APPENDIX 8.1I

Modeling Protocol

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December 28, 2005

Mr. Ralph DeSiena
San Diego Air Pollution Control District
10124 Old Grove Road
San Diego, CA 92131-1649

Subject: Modeling Protocol for the Duke Energy's Proposed South Bay Energy Facility in Chula Vista, California

Dear Mr. DeSiena:

Please find attached the emissions modeling protocol for Duke Energy's proposed South Bay Energy Facility ("SBEF") project to be located in Chula Vista, California, adjacent to the existing South Bay Power Plant. Duke will be applying to the District for an Authority to Construct and a Determination of Compliance for this new 678-megawatt combined cycle power generating facility configured using two natural gas-fired combustion turbines, two duct-fired heat recovery steam generators, and a single steam turbine.

Attached for your review and approval is a description of the analytical approach that will be used to comply with applicable District and EPA modeling requirements and California Energy Commission (CEC) guidelines. We expect to file a permit application with the District early in the second quarter of 2006, and are requesting approval of the modeling protocol by January 20, 2006.

We would be pleased to meet with you to discuss this protocol if such a meeting would be useful. We look forward to working with you. If you have any questions, please do not hesitate to call me at (916) 444-6666. Thank you for your attention in this matter.

Sincerely,

Jeffrey Adkins

Attachment

cc w/att:

Mike Ringer, CEC
Andrew Trump, Duke
Joe Otahal, Duke
Robert Mason, CH2M Hill

South Bay Energy Facility
Modeling Protocol

December 2005

Prepared by

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Modeling Protocol

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BACKGROUND

Duke Energy North America (Duke) is planning to submit an Application for an Authority to Construct/Permit to Operate to the San Diego Air Pollution Control District (SDAPCD) and an Application for Certification (AFC) to the California Energy Commission (CEC) for the installation of two natural gas-fired combustion turbine generator units (CTGs) and one steam turbine at the proposed South Bay Energy Facility (SBEF). The SBEF is proposed to replace the existing South Bay Power Plant (SBPP), using two class General Electric 7FA natural gas-fired CTGs and one steam turbine operating in combined-cycle mode. Each unit will be equipped with a dry low-NOx (DLN) combustor system, selective catalytic reduction (SCR) for post-combustion NOx control, and an oxidation catalyst for post-combustion control of carbon monoxide (CO).

The Applicant will submit an ambient air quality impact analysis to the SDAPCD, CEC and, potentially, the U.S. Environmental Protection Agency (USEPA) in accordance with the current modeling guidance.[1] This modeling protocol outlines the proposed air dispersion modeling techniques that will be used to assess impacts from the proposed sources. The protocol follows modeling guidance provided by the USEPA in its "*Guideline on Air Quality Models*" (including supplements).

Impacts from operation of the facility will be compared to the following:

Air Quality Criteria	NO_2	PM_{10}	$PM_{2.5}$	CO	SO_2
PSD Significant Impact Levels[a]	X		X	X	X
SDAPCD Significant Impact Levels	X	X	X	X	X
PSD Monitoring Exemption Levels[a]	X		X	X	X
Ambient Air Quality Standards	X	X	X	X	X

[a] PSD significant impact and monitoring exemption levels only apply if the project is subject to PSD review.

[1] At the present time, the Applicant believes that the project is not subject to federal PSD review. If that conclusion is confirmed, a modeling protocol will only be submitted to the SDAPCD and CEC.

PROJECT LOCATION

The proposed gas turbine units will be constructed adjacent to the existing SBPP on Bay Boulevard in Chula Vista, California. The UTM coordinates of the site are approximately 3,607.94 kilometers northing, 491.17 kilometers easting (NAD 27, Zone 11). The nominal site elevation is 1 foot above mean sea level.

PROPOSED EMISSION SOURCES

The primary emission sources at the SBEF will be the two combined-cycle gas turbines. The turbines will be fired with natural gas only. The turbines will utilize advanced combustion designs and emission controls to limit emissions of NOx to 2.0 parts per million dry, corrected to 15% oxygen (ppmc) at full load and emissions of CO to 4 ppmc at full load. Emissions of PM_{10} and SO_2 will be kept to a minimum through the exclusive use of natural gas.

EXISTING METEOROLOGICAL DATA

The SDAPCD recommends that meteorological data from San Diego Lindbergh Field (surface data from Lindbergh, Station 23188 and upper air data from Miramar, Station 03190) be used for coastal locations and data from Miramar MCAS (surface and upper air data from Miramar, Station, 93107 & 03190) be used for inland locations. The SBEF site is in a coastal location; therefore, surface data from Lindbergh Field and upper air data from Miramar MCAS will be used. The Lindbergh Field station measures and records surface data (e.g., wind speed, direction, and temperature) on a continual basis. A wind rose for the Lindbergh Field meteorological monitoring site is shown in Figure 1. The District requires a minimum of three consecutive years of meteorological data to be used for modeling. Five years of meteorological data from 1990 to 1994 will be used for this project.

The project site and monitoring stations for both meteorological and ambient air quality monitoring data are presented in Figure 2. The area in the immediate vicinity of the project site is relatively flat with the western edge of the project area bordering on San Diego Bay.

Figure 1
Lindbergh Field Meteorological Station Wind Rose

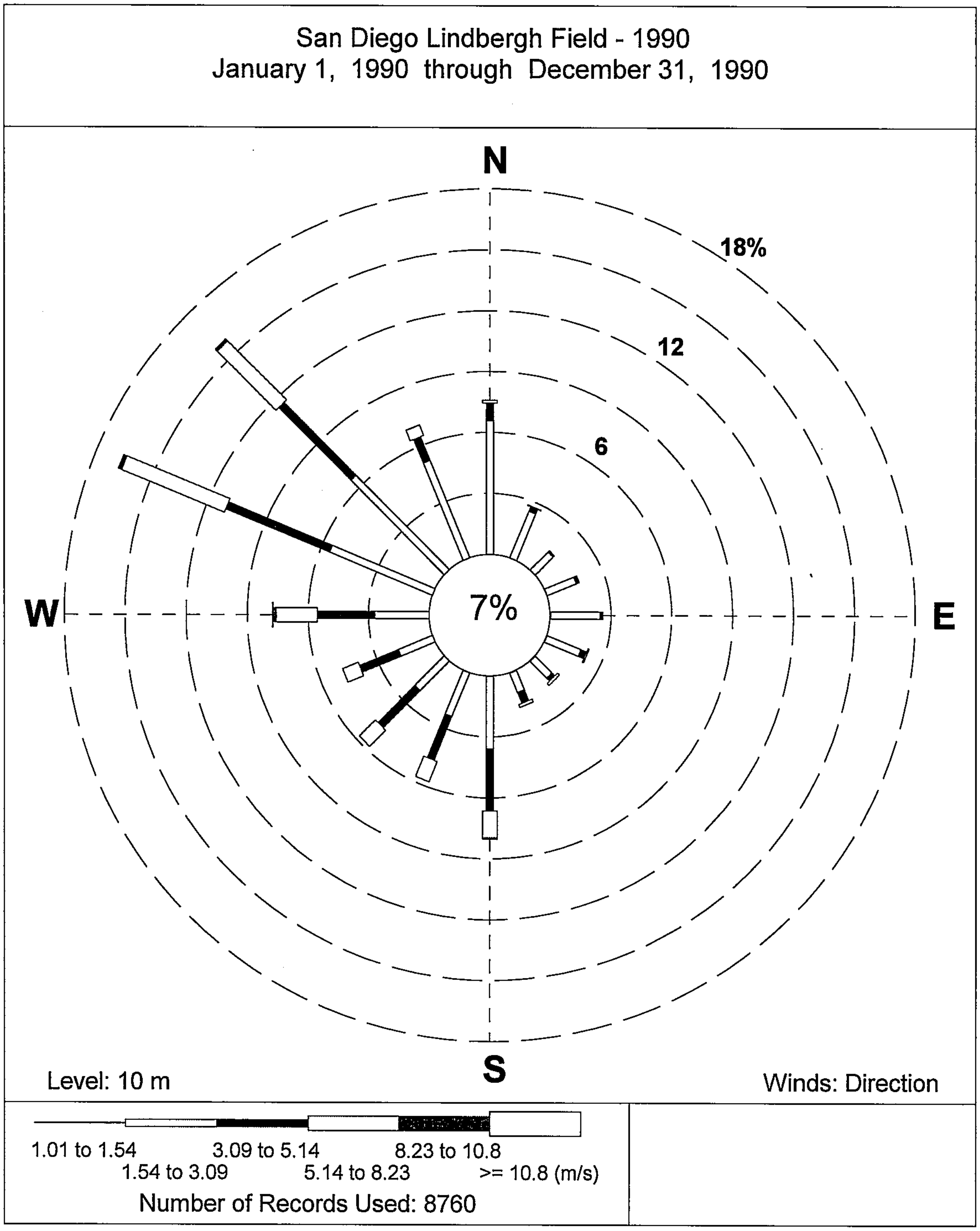
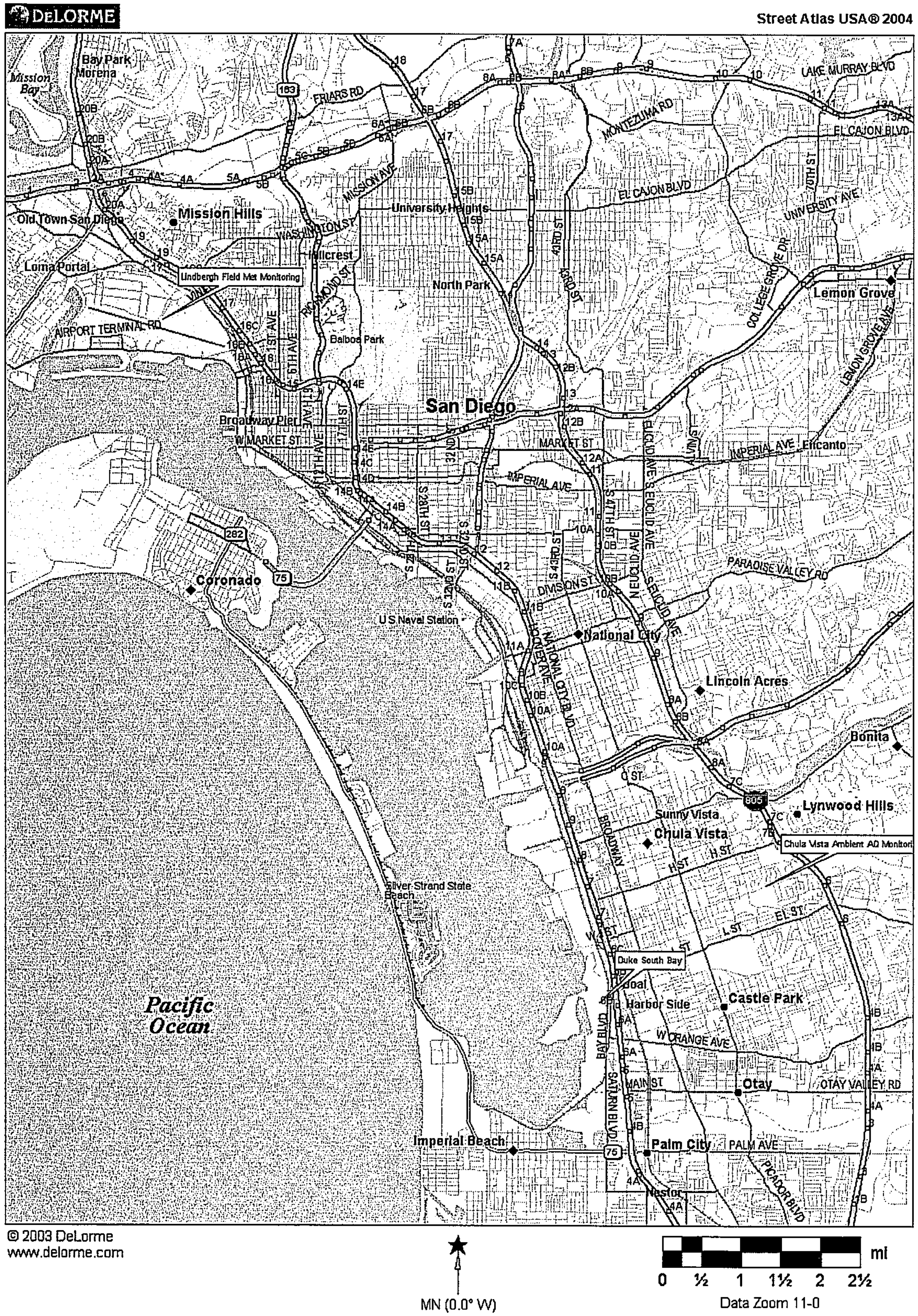


Figure 2
SBEF Site Location, with Met and Ambient Data Monitoring Sites Indicated



SITE REPRESENTATION – METEOROLOGICAL DATA

USEPA defines the term "on-site data" to mean data that would be representative of atmospheric dispersion conditions at the source and at locations where the source may have a significant impact on air quality. Specifically, the meteorological data requirement originates in the Clean Air Act at Section 165(e)(1), which requires an analysis "of the ambient air quality at the proposed site and in areas which may be affected by emissions from such facility for each pollutant subject to regulation under [the Act] which will be emitted from such facility."

This requirement and USEPA's guidance on the use of on-site monitoring data are also outlined in the "*On-Site Meteorological Program Guidance for Regulatory Modeling Applications*" (1987a). The representativeness of the data depends on (a) the proximity of the meteorological monitoring site to the area under consideration, (b) the complexity of the topography of the area, (c) the exposure of the meteorological sensors, and (d) the period of time during which the data are collected. As discussed below, we believe the Lindbergh Field meteorological data are representative of conditions at the project site.

The wind rose (Figure 1) indicates that on an annual basis, prevailing winds are from the northwest. The occurrence of high wind speeds (defined here as wind speeds greater than 8.23 m/s) is low. Calm conditions are reasonably common, occurring approximately 7% of the time.

Representativeness has also been defined in the "*Workshop on the Representativeness of Meteorological Observations*" (Nappo et. al., 1982) as "the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application." Judgments of representativeness should be made only when sites are climatologically similar, as the project site and the Lindbergh Field meteorological data clearly are. Representativeness has additionally been defined in the PSD Monitoring Guideline (USEPA 1987b) as data that characterize the air quality for the general area in which the proposed project would be constructed and operated. Because of the reasonably close proximity of the Lindbergh Field meteorological data site to the proposed project site (distance between the two locations is approximately 16.4 km, or 10.2 miles), the same large-scale topographic features that influence the meteorological data monitoring station also influence the proposed project site in the same manner.

However, it should be noted that there are hills immediately east of Lindbergh Field, and these hills are roughly three times steeper than the hills east of the proposed SBEF project. To determine whether the hills near Lindbergh Field resulted in a noticeable terrain effect, wind roses for both Miramar NAS, several miles inland in the San Clemente Valley (15.4 km NNE of Lindbergh Field), and a coastal location at Oceanside, at the mouth of the San Luis Rey Valley (57 km NNW of Lindbergh Field), were reviewed. Wind speeds at Lindbergh Field are significantly higher than at the other two locations, and wind directions are much more persistently from the NW. An easterly, or northeasterly, nighttime drainage wind component is missing at Lindbergh Field compared to the other two sites, suggesting that the hills immediately to the east of Lindbergh Field shunt nighttime drainage flows to the north (Mission Bay) or to the south (San Diego Bay), shielding Lindbergh Field, and allowing instead a light, northwesterly wind to persist all night long.

The SBEF project site is a coastal location, likely with similar daytime wind speeds as at Lindbergh Field, but also near the drainage path of the Sweetwater Valley, where nighttime drainage winds might be expected. Thus, use of the Lindbergh Field meteorological data at this location may miss this easterly component, and thereby miss impacts from the facility occurring either over San Diego Bay, or over the open ocean, at night. On the other hand, use of the Lindbergh Field meteorological data is likely to be conservative for air-quality modeling purposes, because northwesterly nighttime winds (low wind speed, very stable flow) will instead carry the plume inland, towards terrain, with even higher resulting impacts than would be registered over the open water. In addition, with higher wind speeds overall, building-wake downwash (often a limiting condition for air-quality modeling) will be more common if the Lindbergh Field met data is used as compared to meteorological data from the other two sites.

Thus, it is our assessment that the wind direction and wind speed data collected at the Lindbergh Field monitoring station are similar to the dispersion conditions at the SBEF project site and to the regional area, and to the extent they are different, it would be conservative to use the Lindbergh Field data. Thus, the Lindbergh Field meteorological data set recommended by the SDAPCD satisfies the definition of representative data.

EXISTING AMBIENT AIR QUALITY DATA

Background ambient air quality data for the project area are available for the Chula Vista monitoring site. Ambient O_3, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and CO data are collected at this site, which is located about 4.1 km (2.6 miles) northeast of the project site.

SITE REPRESENTATION – AMBIENT AIR QUALITY DATA

As shown in Figure 2, the Chula Vista ambient monitoring station is located less than 3 miles from the project site; no other District/State/Federal-operated ambient monitoring stations are located closer to the project site. Consequently, this monitoring station was selected to represent the background ambient levels for the project site. Modeled concentrations will be added to these representative background concentrations to determine compliance with the CAAQS and NAAQS.

AIR QUALITY DISPERSION MODELS

Overview

Several USEPA air dispersion models are proposed for use to quantify pollutant impacts on the surrounding environment based on the emission sources' operating parameters and their locations. The models proposed for use are Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME, current version 95086); American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC) model, also known as AERMOD (AERMOD, current version 04300); SCREEN3 (current version 96043), and the VISCREEN visibility model (current version 88341). These models, along with options for their use and how they are used, are discussed below.

Simple, Complex, and Intermediate Terrain Impacts

For modeling the project in simple, complex, and intermediate terrain, the guideline model AERMOD will be used with the hourly meteorological data from the Lindbergh Field monitoring station for the project site. USEPA adopted AERMOD as a guideline model on November 9, 2005. The AERMOD model is a steady-state, multiple-source, Gaussian dispersion model designed for use with stack emission sources situated in terrain where ground elevations can exceed the stack heights of the emission sources (i.e. complex terrain).[2] The AERMOD model requires hourly meteorological data consisting of wind vector and speed (with reference height), temperature (with reference height), Monin-Obukhov length, surface roughness length, heights of the mechanically and convectively generated boundary layers, surface friction velocity, convective velocity scale, and vertical potential temperature gradient in the 500-meter layer above the planetary boundary layer. The model assumes that there is no variability in meteorological parameters over a one-hour time period, hence the term "steady-state." The AERMOD model allows input of multiple sources and source groupings, eliminating the need for multiple model runs. Complex phenomena such as building-induced plume downwash are treated in this model.

Standard AERMOD control parameters will be used (stack tip downwash, non-screening mode, non-flat terrain, sequential meteorological data check employed). Stack-tip downwash, which adjusts the effective stack height downward following the methods of Briggs (1972) for cases where the stack exit velocity is less than 1.5 times the wind speed at stack top, will be selected per USEPA guidance.

Two AERMET preprocessors (Stage 1&2 and Stage 3) are used to prepare meteorological data for use in AERMOD. Albedo, Bowen Ratio, and surface characteristics are input for wind

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[2] AERMOD was recently adopted as a guideline model by USEPA as a replacement for ISCST3. AERMOD incorporates an improved downwash algorithm as compared to ISCST3 (Federal Register, November 9, 2005; Volume 70, Number 216, Pages 68218-68261).

direction sectors in the vicinity of the facility at Stage 3 of the met data preparation. In defining sectors for surface characteristics, USEPA (2000) suggests that a user specify a sector no smaller than a 30-degree arc. The expected wind direction variability over the course of an hour, as well as the encroachment of characteristics from the adjacent sectors with travel time, makes it hard to preserve the identity of a very narrow sector's characteristics. Use of a weighted-average[3] of characteristics by surface area within a 30-degree (or wider) sector makes it possible to have a unique portion of the surface significantly influence the properties of the sector that it occupies.

The length of the upwind fetch for defining the nature of the turbulent characteristics of the atmosphere at the source location has been defined as 3 kilometers in Irwin (1978) and in USEPA's *Guideline on Air Quality Models*[4] for the purpose of defining land-use characteristics.

For the SBEF facility , at least two wind direction sectors are indicated: one sector for winds from the San Diego Bay and the Pacific, and a second wind sector for directions from the land Thus, at least two wind direction sectors will be employed; more will be used if appropriate. Given the general lack of seasonality at this California coastal, Mediterranean climate location, site characteristics will be varied only seasonally, not monthly.

Ambient Ratio Method and Ozone Limiting Method

Annual NO_2 concentrations will be calculated using the Ambient Ratio Method (ARM), adopted in Supplement C to the Guideline on Air Quality Models (USEPA, 1995). The Guideline allows a nationwide default of 75% for the conversion of nitric oxide (NO) to NO_2 on an annual basis and the calculation of NO_2/NOx ratios.

If NO_2 concentrations need to be examined in more detail, the Ozone Limiting Method (OLM) (Cole and Summerhays, 1979) will be used. Hourly ozone data collected at the Chula Vista monitoring station during the years 1990-1994 will be used in conjunction with OLM to calculate hourly NO_2 concentrations from hourly NOx concentrations. The OLM involves an initial comparison of the estimated maximum NOx concentration and the ambient O_3 concentration to determine which is the limiting factor to NO_2 formation. If the O_3 concentration is greater than the maximum NOx concentration, total conversion is assumed. If the NOx concentration is greater than the O_3 concentration, the formation of NO_2 is limited by the ambient O_3 concentration. In this case, the NO_2 concentration is set equal to the O_3 concentration plus a correction factor that accounts for in-stack and near-stack thermal conversion.

Since 1998, OLM has been implemented using the ISCST3-OLM model. There is now a second option. AERMOD OLM is a non-regulatory option that is now available for use. For this project, AERMOD OLM will be used to calculate the NO_2 concentration based on the OLM method, and hourly ozone data. Missing hourly ozone data will be substituted prior to use with day-appropriate

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[3] Weighting will be based on wind direction frequency, such as determined from a wind rose.
[4] Published as Appendix W to 40 CFR Part 51 (as revised).

values (e.g., from the previous day, or the next day, for the same hour). Any other missing hourly ozone data (if any) will be substituted with 40 ppb ozone (typical ozone tropospheric background level).

Fumigation

The SCREEN3 model will be used to evaluate inversion breakup and shoreline fumigation impacts for short-term averaging periods (24 hours or less), as appropriate. The methodology in USEPA, 1992 (Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised) will be followed for these analyses. Combined impacts for all sources under fumigation conditions will be evaluated, based on USEPA and any applicable SDAPCD modeling guidelines.

GOOD ENGINEERING PRACTICE (GEP) STACK HEIGHT AND DOWNWASH

AERMOD can account for building downwash effects on dispersing plumes. Stack locations and heights and building locations and dimensions will be input to BPIP-PRIME. The first part of BPIP-PRIME determines and reports on whether a stack is being subjected to wake effects from a structure or structures. The second part calculates direction-specific building dimensions for each structure that are used by AERMOD to evaluate wake effects. The BPIP-PRIME output is formatted for use in AERMOD input files.

RECEPTOR SELECTION

Receptor and source base elevations will be determined from USGS Digital Elevation Model (DEM) data using the 7½-minute format (10- to 30-meter spacing between grid nodes). All coordinates will be referenced to UTM North American Datum 1927 (NAD27), Zone 11. The AERMOD receptor elevations will be interpolated among the DEM nodes according to standard AERMAP procedure. For determining concentrations in elevated terrain, the AERMAP terrain preprocessor receptor-output (ROU) file option will be chosen; hills will not be imported into AERMOD for CTDM-like processing.

Cartesian coordinate receptor grids will be used to provide adequate spatial coverage surrounding the project area for assessing ground-level pollution concentrations, to identify the extent of significant impacts, and to identify maximum impact locations. A 250-meter resolution coarse receptor grid will be developed and will extend outwards at least 10 km (or more as necessary to calculate the significant impact area).

For the full impact analyses, a nested grid will be developed to fully represent the maximum impact area(s). This grid will have 25-meter resolution along the facility fence-line in a single tier of receptors composed of four segments extending out to 100 meters from the fenceline, 100-meter resolution from 100 meters to 1,000 meters from the fenceline, and 250-meter spacing out to at least as far as 10 km from the site. When maximum first-high or maximum second-high impacts occur in the 250-meter spaced area, additional refined receptor grids with 25-meter resolution will be placed around the maximum coarse grid impacts and extended out 1,000 meters in all directions. Concentrations within the facility fenceline will not be calculated.

The following 7.5 minute USGS Digital Elevation Model (DEM) quadrangles will be employed for modeling the South Bay Energy Facility:

- Point Loma;
- National City;
- Jamul Mountains
- Imperial Beach; and
- Otay Mesa.

MODELING SCENARIOS

Pollutant emissions to the atmosphere from the proposed facility will be dominated by the products of combustion of natural gas in the combustion turbines. Emission rates will be included in the permit application for the project and will be based on vendor data and additional conservative assumptions of equipment performance. Turbine emissions and stack parameters, such as flow rate and exit temperature, exhibit some variation with ambient temperature and operating load. In order to calculate the worst-case air quality impacts, a screening analysis will be performed to evaluate each operating scenario (based on operating load and atmospheric conditions) to predict the worst-case facility configuration on a pollutant-specific basis.

In the modeling analysis, maximum impacts will be predicted for maximum (100%) and reduced load conditions. In addition, different ambient temperatures will be evaluated for each load condition. Each of these conditions has unique performance characteristics that affect plume dispersion and thus predicted impacts. This analysis is most relevant to analyses for short-term impacts. The temperatures selected for the short-term screening analysis will closely reflect the range of possible site conditions. The results of this screening analysis will be used to select the worst-case operational scenarios for the modeling analyses in order to provide maximum operating flexibility. Refined modeling for the permit application will be based on these worst-case scenarios.

The screening modeling will use five consecutive years of meteorological data and the nested receptor grid described above to determine the worst-case source configuration (i.e., configuration that produces maximum facility impacts). This worst-case source configuration will then be executed with all available meteorological data (here, five consecutive years from 1990 to 1994 of Lindbergh Field meteorological data) and, if necessary, coarse grid impacts will be refined with fine grid receptors spaced 25 meters apart.

Ambient Air Quality Impact Analyses

In evaluating the impacts of the proposed project on ambient air quality, we will model the ambient impacts of the project, add those impacts to background concentrations, and compare the results to the state and federal ambient standards for SO_2, NO_2, PM_{10}, $PM_{2.5}$, and CO.

In accordance with USEPA guidelines[5], the highest second-highest modeled concentrations will be used to demonstrate compliance with the short-term federal standards and the highest modeled concentration will be used to demonstrate compliance with the federal annual and all state standards.

FINAL MODELING SUBMITTAL

The final modeling analyses will include the following materials:

- Summaries of maximum modeled impacts for each air quality scenario showing meteorological conditions and receptor location and elevation;
- All modeling outputs (including BPIP-PRIME and meteorological files) in electronic format, together with a description of all filenames;
- Plot plan showing emission points, nearby buildings (including dimensions), cross-section lines, property lines, fencelines, roads, and UTM coordinates; and
- A table showing building heights used in the modeling analysis.

CLASS I AREA IMPACT METHODOLOGY

If the project is subject to PSD review, an analysis of air quality impacts at nearby Class I areas will be conducted for the proposed SBEF. This analysis will be performed according to the Federal Land Managers' (FLMs') Air Quality Related Values (AQRV) Workgroup (FLAG) Phase I Report (U.S. Forest Service et. al., 2000) and the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report (USEPA, 1998). A detailed description of the approach that will be used for the Class I impact analysis will be included in a Class I modeling protocol that will be submitted separately, if required.

RULE 1200 ANALYSIS

A screening-level health risk assessment will be performed using the current version of CARB's Hot Spots Analysis and Reporting Program (HARP) to determine the impacts of the toxic air pollutant emissions associated with the proposed project. This analysis will be performed in accordance with the current OEHHA Risk Assessment Guidelines and the SDAPCD Supplemental Health Risk Assessment Guidelines.

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[5] 40 CFR part 51, Appendix W, Sections 11.2.3.2 and 11.2.3.3

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AIR POLLUTION CONTROL DISTRICT
COUNTY OF SAN DIEGO

May 4, 2006

Mr. Eric G. Walther
SIERRA RESEARCH
1801 J STREET
SACRAMENTO, CA 95814

SUBJECT: Modeling Protocol for the Duke Energy Proposed South Bay Energy Facility
In Chula Vista, California

Dear Mr. Walther:

We have reviewed your proposed modeling protocol for Duke Energy's South Bay Energy Facility (SBEF) to be located in Chula Vista, California adjacent to the existing South Bay Power Plant.

The modeling approach proposed in the protocol is generally acceptable and consistent with the San Diego Air Pollution Control District (SDAPCD) procedures for estimation of impacts from new sources. Our proposed protocol modifications are presented below.

As we have recently discussed, the SDAPCD is in the process of preparing AERMOD ready meteorological data sets for all of our ambient monitoring stations using the AERMET data processor. We are currently processing data from our Chula Vista monitoring station for the years 2000-2003. This meteorological surface data will be augmented with our Point Loma lower atmosphere profiler data, additional surface meteorological data collected at the nearest National Weather Surface (NWS) station, Lindbergh Field, and twice daily atmospheric soundings from MCAS, Miramar, California. When completed we will supply the meteorological data set to be used with the current version of AERMOD to you. We expect to have this work completed by the end of May, 2006.

The Ozone Limiting Method (OLM), as proposed in your protocol, shall be used to determine compliance with the California 1-Hour Ambient Air Quality Standard for NO_2 of 470 $\mu g/m^3$. Hourly O_3 and NO_2 data collected at the Chula Vista monitoring station during the years 2000-2003 shall be used. As stated, if the background O_3 concentration is greater than the maximum predicted NO_x impact, total conversion to NO_2 is assumed. This estimated NO_2 impact plus the NO_2 background concentration shall be compared to the California standard for each applicable hour. If the predicted NOx impact is greater than the background O_3 concentration the initial in-stack NO_2 concentration (%

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of NO_x) for normal, startup or commissioning plant operations, as provided by the SDAPCD, will be used. This data will be compiled from source test data available for similar turbines with and without control equipment. Additional NO_2 concentrations, as determined based upon background O_3 concentrations, initial NO_2 in-stack concentration and background NO_2 values shall be summed and compared with the California standard for each applicable hour to determine compliance.

If you have any questions please give me a call at 858-586-2772.

Sincerely,

RALPH P. DESIENA
Air Pollution Meteorologist

RPD:

cc: Tom Weeks
Dan Speer
Bill Reeve