.0E-05,</td>
<td>0.0E00 !</td>
</tr>
<tr>
<td>! SO4 =</td>
<td>1.0E-04,</td>
<td>3.0E-05 !</td>
</tr>
<tr>
<td>! NOX =</td>
<td>0.0E00,</td>
<td>0.0E00 !</td>
</tr>
<tr>
<td>! HNO3 =</td>
<td>6.0E-05,</td>
<td>0.0E00 !</td>
</tr>
<tr>
<td>! NO3 =</td>
<td>1.0E-04,</td>
<td>3.0E-05 !</td>
</tr>
<tr>
<td>! PM =</td>
<td>1.0E-04,</td>
<td>3.0E-05 !</td>
</tr>
<tr>
<td>! EC =</td>
<td>1.0E-04,</td>
<td>3.0E-05 !</td>
</tr>
<tr>
<td>! SOA =</td>
<td>1.0E-04,</td>
<td>3.0E-05 !</td>
</tr>
</tbody>
</table>

!END!

INPUT GROUP: 11 -- Chemistry Parameters

Ozone data input option (MOZ)  Default: 1  ! MOZ = 0 !
(Used only if MCHEM = 1, 3, or 4)
  0 = use a monthly background ozone value
  1 = read hourly ozone concentrations from
       the OZONE.DAT data file

Monthly ozone concentrations
(Used only if MCHEM = 1, 3, or 4 and
 MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
(BCKO3) in ppb  Default: 12*80.
! BCKO3 = 12*60. !

Monthly ammonia concentrations
(Used only if MCHEM = 1, or 3)
(BCKNH3) in ppb  Default: 12*10.
! BCKNH3 = 12*17.0 !

Nighttime SO2 loss rate (RNITE1)
in percent/hour  Default: 0.2  ! RNITE1 = .2 !

Nighttime NOx loss rate (RNITE2)
in percent/hour  Default: 2.0  ! RNITE2 = 2.0 !

Nighttime HNO3 formation rate (RNITE3)
in percent/hour  Default: 2.0  ! RNITE3 = 2.0 !
H2O2 data input option (MH2O2) Default: 1 ! MH2O2 = 1 ! (Used only if MAQCHEM = 1)
0 = use a monthly background H2O2 value
1 = read hourly H2O2 concentrations from the H2O2.DAT data file

Monthly H2O2 concentrations (Used only if MQACHEM = 1 and MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
(BCKH2O2) in ppb Default: 12*1.
! BCKH2O2 = 12*1.0 !

--- Data for SECONDARY ORGANIC AEROSOL (SOA) Option (used only if MCHEM = 4)

The SOA module uses monthly values of:
- Fine particulate concentration in ug/m^3 (BCKPMF)
- Organic fraction of fine particulate (OFRAC)
- VOC / NOx ratio (after reaction) (VCNX)

to characterize the air mass when computing the formation of SOA from VOC emissions.

Typical values for several distinct air mass types are:

<table>
<thead>
<tr>
<th>Month</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Feb</td>
<td>1.0</td>
<td>1.5</td>
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<tr>
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<td>15.0</td>
<td>15.0</td>
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<td>15.0</td>
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<td>15.0</td>
</tr>
</tbody>
</table>
Urban - no controls present
  BCKPMF  100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
  OFRAC  .30  .30  .35  .35  .55  .55  .35  .35  .35  .30
  VCNX    2.  2.  2.  2.  2.  2.  2.  2.  2.  2.  2.  2.

Default: Clean Continental
  !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
  !  OFRAC = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15,
  !  VCNX  = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,

!END!

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

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
-----------------

Horizontal size of puff (m) beyond which
time-dependent dispersion equations (Heffter)
are used to determine sigma-y and
sigma-z (SYTDEP)                      Default: 550.  ! SYTDEP = 5.5E02 !

Switch for using Heffter equation for sigma z
as above (0 = Not use Heffter; 1 = use Heffter
(MHFTSZ)                           Default: 0      ! MHFTSZ =  0   !

Stability class used to determine plume
growth rates for puffs above the boundary
layer (JSUP)                       Default: 5      ! JSUP =  5   !

Vertical dispersion constant for stable
conditions (k1 in Eqn. 2.7-3)  (CONK1)       Default: 0.01  ! CONK1 = .01 !

Vertical dispersion constant for neutral/
unstable conditions (k2 in Eqn. 2.7-4)
(CONK2)                        Default: 0.1  ! CONK2 = .1 !

Factor for determining Transition-point from
Schulman-Scire to Huber-Snyder Building Downwash
scheme (SS used for Hs < Hb + TBD * HL)
(TBD)                          Default: 0.5  ! TBD = .5 !
    TBD < 0  ==> always use Huber-Snyder
    TBD = 1.5 ==> always use Schulman-Scire
    TBD = 0.5 ==> ISC Transition-point
Range of land use categories for which urban dispersion is assumed
(IURB1, IURB2) Default: 10 ! IURB1 = 10 !
19 ! IURB2 = 19 !

Site characterization parameters for single-point Met data files --------
(needed for METFM = 2,3,4,5)

Land use category for modeling domain
(ILANDUIN) Default: 20 ! ILANDUIN = 20 !

Roughness length (m) for modeling domain
(Z0IN) Default: 0.25 ! Z0IN = .25 !

Leaf area index for modeling domain
(XLAIIN) Default: 3.0 ! XLAIIN = 3.0 !

Elevation above sea level (m)
(ELEVIN) Default: 0.0 ! ELEVIN = .0 !

Latitude (degrees) for met location
(XLATIN) Default: -999. ! XLATIN = -999.0 !

Longitude (degrees) for met location
(XLONIN) Default: -999. ! XLONIN = -999.0 !

Specialized information for interpreting single-point Met data files ------

Anemometer height (m) (Used only if METFM = 2,3)
(ANEMHT) Default: 10. ! ANEMHT = 10.0 !

Form of lateral turbulence data in PROFILE.DAT file
(Used only if METFM = 4,5 or MTURBVW = 1 or 3)
(ISIGMAV) Default: 1 ! ISIGMAV = 1 !
0 = read sigma-theta
1 = read sigma-v

Choice of mixing heights (Used only if METFM = 4)
(IMIXCTDM) Default: 0 ! IMIXCTDM = 0 !
0 = read PREDICTED mixing heights
1 = read OBSERVED mixing heights

Maximum length of a slug (met. grid units)
(XMXLEN) Default: 1.0 ! XMXLEN = 1.0 !

Maximum travel distance of a puff/slug (in grid units) during one sampling step
(XSAMLEN) Default: 1.0 ! XSAMLEN = 1.0 !

Maximum Number of slugs/puffs release from one source during one time step
(MXNEW) Default: 99 ! MXNEW = 99 !
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

Maximum Number of sampling steps for one puff/slug during one time step (MXSAM)  Default: 99 ! MXSAM = 99 !

Number of iterations used when computing the transport wind for a sampling step that includes gradual rise (for CALMET and PROFILE winds) (NCOUNT)  Default: 2 ! NCOUNT = 2 !

Minimum sigma y for a new puff/slug (m) (SYMIN)  Default: 1.0 ! SYMIN = 1.0 !

Minimum sigma z for a new puff/slug (m) (SZMIN)  Default: 1.0 ! SZMIN = 1.0 !

Default minimum turbulence velocities sigma-v and sigma-w for each stability class over land and over water (m/s) (SVMIN(12) and SWMIN(12))

<table>
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<tr>
<th>Stab Class</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
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<tr>
<td>Default SVMIN:</td>
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<td>.50</td>
<td>.50</td>
<td>.50</td>
<td>.50</td>
<td>.50</td>
<td>.37</td>
<td>.37</td>
<td>.37</td>
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<tr>
<td>Default SWMIN:</td>
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<td>.08</td>
<td>.06</td>
<td>.03</td>
<td>.016</td>
<td>.20</td>
<td>.12</td>
<td>.08</td>
<td>.06</td>
<td>.03</td>
<td>.016</td>
</tr>
</tbody>
</table>

* SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.370, 0.370, 0.370, 0.370, 0.370, 0.370*

! SVMIN = 12* 0.5 ! mreg =1 requirement

! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120, 0.080, 0.060, 0.030, 0.016!

Divergence criterion for dw/dz across puff used to initiate adjustment for horizontal convergence (1/s)
Partial adjustment starts at CDIV(1), and full adjustment is reached at CDIV(2) (CDIV(2))  Default: 0.0, 0.0 ! CDIV = 0.0, 0.0 !

Minimum wind speed (m/s) allowed for non-calm conditions. Also used as minimum speed returned when using power-law extrapolation toward surface (WSCALM)  Default: 0.5 ! WSCALM = 0.5 !

Maximum mixing height (m) (XMAXZI)  Default: 3000. ! XMAXZI = 3000.0 !

Minimum mixing height (m) (XMINZI)  Default: 50. ! XMINZI = 50.0 !
Default wind speed classes --
5 upper bounds (m/s) are entered;
the 6th class has no upper limit

(WSCAT(5))

Default : ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8 (10.8+)

Wind Speed Class : 1 2 3 4 5
--- --- --- --- ---
! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80!

Default wind speed profile power-law
exponents for stabilities 1-6

(PLX0(6))

Default : ISC RURAL values
ISC RURAL : .07, .07, .10, .15, .35, .55
ISC URBAN : .15, .15, .20, .25, .30, .30

Stability Class : A B C D E F
--- --- --- --- --- ---
! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35, 0.55!

Default potential temperature gradient
for stable classes E, F (degK/m)

(PTG0(2))

Default: 0.020, 0.035
! PTG0 = 0.020, 0.035!

Default plume path coefficients for
each stability class (used when option
for partial plume height terrain adjustment
is selected -- MCTADJ=3)

(PPC(6))

Default PPC : .50, .50, .50, .50, .35, .35
--- --- --- --- --- ---
! PPC = 0.50, 0.50, 0.50, 0.50, 0.35, 0.35!

Slug-to-puff transition criterion factor
equal to sigma-y/length of slug

(SL2PF)

Default: 10.
! SL2PF = 10.0!

Puff-splitting control variables ------------------------

VERTICAL SPLIT
-----------

Number of puffs that result every time a puff
is split - nsplit=2 means that 1 puff splits
into 2

(NSPLIT)

Default: 3
! NSPLIT = 3!
24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
0=do not re-split   1=eligible for re-split
(IRESPLIT(24))     Default: Hour 17 = 1
!  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0 !

Split is allowed only if last hour's mixing height (m) exceeds a minimum value
(ZISPLIT)     Default: 100.       ! ZISPLIT = 100.0 !

Split is allowed only if ratio of last hour's mixing ht to the maximum mixing ht experienced
by the puff is less than a maximum value (this postpones a split until a nocturnal layer develops)
(ROLDMAX)     Default: 0.25       ! ROLDMAX = 0.25 !

HORIZONTAL SPLIT
--------------
Number of puffs that result every time a puff
is split - nsplith=5 means that 1 puff splits
into 5
(NSPLITH)     Default: 5        ! NSPLITH = 5 !

Minimum sigma-\(y\) (Grid Cells Units) of puff
before it may be split
(SYSPLITH)     Default: 1.0       ! SYSPLITH = 1.0 !

Minimum puff elongation rate (SYSPLITH/hr) due to
wind shear, before it may be split
(SHSPLITH)     Default: 2.0       ! SHSPLITH = 2.0 !

Minimum concentration (g/m^3) of each
species in puff before it may be split
Enter array of NSPEC values; if a single value is
entered, it will be used for ALL species
(CNSPLITH)     Default: 1.0E-07   ! CNSPLITH = 1.0E-07 !

Integration control variables ------------------------
Fractional convergence criterion for numerical SLUG
sampling integration
(EPSSLUG)     Default: 1.0e-04   ! EPSSLUG = 1.0E-04 !

Fractional convergence criterion for numerical AREA
source integration
(EPSAREA)     Default: 1.0e-06   ! EPSAREA = 1.0E-06 !

Trajectory step-length (m) used for numerical rise
integration
(DSRISE)     Default: 1.0        ! DSRISE = 1.0 !
Boundary Condition (BC) Puff control variables -------------------------

Minimum height (m) to which BC puffs are mixed as they are emitted 
(MBCON=2 ONLY). Actual height is reset to the current mixing height 
at the release point if greater than this minimum. 
(HTMINBC) Default: 500. ! HTMINBC = 500 !

Search radius (km) about a receptor for sampling nearest BC puff. 
BC puffs are typically emitted with a spacing of one grid cell 
length, so the search radius should be greater than DGRIDKM. 
(RSAMPBC) Default: 10. ! RSAMPBC = 10 !

Near-Surface depletion adjustment to concentration profile used when 
sampling BC puffs? 
(MDEPBC) Default: 1 ! MDEPBC = 1 ! 
  0 = Concentration is NOT adjusted for depletion 
  1 = Adjust Concentration for depletion

!END!

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

INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
----------------------------------------------------------------------------------------

Subgroup (13a)

Number of point sources with 
parameters provided below (NPT1) No default ! NPT1 = 6 !

Units used for point source 
emissions below (IPTU) Default: 1 ! IPTU = 3 !
  1 = g/s
  2 = kg/hr
  3 = lb/hr
  4 = tons/yr
  5 = Odour Unit * m**3/s (vol. flux of odour compound)
  6 = Odour Unit * m**3/min
  7 = metric tons/yr

Number of source-species 
combinations with variable 
emissions scaling factors 
provided below in (13d) (NSPT1) Default: 0 ! NSPT1 = 0 !

Number of point sources with 
variable emission parameters 
provided in external file (NPT2) No default ! NPT2 = 0 !
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

(If NPT2 > 0, these point source emissions are read from the file: PTEMARB.DAT)

!END!

-------------
Subgroup (13b)  
-------------  

a  

POINT SOURCE: CONSTANT DATA  
-------------------------------  

Source      X UTM     Y UTM     Stack   Base     Stack    Exit  Exit    Bldg.  
Emission     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash  
No.          (km)      (km)       (m)      (m)       (m)  (m/s) (deg. K)  
---    --------   --------   -------  -------   -------  ------  ------  ------  
--
** emiss updated 3/5/2009**
**                                                                  so2    so4    nox**
---

hno3  no3  pmc  pmf  ec  soa/oc

! SRCNAM = ctg3  !
  ! X = -181.612, -215.428, 54.9, 74.5, 5.49, 20.2, 344.7, 0.0, 4.854, 3.640,  
20.008,0.0, 0.000, 0.0, 0.000, 4.750, 9.245!!END!
  ! SRCNAM = ctg4  !
  ! X = -181.571, -215.431, 54.9, 74.5, 5.49, 20.2, 344.7, 0.0, 4.854, 3.640,  
20.008,0.0, 0.000, 0.0, 0.000, 4.750, 9.245!!END!
  ! SRCNAM = auxb2  !
  ! X = -181.516, -215.443, 14.9, 74.6, 0.54, 20.8, 476.5, 0.0, 0.179, 0.021, 0.322,  
0.0,0.0006, 0.0, 0.028, 0.000, 0.088!!END!
  ! SRCNAM = dg2  !
  ! X = -181.542, -215.431, 4.0, 74.5, 0.15, 94.6, 760.9, 0.0, 0.000, 0.000, 0.164,  
0.0, 0.000, 0.0, 0.000, 0.006, 0.002!!END!
  ! SRCNAM = fmpm2  !
  ! X = -181.610, -215.406, 4.0, 74.3, 0.13, 72.7, 828.7, 0.0, 0.000, 0.000, 0.057,  
0.0, 0.000, 0.0, 0.000, 0.006, 0.002!!END!
  ! SRCNAM = cool  !
  ! X = -181.549, -215.376, 15.8, 74.0, 12.98, 5.4, 312.0, 0.0, 0.000, 0.000, 0.000,  
0.0, 0.000, 0.0, 0.788, 0.000, 0.000!!END!

---------------
Subgroup (13b)  
---------------  

a  

Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

SRCNAM is a 12-character name for a source (No default)
X is an array holding the source data listed by the column headings (No default)
SIGYZI is an array holding the initial sigma-y and sigma-z (m) (Default: 0., 0.)
FMFAC is a vertical momentum flux factor (0. or 1.0) used to represent the effect of rain-caps or other physical configurations that reduce momentum rise associated with the actual exit velocity. (Default: 1.0 -- full momentum used)
ZPLTFM is the platform height (m) for sources influenced by an isolated structure that has a significant open area between the surface and the bulk of the structure, such as an offshore oil platform. The Base Elevation is that of the surface (ground or ocean), and the Stack Height is the release height above the Base (not above the platform). Building heights entered in Subgroup 13c must be those of the buildings on the platform, measured from the platform deck. ZPLTFM is used only with MBDW=1 (ISC downwash method) for sources with building downwash. (Default: 0.0)

b
0. = No building downwash modeled
1. = Downwash modeled for buildings resting on the surface
2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
NOTE: must be entered as a REAL number (i.e., with decimal point)

c
An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IPTU (e.g. 1 for g/s).

------------------------
Subgroup (13c)
------------------------

BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
--------------------------------------------------------
Source No. Effective building height, width, length and X/Y offset (in meters) every 10 degrees. LENGTH, XBADJ, and YBADJ are only needed for MBDW=2 (PRIME downwash option)
----

a
Building height, width, length, and X/Y offset from the source are treated as a separate input subgroup for each source and therefore must end with an input group terminator.

------------------------
Subgroup (13d)
-------------

POINT SOURCE: VARIABLE EMISSIONS DATA
----------------------------------------

Use this subgroup to describe temporal variations in the emission rates given in 13b. Factors entered multiply the rates in 13b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

IVARY determines the type of variation, and is source-specific:

(IVARY)
Default: 0
0 = Constant
1 = Diurnal cycle (24 scaling factors: hours 1-24)
2 = Monthly cycle (12 scaling factors: months 1-12)
3 = Hour & Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)
4 = Speed & Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12
5 = Temperature (12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

--------

Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

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

INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
-----------------------------------------------------------

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Subgroup (14a)
-------------

Number of polygon area sources with parameters specified below (NAR1) No default! NAR1 = 0!

Units used for area source emissions below (IARU) Default: 1! IARU = 1!

1 = g/m**2/s
2 = kg/m**2/hr
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

3 = lb/m**2/hr
4 = tons/m**2/yr
5 = Odour Unit * m/s (vol. flux/m**2 of odour compound)
6 = Odour Unit * m/min
7 = metric tons/m**2/yr

Number of source-species combinations with variable emissions scaling factors provided below in (14d) (NSAR1) Default: 0 ! NSAR1 = 0 !

Number of buoyant polygon area sources with variable location and emission parameters (NAR2) No default ! NAR2 = 0 !
(If NAR2 > 0, ALL parameter data for these sources are read from the file: BAEMARB.DAT)

!END!

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

Subgroup (14b)
--------------

a

AREA SOURCE: CONSTANT DATA

Source No. Effect. Height (m) Base Elevation (m) Initial Sigma z Emission Rates (m)
-------- ------ ------ ------- ------ -------- --------

--------

a Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

b An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IARU (e.g. 1 for g/m**2/s).

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

Subgroup (14c)
--------------

COORDINATES (UTM-km) FOR EACH VERTEX(4) OF EACH POLYGON

Source No. Ordered list of X followed by list of Y, grouped by source
----- -------------------------------------------------------------
------
  a
Data for each source are treated as a separate input subgroup
and therefore must end with an input group terminator.

-----------------------
Subgroup (14d)
-----------------------
  a
AREA SOURCE: VARIABLE EMISSIONS DATA
--------------------------------------

Use this subgroup to describe temporal variations in the emission
rates given in 14b. Factors entered multiply the rates in 14b.
Skip sources here that have constant emissions. For more elaborate
variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

IVARY determines the type of variation, and is source-specific:

(IVARY)                  Default: 0
  0 =       Constant
  1 =       Diurnal cycle (24 scaling factors: hours 1-24)
  2 =       Monthly cycle (12 scaling factors: months 1-12)
  3 =       Hour & Season (4 groups of 24 hourly scaling factors,
             where first group is DEC-JAN-FEB)
  4 =       Speed & Stab. (6 groups of 6 scaling factors, where
             first group is Stability Class A,
             and the speed classes have upper
             bounds (m/s) defined in Group 12
  5 =       Temperature (12 scaling factors, where temperature
             classes have upper bounds (C) of:
             0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

------
  a
Data for each species are treated as a separate input subgroup
and therefore must end with an input group terminator.

----------------------------------------------------------------------------------
INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
--------------------------

--------------------------
Subgroup (15a)
--------------------------
Number of buoyant line sources with variable location and emission parameters (NLN2) No default ! NLN2 = 0 !

(If NLN2 > 0, ALL parameter data for these sources are read from the file: LNEMARB.DAT)

Number of buoyant line sources (NLINES) No default ! NLINES = 0 !

Units used for line source emissions below (ILNU) Default: 1 ! ILNU = 1 !
1 = g/s
2 = kg/hr
3 = lb/hr
4 = tons/yr
5 = Odour Unit * m**3/s (vol. flux of odour compound)
6 = Odour Unit * m**3/min
7 = metric tons/yr

Number of source-species combinations with variable emissions scaling factors provided below in (15c) (NSLN1) Default: 0 ! NSLN1 = 0 !

Maximum number of segments used to model each line (MXNSEG) Default: 7 ! MXNSEG = 7 !

The following variables are required only if NLINES > 0. They are used in the buoyant line source plume rise calculations.

Number of distances at which transitional rise is computed Default: 6 ! NLRISE = 6 !

Average building length (XL) No default ! XL = .0 ! (in meters)

Average building height (HBL) No default ! HBL = .0 ! (in meters)

Average building width (WBL) No default ! WBL = .0 ! (in meters)

Average line source width (WML) No default ! WML = .0 ! (in meters)

Average separation between buildings (DXL) No default ! DXL = .0 ! (in meters)

Average buoyancy parameter (FPRIMEL) No default ! FPRIMEL = .0 ! (in m**4/s**3)

!END!
Subgroup (15b)

**BUOYANT LINE SOURCE: CONSTANT DATA**

<table>
<thead>
<tr>
<th>Source No.</th>
<th>Beg. X Coordinate (km)</th>
<th>Beg. Y Coordinate (km)</th>
<th>End. X Coordinate (km)</th>
<th>End. Y Coordinate (km)</th>
<th>Release Height (m)</th>
<th>Base Elevation (m)</th>
<th>Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>............</td>
<td>..............</td>
<td>..............</td>
<td>..............</td>
<td>..............</td>
<td>..............</td>
<td>..............</td>
<td>-------</td>
</tr>
</tbody>
</table>

a Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

b An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by ILNTU (e.g. 1 for g/s).

Subgroup (15c)

**BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA**

Use this subgroup to describe temporal variations in the emission rates given in 15b. Factors entered multiply the rates in 15b. Skip sources here that have constant emissions.

IVARY determines the type of variation, and is source-specific:

<table>
<thead>
<tr>
<th>(IVARY)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Constant</td>
</tr>
<tr>
<td>1</td>
<td>Diurnal cycle (24 scaling factors: hours 1-24)</td>
</tr>
<tr>
<td>2</td>
<td>Monthly cycle (12 scaling factors: months 1-12)</td>
</tr>
<tr>
<td>3</td>
<td>Hour &amp; Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)</td>
</tr>
<tr>
<td>4</td>
<td>Speed &amp; Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12)</td>
</tr>
<tr>
<td>5</td>
<td>Temperature (12 scaling factors, where temperature classes have upper bounds (°C) of:</td>
</tr>
</tbody>
</table>
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

--------
a
   Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

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

INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters

-----------------
Subgroup (16a)


Number of volume sources with parameters provided in 16b,c (NVL1)  No default ! NVL1 = 0 !

Units used for volume source emissions below in 16b (IVLU)  Default: 1 ! IVLU = 1 !
1 = g/s
2 = kg/hr
3 = lb/hr
4 = tons/yr
5 = Odour Unit * m**3/s  (vol. flux of odour compound)
6 = Odour Unit * m**3/min
7 = metric tons/yr

Number of source-species combinations with variable emissions scaling factors provided below in (16c) (NSVL1)  Default: 0 ! NSVL1 = 0 !

Number of volume sources with variable location and emission parameters (NVL2)  No default ! NVL2 = 0 !

(If NVL2 > 0, ALL parameter data for these sources are read from the VOLEMARB.DAT file(s) )

!END!

-----------------
Subgroup (16b)

a
VOLUME SOURCE: CONSTANT DATA
----------------------------------------

<table>
<thead>
<tr>
<th>X UTM Coordinate (km)</th>
<th>Y UTM Coordinate (km)</th>
<th>Effect. Height (m)</th>
<th>Base Elevation (m)</th>
<th>Initial Sigma y (m)</th>
<th>Initial Sigma z (m)</th>
<th>Emission Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a
Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

b
An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IVLU (e.g. 1 for g/s).

Subgroup (16c)
----------------------------------------
VOLUME SOURCE: VARIABLE EMISSIONS DATA
----------------------------------------

Use this subgroup to describe temporal variations in the emission rates given in 16b. Factors entered multiply the rates in 16b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

IVARY determines the type of variation, and is source-specific:

<table>
<thead>
<tr>
<th>IVARY</th>
<th>Default: 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Constant</td>
</tr>
<tr>
<td>1</td>
<td>Diurnal cycle (24 scaling factors: hours 1-24)</td>
</tr>
<tr>
<td>2</td>
<td>Monthly cycle (12 scaling factors: months 1-12)</td>
</tr>
<tr>
<td>3</td>
<td>Hour &amp; Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)</td>
</tr>
<tr>
<td>4</td>
<td>Speed &amp; Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12)</td>
</tr>
<tr>
<td>5</td>
<td>Temperature (12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)</td>
</tr>
</tbody>
</table>

a
Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information

Subgroup (17a)

Number of non-gridded receptors (NREC)  No default ! NREC = 3541 !

!END!

Subgroup (17b)

NON-GRIDDED (DISCRETE) RECEPTOR DATA

<table>
<thead>
<tr>
<th>Receptor No.</th>
<th>X UTM Coordinate (km)</th>
<th>Y UTM Coordinate (km)</th>
<th>Ground Elevation (m)</th>
<th>Height Above Ground (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>** alla</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-24.542, -173.238, 1477.0</td>
<td>!END!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-23.330, -173.243, 1463.0</td>
<td>!END!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-25.746, -171.442, 1478.0</td>
<td>!END!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-24.535, -171.447, 1604.0</td>
<td>!END!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-23.323, -171.452, 1183.0</td>
<td>!END!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<< removed receptors 6 through 3536 for brevity >>

3537 ! x = -30.266, -346.802, 382.0 ! !END!
3538 ! x = -29.018, -346.809, 593.0 ! !END!
3539 ! x = -27.770, -346.814, 430.0 ! !END!
3540 ! x = -27.762, -345.025, 505.0 ! !END!
3541 ! x = -26.506, -343.242, 667.0 ! !END!

Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

Receptor height above ground is optional. If no value is entered, the receptor is placed on the ground.
Appendix D

Example CALPOST Input File
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

GHE Unit 3&4 Class I Analysis 2003 Visibility Analysis alla Recs
Visibility Method 2
---------------- Run title (3 lines) ------------------------------------------

CALPOST MODEL CONTROL FILE
-----------------------------

INPUT GROUP: 0 -- Input and Output File Names
-----------------

Input Files
---------

<table>
<thead>
<tr>
<th>File</th>
<th>Default File Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc/Dep Flux File</td>
<td>MODEL.DAT</td>
</tr>
<tr>
<td>Relative Humidity File</td>
<td>VISB.DAT</td>
</tr>
<tr>
<td>Background Data File</td>
<td>BACK.DAT</td>
</tr>
<tr>
<td>Transmissometer or Nephelometer Data File</td>
<td>VSRN.DAT</td>
</tr>
<tr>
<td>DATSAV Weather Data File</td>
<td>or</td>
</tr>
<tr>
<td>Prognostic Weather File</td>
<td>or</td>
</tr>
</tbody>
</table>

Output Files
-----------

<table>
<thead>
<tr>
<th>File</th>
<th>Default File Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>List File</td>
<td>CALPOST.LST</td>
</tr>
<tr>
<td>Pathname for Timeseries Files</td>
<td>(blank)</td>
</tr>
<tr>
<td>Pathsname for Plot Files</td>
<td>(blank)</td>
</tr>
<tr>
<td>User Character String (U)</td>
<td>to augment default filenames</td>
</tr>
</tbody>
</table>

Timeseries
---------

<table>
<thead>
<tr>
<th>Timeseries</th>
<th>TSERIES_ASPEC_ttHR_CONC_TSUNAM.DAT</th>
</tr>
</thead>
</table>

Peak Value
-----------

<table>
<thead>
<tr>
<th>Peak Value</th>
<th>PEAKVAL_ASPEC_ttHR_CONC_TSUNAM.DAT</th>
</tr>
</thead>
</table>

Top Nth Rank Plot
-----------------

<table>
<thead>
<tr>
<th>Top Nth Rank Plot</th>
<th>RANK(ALL)_ASPEC_ttHR_CONC_TURNAM.DAT</th>
</tr>
</thead>
</table>

* TSUNAM = *

* TSPATH = *

* PLPATH = *

* PLPATH = *

* TSUNAM = *

* BACKDAT = *

* VSRDAT = *

* VSRDAT = *

* PSTLST =vis.alla.2003.mth2.lst !
* TUNAM = *

Exceedance Plot

EXCEED_ASPEC_ttHR_CONC_XUNAM.DAT
or EXCEED_ASPEC_ttHR_CONC_XUNAM.GRD

* XUNAM = *

Echo Plot

(Specific Days)

yyyy_Mmm_Ddd_hhmm(UTCszzzz)_L00_ASPEC_ttHR_CONC.DAT
or yyyy_Mmm_Ddd_hhmm(UTCszzzz)_L00_ASPEC_ttHR_CONC.GRD

Visibility Plot

DAILY_VISIB_VUNAM.DAT   ! VUNAM = alla03m2 !
(Daily Peak Summary)

Auxiliary Output Files
----------------------

File                      Default File Name
----                      -----------------
Visibility Change         DELVIS.DAT         ! DVISDAT = delv_alla.2003.mth2.dat !
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
T = lower case               ! LCFILES = T !
F = UPPER CASE
NOTE: (1) file/path names can be up to 132 characters in length
NOTE: (2) Filenames for ALL PLOT and TIMESERIES FILES are constructed using a template that includes a pathname, user-supplied character(s), and context-specific strings, where
ASPEC = Species Name
CONC = CONC Or WFLX Or DFLX Or TFLX
tt = Averaging Period (e.g. 03)
i = Rank (e.g. 02)
hh = Hour(ending) in LST
szzzz = LST time zone shift (EST is -0500)
yyyy = Year(LST)
mm = Month(LST)
dd = day of month (LST)
are determined internally based on selections made below.
If a path or user-supplied character(s) are supplied, each must contain at least 1 non-blank character.

!END!
--------------------------------------------------------------------------------

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

29-22706A       D-2
ENVIRON
Option to run all periods found in the met. file(s) (METRUN) Default: 0 ! METRUN = 0 !

METRUN = 0 - Run period explicitly defined below
METRUN = 1 - Run all periods in CALPUFF data file(s)

Starting date: Year (ISYR) -- No default ! ISYR = 2003 !
Month (ISMO) -- No default ! ISMO = 1 !
Day (ISDY) -- No default ! ISDY = 1 !
Starting time: Hour (ISHR) -- No default ! ISHR = 1 !

Number of hours to process (NHRS) -- No default ! NHRS = 8760 !

(These are only used if METRUN = 0)

Process every period of data? (NREP) -- Default: 1 ! NREP = 1 !
(1 = every period processed,
2 = every 2nd period processed,
5 = every 5th period processed, etc.)

Species & Concentration/Deposition Information
-----------------------------------------------

Species to process (ASPEC) -- No default ! ASPEC = VISIB !
(ASPEC = VISIB for visibility processing)

Layer/deposition code (ILAYER) -- Default: 1 ! ILAYER = 1 !
'1' for CALPUFF concentrations,
'-1' for dry deposition fluxes,
'-2' for wet deposition fluxes,
'-3' for wet+dry deposition fluxes.

Scaling factors of the form: -- Defaults: A = 0.0 !
X(new) = X(old) * A + B
A = 0.0 ! B = 0.0 !
(NOT applied if A = B = 0.0)

Add Hourly Background Concentrations/Fluxes? (LBACK) -- Default: F ! LBACK = F !

Source information
-------------------

Option to process source contributions:
0 = Process only total reported contributions
1 = Sum all individual source contributions and process
2 = Run in TRACBACK mode to identify source contributions at a SINGLE receptor
(MSOURCE) -- Default: 0 ! MSOURCE = 0 !

Receptor information
Gridded receptors processed? (LG) -- Default: F ! LG = F !
Discrete receptors processed? (LD) -- Default: F ! LD = T !
CTSG Complex terrain receptors processed? (LCT) -- Default: F ! LCT = F !

--Report results by DISCRETE receptor RING?
(only used when LD = T) (LDRING) -- Default: F ! LDRING = F !

--Select range of DISCRETE receptors (only used when LD = T):
Select ALL DISCRETE receptors by setting NDRECP flag to -1;
OR
Select SPECIFIC DISCRETE receptors by entering a flag (0,1) for each
0 = discrete receptor not processed
1 = discrete receptor processed
using repeated value notation to select blocks of receptors:
23*1, 15*0, 12*1
Flag for all receptors after the last one assigned is set to 0
(NDRECP) -- Default: -1
alla    ! NDRECP = 693*1,2848*0 !

--Select range of GRIDDED receptors (only used when LG = T):
X index of LL corner (IBGRID) -- Default: -1 ! IBGRID = -1 !
(-1 OR 1 <= IBGRID <= NX)
Y index of LL corner (JBGRID) -- Default: -1 ! JBGRID = -1 !
(-1 OR 1 <= JBGRID <= NY)
X index of UR corner (IEGRID) -- Default: -1 ! IEGRID = -1 !
(-1 OR 1 <= IEGRID <= NX)
Y index of UR corner (JEGRID) -- Default: -1 ! JEGRID = -1 !
(-1 OR 1 <= JEGRID <= NY)

Note: Entire grid is processed if IBGRID=JBGRID=IEGRID=JEGRID=-1

--Specific gridded receptors can also be excluded from CALPOST
processing by filling a processing grid array with 0s and 1s. If the
processing flag for receptor index (i,j) is 1 (ON), that receptor
will be processed if it lies within the range delineated by IBGRID,
JBGRID,IEGRID,JEGRID and if LG=T. If it is 0 (OFF), it will not be
processed in the run. By default, all array values are set to 1 (ON).

Number of gridded receptor rows provided in Subgroup (1a) to
identify specific gridded receptors to process
(NGONOFF) -- Default: 0 ! NGONOFF = 0 !
Subgroup (1a) -- Specific gridded receptors included/excluded

Specific gridded receptors are excluded from CALPOST processing by filling a processing grid array with 0s and 1s. A total of \( NGONOFF \) lines are read here. Each line corresponds to one 'row' in the sampling grid, starting with the NORTHERNMOST row that contains receptors that you wish to exclude, and finishing with row 1 to the SOUTH (no intervening rows may be skipped). Within a row, each receptor position is assigned either a 0 or 1, starting with the westernmost receptor.

- 0 = gridded receptor not processed
- 1 = gridded receptor processed

Repeated value notation may be used to select blocks of receptors:

23*1, 15*0, 12*1

Because all values are initially set to 1, any receptors north of the first row entered, or east of the last value provided in a row, remain ON.

\( (NGXRECP) \) -- Default: 1

INPUT GROUP: 2 -- Visibility Parameters (ASPEC = VISIB)

Identify the Base Time Zone for the CALPUFF simulation

\( (BTZONE) \) -- No default ! \( BTZONE = 8.0! \)

Particle growth curve \( f(RH) \) for hygroscopic species

\( (MFRH) \) -- Default: 2 ! \( MFRH = 2 ! \)

1 = IWAQM (1998) \( f(RH) \) curve (originally used with MVISBK=1)
2 = FLAG (2000) \( f(RH) \) tabulation
3 = EPA (2003) \( f(RH) \) tabulation

Maximum relative humidity (%) used in particle growth curve

\( (RHMAX) \) -- Default: 98 ! \( RHMAX = 95.0 ! \)

Modeled species to be included in computing the light extinction

Include SULFATE? \( (LVS04) \) -- Default: T ! \( LVS04 = T ! \)
Include NITRATE? \( (LVNO3) \) -- Default: T ! \( LVNO3 = T ! \)
Include ORGANIC CARBON? \( (LVOC) \) -- Default: T ! \( LVOC = T ! \)
Include COARSE PARTICLES? \( (LVPMC) \) -- Default: T ! \( LVPMC = T ! \)
Include FINE PARTICLES? (LVPMF) -- Default: T ! LVPMF = T !
Include ELEMENTAL CARBON? (LVEC) -- Default: T ! LVEC = T !

And, when ranking for TOP-N, TOP-50, and Exceedance tables,
Include BACKGROUND? (LVBK) -- Default: T ! LVBK = F !

Species name used for particulates in MODEL.DAT file
COARSE (SPECPMC) -- Default: PMC ! SPECPMC = PMC !
FINE (SPECPMF) -- Default: PMF ! SPECPMF = PMF !

Extinction Efficiency (1/Mm per ug/m**3)
----------------------------------------
MODELED particulate species:
PM COARSE (EEPMC) -- Default: 0.6 ! EEPMC = 0.6 !
PM FINE (EEPMF) -- Default: 1.0 ! EEPMF = 1.0 !

BACKGROUND particulate species:
PM COARSE (EEPMCBK) -- Default: 0.6 ! EEPMCBK = 0.6 !

Other species:
AMMONIUM SULFATE (EESO4) -- Default: 3.0 ! EESO4 = 3.0 !
AMMONIUM NITRATE (EENO3) -- Default: 3.0 ! EENO3 = 3.0 !
ORGANIC CARBON (EEOC) -- Default: 4.0 ! EEOC = 4.0 !
SOIL (EESOIL) -- Default: 1.0 ! EESOIL = 1.0 !
ELEMENTAL CARBON (EEEC) -- Default: 10. ! EEEC = 10.0 !

Background Extinction Computation
----------------------------------
Method used for the 24h-average of percent change of light extinction:
Hourly ratio of source light extinction / background light extinction is averaged?
(LAVER) -- Default: F ! LAVER = F !

Method used for background light extinction
(MVISBK) -- Default: 2 ! MVISBK = 2 !

1 = Supply single light extinction and hygroscopic fraction
   - Hourly F(RH) adjustment applied to hygroscopic background and modeled sulfate and nitrate
2 = Compute extinction from speciated PM measurements (A)
   - Hourly F(RH) adjustment applied to observed and modeled sulfate and nitrate
   - F(RH) factor is capped at F(RHMAX)
3 = Compute extinction from speciated PM measurements (B)
   - Hourly F(RH) adjustment applied to observed and modeled sulfate and nitrate
   - Receptor-hour excluded if RH>RHMAX
   - Receptor-day excluded if fewer than 6 valid receptor-hours
4 = Read hourly transmissometer background extinction measurements
   - Hourly F(RH) adjustment applied to modeled sulfate and nitrate
   - Hour excluded if measurement invalid (missing, interference, or large RH)
   - Receptor-hour excluded if RH>RHMAX
Modeling Protocol in Support of a NOC/PSD Permit Application to Install Two Power Generation Units

5 = Read hourly nephelometer background extinction measurements
- Rayleigh extinction value (BEXTRAY) added to measurement
- Hourly F(RH) adjustment applied to modeled sulfate and nitrate
- Hour excluded if measurement invalid (missing, interference, or large RH)
- Receptor-hour excluded if RH>RHMAX
- Receptor-day excluded if fewer than 6 valid receptor-hours

6 = Compute extinction from speciated PM measurements
- FLAG monthly RH adjustment factor applied to observed and modeled sulfate and nitrate

7 = Use observed weather or prognostic weather information for
background extinction during weather events; otherwise, use Method 2
- Hourly F(RH) adjustment applied to modeled sulfate and nitrate
- F(RH) factor is capped at F(RHMAX)
- During observed weather events, compute Bext from visual range
  if using an observed weather data file, or
- During prognostic weather events, use Bext from the prognostic weather file
- Use Method 2 for hours without a weather event

Additional inputs used for MVISBK = 1:
--------------------------------------
Background light extinction (1/Mm)
(BEXTBK) -- No default ! BEXTBK = 0.0 !
Percentage of particles affected by relative humidity
(RHFRAC) -- No default ! RHFRAC = 0.0 !

Additional inputs used for MVISBK = 6:
--------------------------------------
Extinction coefficients for hygroscopic species (modeled and background) are computed using a monthly RH adjustment factor in place of an hourly RH factor (VISB.DAT file is NOT needed).
Enter the 12 monthly factors here (RHFAC). Month 1 is January.

(RHFAC) -- No default ! RHFAC = 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0 !

Additional inputs used for MVISBK = 7:
--------------------------------------
The weather data file (DATSAV abbreviated space-delimited) that is identified as VSRN.DAT may contain data for more than one station. Identify the stations that are needed in the order in which they will be used to obtain valid weather and visual range. The first station that contains valid data for an hour will be used. Enter up to MXWSTA (set in PARAMS file) integer station IDs of up to 6 digits each as variable IDWSTA, and enter the corresponding time zone for each, as variable TZONE (= UTC-LST).

A prognostic weather data file with Bext for weather events may be used in place of the observed weather file. Identify this as the VSRN.DAT
file and use a station ID of IDWSTA = 999999, and TZONE = 0.

NOTE: TZONE identifies the time zone used in the dataset. The DATSAV abbreviated space-delimited data usually are prepared with UTC time rather than local time, so TZONE is typically set to zero.

(IDWSTA) -- No default
 ! IDWSTA = 999999 !
(TZONE) -- No default
 ! TZONE = 0.0 !

Additional inputs used for MVISBK = 2,3,6,7:

Background extinction coefficients are computed from monthly CONCENTRATIONS of ammonium sulfate (BKSO4), ammonium nitrate (BKNO3), coarse particulates (BKPMC), organic carbon (BKOC), soil (BKSOIL), and elemental carbon (BKEC). Month 1 is January.

**FLAG 2000**

(BKSO4) -- No default
 ! BKSO4 = .20, .20, .20, .20, .20, .20, .20, .20, .20, .20, .20, .20 !

(BKNO3) -- No default
 ! BKNO3 = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 !

(BKSOIL) -- No default
 ! BKSOIL = 4.5, 4.5, 4.5, 4.5, 4.5, 4.5, 4.5, 4.5, 4.5, 4.5, 4.5, 4.5 !

(BKOC) -- No default
 ! BKOC = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 !

(BKPMC) -- No default
 ! BKPMC = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 !

(BKEC) -- No default
 ! BKEC = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 !

Additional inputs used for MVISBK = 2,3,5,6,7:

Extinction due to Rayleigh scattering is added (1/Mm)

(BEXTRAY) -- Default: 10.0 ! BEXTRAY = 10.0 !

!END!
Documentation records contained in the header of the CALPUFF output file may be written to the list file. Print documentation image?

\[(LDOC) \text{ -- Default: } F \text{ ! } LDOC = F \text{ !}\]

Output Units

\[\text{Units for All Output} \text{ (IPRTU) -- Default: 1 } ! \text{ IPRTU} = 3 \text{ !}\]

\[
\begin{array}{ll}
1 &= g/m^3 & g/m^2/s \\
2 &= mg/m^3 & mg/m^2/s \\
3 &= mg/m^3 & mg/m^2/s \\
4 &= ng/m^3 & ng/m^2/s \\
5 &= \text{Odour Units} & \\
\end{array}
\]

Visibility: extinction expressed in 1/Mega-meters (IPRTU is ignored)

Averaging time(s) reported

\[\text{1-hr averages} \text{ (L1HR) -- Default: } T \text{ ! } L1HR = F \text{ !}\]

\[\text{3-hr averages} \text{ (L3HR) -- Default: } T \text{ ! } L3HR = F \text{ !}\]

\[\text{24-hr averages} \text{ (L24HR) -- Default: } T \text{ ! } L24HR = T \text{ !}\]

\[\text{Run-length averages} \text{ (LRUNL) -- Default: } T \text{ ! } LRUNL = F \text{ !}\]

User-specified averaging time in hours, minutes, seconds - results for this averaging time are reported if it is not zero

\[(NAVG) \text{ -- Default: 0 ! } NAVG = 0 \text{ !}\]

Types of tabulations reported

\------------------------

1) Visibility: daily visibility tabulations are always reported for the selected receptors when ASPEC = VISIB. In addition, any of the other tabulations listed below may be chosen to characterize the light extinction coefficients. [List file or Plot/Analysis File]

2) Top 50 table for each averaging time selected [List file only]

\[(LT50) \text{ -- Default: } T \text{ ! } LT50 = F \text{ !}\]
3) Top 'N' table for each averaging time selected
   [List file or Plot file]
   (LTOPN) -- Default: F ! LTOPN = T !

   -- Number of 'Top-N' values at each receptor
      selected (NTOP must be <= 4)
      (NTOP) -- Default: 4 ! NTOP = 1 !

   -- Specific ranks of 'Top-N' values reported
      (NTOP values must be entered)
      (ITOP(4) array) -- Default: ! ITOP = 1 !
      1,2,3,4

4) Threshold exceedance counts for each receptor and each averaging
   time selected
   [List file or Plot file]
   (LEXCD) -- Default: F ! LEXCD = F !

   -- Identify the threshold for each averaging time by assigning a
      non-negative value (output units).
      -- Default: -1.0
      Threshold for 1-hr averages (THRESH1) ! THRESH1 = -1.0 !
      Threshold for 3-hr averages (THRESH3) ! THRESH3 = -1.0 !
      Threshold for 24-hr averages (THRESH24) ! THRESH24 = -1.0 !
      Threshold for NAVG-hr averages (THRESHN) ! THRESHN = -1.0 !

   -- Counts for the shortest averaging period selected can be
      tallied daily, and receptors that experience more than NCOUNT
      counts over any NDAY period will be reported. This type of
      exceedance violation output is triggered only if NDAY > 0.

      Accumulation period(Days)
      (NDAY) -- Default: 0 ! NDAY = 0 !
      Number of exceedances allowed
      (NCOUNT) -- Default: 1 ! NCOUNT = 1 !

5) Selected day table(s)

   Echo Option -- Many records are written each averaging period
      selected and output is grouped by day
   [List file or Plot file]
   (LECHO) -- Default: F ! LECHO = F !

   Timeseries Option -- Averages at all selected receptors for
      each selected averaging period are written to timeseries files.
      Each file contains one averaging period, and all receptors are
      written to a single record each averaging time.
[TSERIES_ASPEC_ttHR_CONC_TSUNAM.DAT files]  
(LTIME) -- Default: F  ! LTIME = F  !

Peak Value Option -- Averages at all selected receptors for 
each selected averaging period are screened and the peak value 
each period is written to timeseries files. 
Each file contains one averaging period.
[PEAKVAL_ASPEC_ttHR_CONC_TSUNAM.DAT files]  
(LPEAK) -- Default: F  ! LPEAK = F  !

-- Days selected for output  
(IECHO(366)) -- Default: 366*0
! IECHO = 366*0  !
(366 values must be entered)

Plot output options  
---------------------

Plot files can be created for the Top-N, Exceedance, and Echo 
tables selected above. Two formats for these files are available, 
DATA and GRID. In the DATA format, results at all receptors are 
listed along with the receptor location [x,y,val1,val2,...].
In the GRID format, results at only gridded receptors are written, 
using a compact representation. The gridded values are written in 
rows (x varies), starting with the most southern row of the grid. 
The GRID format is given the .GRD extension, and includes headers 
compatible with the SURFER(R) plotting software.

A plotting and analysis file can also be created for the daily 
peak visibility summary output, in DATA format only.

Generate Plot file output in addition to writing tables 
to List file?  
(LPLT) -- Default: F  ! LPLT = T  !

Use GRID format rather than DATA format, 
when available?  
(LGRD) -- Default: F  ! LGRD = F  !

Auxiliary Output Files (for subsequent analyses)  
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Visibility

A separate output file may be requested that contains the change 
in visibility at each selected receptor when ASPEC = VISIB. This 
file can be processed to construct visibility measures that are 
not available in CALPOST.

Output file with the visibility change at each receptor?  
(MDVIS) -- Default: 0  ! MDVIS = 2  !
Modeling Protocol in Support of a NOC/PSD Permit Application to
Install Two Power Generation Units

0 = Do Not create file
1 = Create file of DAILY (24 hour) Delta-Deciview
2 = Create file of DAILY (24 hour) Extinction Change (%)
3 = Create file of HOURLY Delta-Deciview
4 = Create file of HOURLY Extinction Change (%)

Additional Debug Output
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Output selected information to List file
for debugging?

(LDEBUG) -- Default: F ! LDEBUG = F !

Output hourly extinction information to REPORT.HRV?
(Visibility Method 7)

(LVEXTHR) -- Default: F ! LVEXTHR = F !

!END!