Technical Area: Air Quality **Response Date: July 23, 2007**

Data Request 1:

Please provide an analysis showing the effectiveness of daily restrictions on construction hours as mitigation to avoid potential violations of the State 1-hour NO_2 air quality standard.

Response:

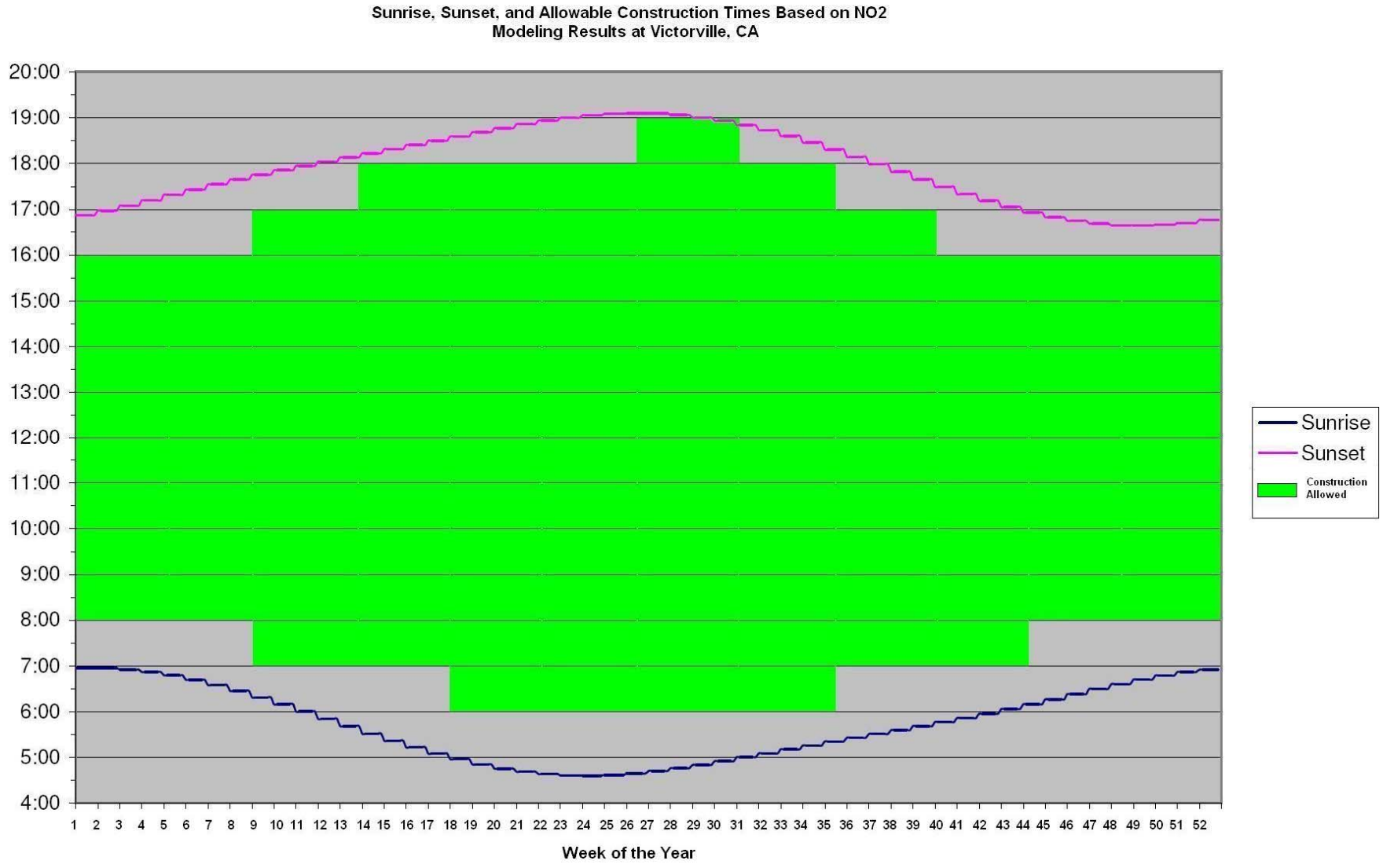
As noted in Section 6.3.4.2.1 of the AFC, initial modeling of NO_2 during construction for ten hours (7:00 am to 5:00 pm) each day showed frequent exceedences of the 1-hour NO_2 CAAQS, with Project contributions of over 800 $\mu g/m^3$. These modeled exceedences occurred in the early morning or evening hours close to sunrise and sunset, when the atmosphere is generally more stable, mixing heights are close to the ground, and winds are light. Almost every day during the winters of the three years modeled (2002-2004) had at least one hour with a modeled concentration which, when added to the ambient NO_2 background value of 169 $\mu g/m^3$, exceeded the 1-hour NO_2 CAAQS.

The construction emissions that were modeled are considered to be conservative. As discussed in AFC Section 6.3.4.1.1, VV2 Project construction is expected to take up to 27 months, and will include various Project components, i.e., the combined-cycle power block, solar array, and linear facilities. Emissions were calculated by summing the emissions from all construction equipment expected to be used in each month of the construction period. The maximum hourly emissions during construction of both the combined-cycle power block and the solar array were modeled simultaneously to give the peak hourly impacts during construction. The assumptions of 1) the maximum hourly power block construction emissions occurring at the same time as the maximum hourly solar array construction emissions, 2) that these two maximum hourly emission rates would occur in every hour for ten hours a day for over two years, and 3) that the maximum hourly background of 169 $\mu g/m^3$ would occur in every hour, is obviously very conservative.

Based on Ozone Limiting Method (OLM) modeling, Project 1-hour NO_2 impacts were found to decrease significantly once the sun rose, from over 800 $\mu g/m^3$ to less than 170 $\mu g/m^3$. Therefore, by restricting the allowable hours of construction, all times that showed a modeled concentration of 1-hour NO_2 in excess of the CAAQS were eliminated. A graphic representation of the hours in which construction could occur with a modeled result of 169 $\mu g/m^3$ or less (which combined with a background of 169 $\mu g/m^3$ is less than the recently adopted 1-hour NO_2 CAAQS of 338 $\mu g/m^3$) is shown in Figure AQ1-1.

Note that this chart does not reflect daylight savings time, which, as of 2007, begins on the second Sunday of March and ends on the first Sunday of November. The hours filled in with dark gray are the allowable hours where construction may occur.

Figure AQ1-1


Sunrise, Sunset, and Allowable Construction Times Based on NO2
Modeling Results at Victorville, CA
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
9:00
8:00
7:00
6:00
5:00
4:00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
Week of the Year
Sunrise
Sunset
Construction Allowed

Data Request 2:

Please provide a NO_2 construction emissions mitigation proposal for the project containing, but not limited to, restrictions on daily hours of construction, enforcement methods, compliance monitoring, and effectiveness measurements tools.

Response:

Figure AQ-1 shows the relationship between sunrise and the hour when construction can occur. The fact that the model shows compliance with discrete hours is an artifact of the meteorological data processing, which assumes the same dispersion conditions will last the entire hour. Therefore, we propose the following Conditions be placed on the VV2 Project:

AQ-C1. The project owner shall fund all expenses for an onsite Air Quality Construction Mitigation Manager (AQCMM), who shall be responsible for maintaining compliance with conditions AQ-C2 and AQ-C3. The onsite AQCMM shall have full access to areas of construction of the project site and linear facilities, and shall have the authority to appeal to the CPM to have the CPM stop any and all construction activities as warranted by applicable construction mitigation conditions. The onsite AQCMM shall have a current certification by the California Air Resources Board (ARB) for Visible Emissions Evaluation (EPA Method 9) prior to commencement of ground disturbance. The onsite AQCMM shall not be terminated without written consent of the CPM.

Verification: At least 60 days prior to the start of any ground disturbance, the project owner shall submit to the CPM, for approval, the name and contact information for the onsite AQCMM.

AQ-C2. The project owner shall provide a construction mitigation plan, for approval, which shows the steps that will be taken, and reporting requirements, to ensure compliance with condition AQ-C3.

Verification: At least 60 days prior to the start of any ground disturbance, the project owner shall submit to the CPM, for approval, the construction mitigation plan.

AQ-C3. The onsite AQCMM shall submit to the CPM, in the Monthly Compliance Report (MCR), a construction mitigation report that demonstrates compliance with the following mitigation measures:

a) The AQCMM shall not allow construction activities at the plant site that include the use of combustion equipment to occur before one hour after sunrise or after 30 minutes before sunset. This requirement can be waived by the CPM upon presentation of a modeling

analysis that demonstrates that compliance with the CAAQS can be met due to reduced construction activities/emissions and/or reduced NO_2 background levels in the future.

b) Scrapers used during site preparation for construction of the solar array shall be model year 2006 or later and comply with California Tier 3 emission standards for off-road engines.

c) The scrapers used during site preparation for construction of the solar array shall have clearly visible tags issued by the onsite AQCMM that shows the engine meets condition AQ-C3(b) above.

Verification: In the MCR, the project owner shall provide the CPM with a copy of the construction mitigation records that show the construction activities conducted and the beginning and end of daily construction activities each day, which clearly show compliance with condition AQ-C3.

Data Request 3:

Please provide an analysis showing the benefits of restricting the daily hours of construction, and describe how the effectiveness in reducing the project's construction PM10 impacts is measured.

Response:

As discussed in Section 6.3.4.2.1 of the AFC, initial modeling of PM10 during construction for ten hours (7:00 am to 5:00 pm) each day resulted in modeled Project contributions to PM10 concentrations that were above the 24-hour PM10 CAAQS of 50 $\mu g/m^3$ for an average of 11 days per year (over the three years modeled, 2002 – 2004), with a maximum Project contribution of 106 $\mu g/m^3$.

In order to demonstrate the effectiveness of restricting the daily hours of construction as discussed in the response for DR-1, AERMOD was run with the hourly PM10 construction emission rate for specific hours representing 8, 9, 10, 11 and 12 hours of construction activity per day. These construction-day sets were matched with the corresponding months shown in Figure AQ1-1. The resulting maximum modeled Project contribution was 28.5 $\mu g/m^3$. Thus, restricting the daily hours of construction reduced the maximum modeled Project impact to PM10 concentrations from 106 $\mu g/m^3$ to 28.5 $\mu g/m^3$, with no days where over 50 $\mu g/m^3$ were contributed by the Project (without background).

Data Request 4:

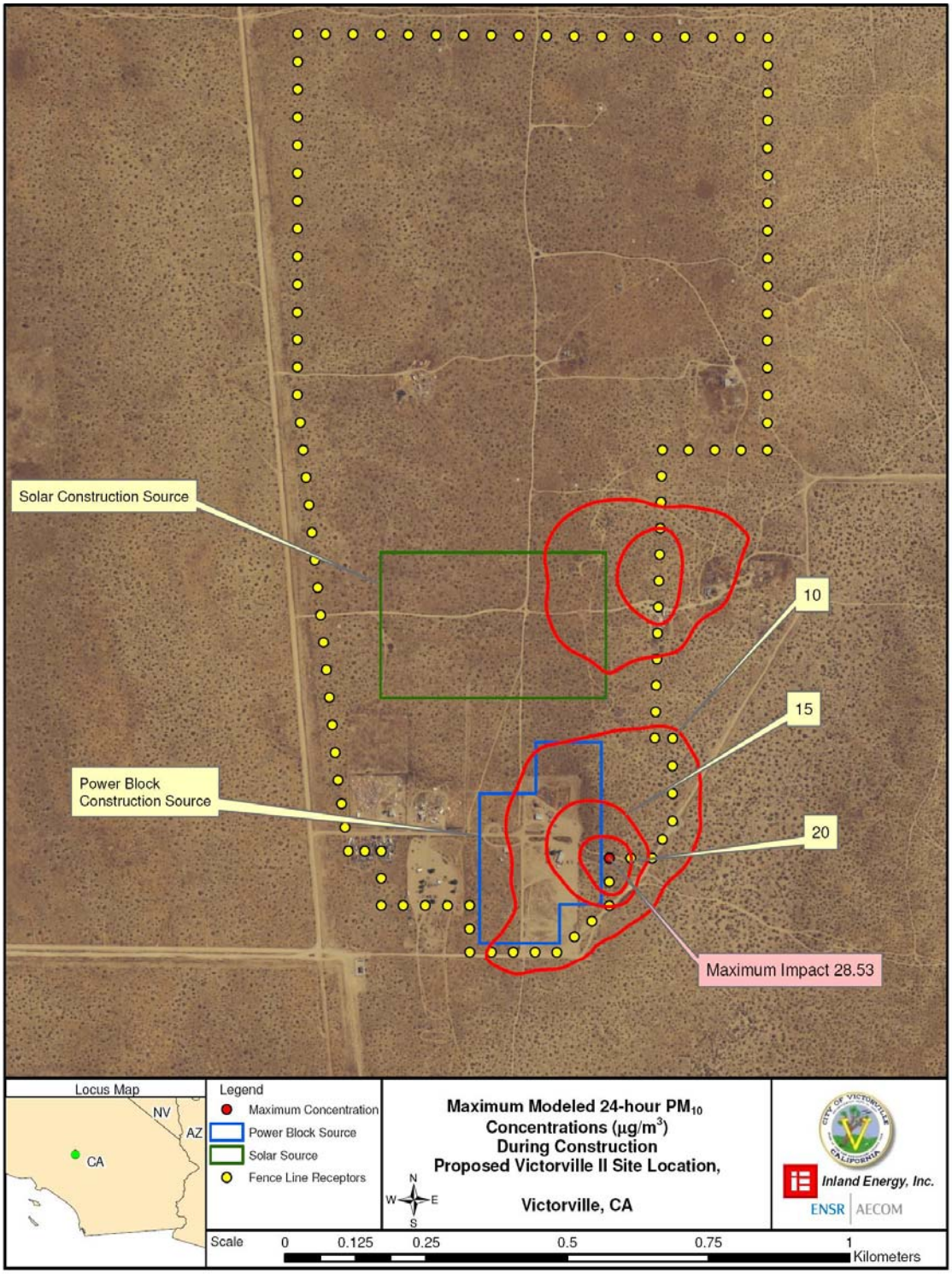
Please identify the expected locations of maximum construction impacts derived from modeling the emissions of PM10.

Response:

The location of the maximum construction impacts for PM10 for the scenario in which only hours identified as allowable for construction by the NO_2 modeling is shown on Figure AQ4-1. As noted in DR-1, this scenario is very conservative in that the peak emissions for both the power block and the solar array are assumed to occur simultaneously and for all days during the 27 month construction period. This scenario also only represents construction in the areas of the site that are expected to be disturbed at any given time, and these areas will move around the site during the construction period. Furthermore, AERMOD, like other Gaussian models, is generally better at predicting the magnitude of the maximum concentration than the specific location.

During construction, the peak 24-hour PM10 (and 1-hour NO_2) impacts were predicted to be on the facility fenceline. Figure AQ4-1 also shows isopleths of 24-hour PM10 concentrations modeled for the day (April 4, 2004) with the maximum modeled value, and this figure shows that the concentrations decrease rapidly away from the fenceline. All existing businesses and residences are well over 1,000 m from the Project site, and hence should not be significantly impacted by Project construction.

Figure AQ4-1 Location of Maximum Modeled PM10 Impact During Construction



Data Request 5:

Please provide evidence and analysis to support the AFC assumption that no more than 50 percent of the cooling tower TSP emissions are PM10.

Response:

The background discussion to this data request states that "In all past siting cases, staff has assumed that 100 percent of the TSP emissions from the cooling tower are PM10." Actually, there have been several past siting cases where the analyses of cooling tower PM10 emissions have been based on less than 100 percent. Examples include the High Desert Power Project, which assumed 50 percent, and the Blythe Energy Project, which assumed 15 percent. Both of these projects are located in the Mojave Desert Air Quality Management District's jurisdiction. The Elk Hills Power Project, in the San Joaquin Valley Air Pollution Control District's jurisdiction, is also based on less than 100 percent. In a response to a CEC comment on the Palomar Energy Center, the San Diego Air Pollution Control District stated "*There is evidence to indicate a 50% assumption for PM_{10} is reasonable: not the least of which is acceptance of such on prior projects. Therefore the District will report the facility PM_{10} in the FDOC assuming 50% of the cooling tower water TDS is converted into PM_{10}.*"

As described in AP-42, because wet cooling towers provide direct contact between the cooling water and air passing through the tower, some of the water may be entrained in the air stream and carried out of the tower as drift. AP-42 also states that large drift droplets settle out of the tower exhaust stream and deposit near the tower. Other drift droplets may evaporate before being deposited in the area surrounding the tower and can produce PM10 emissions. AP-42 states that a "**conservatively high**" PM10 emission rate can be developed by assuming that all the drift forms PM10.

The assumption in the VV2 Project AFC is based on a more realistic assessment of cooling tower emissions. When studying aerosol physics, nebulizers are used to produce solid particles. When a 1,000 parts per million (ppm) solution is nebulized, a solid particle with a volume that is 0.001 times the original droplet volume will be produced.[1] Under these conditions, experience shows that a single particle will be produced. The size of the final aerosol particle depends on the volume fraction of solid material and the droplet diameter as follows:

[1] Hinds, William C., 1982. Aerosol Technology, Properties, Behavior and Measurements of Airborne Particles. John Wiley & Sons, Inc.

$$D_s = D_d \times (F_v)^{1/3}$$

Where:
D_s = diameter of solid particle
D_d = diameter of liquid droplet
F_v = volume fraction of solid material

This equation can be converted to calculate the resulting particle diameter for a cooling tower by accounting for the density of the particle. This equation is presented below:

$$D_s = D_d \times (\rho_d/\rho_s \times TDS / 1{,}000{,}000)^{1/3}$$

Where:
D_s = diameter of solid particle
D_d = diameter of liquid droplet
ρ_d = density of droplet = 1 g/cm^3
ρ_s = density of solid particle = 2.2 g/cm^3 for sodium chloride
TDS = total dissolved solids, ppm

The above equation predicts the physical diameter of a particle formed from a cooling tower droplet. This equation assumes that a single particle will be formed when a droplet evaporates, because there is no evidence that multiple particles will be formed. In order to calculate PM10 emission, the aerodynamic diameter must be calculated as follows:[2]

$$D_a = D_s \times (\rho_s)^{0.5}$$

Several sources of data were considered to determine the droplet size of cooling tower drift. In order to be conservative, the size distribution that showed the greatest percentage of small droplets was used to calculate PM10 emissions. The droplet size distribution and the resulting particle size distribution are shown in Table DR5-1.

A chart showing the predicted particle size distribution based on the conservative droplet size is shown in Figure AQ5-1. This figure show that approximately 50 percent of the mass formed from evaporation of the drift droplets is expected to be in particles with an aerodynamic diameter of 10 microns or less, which supports the assumption that 50 percent of the particulate matter formed from evaporation of cooling tower drift will be PM10.

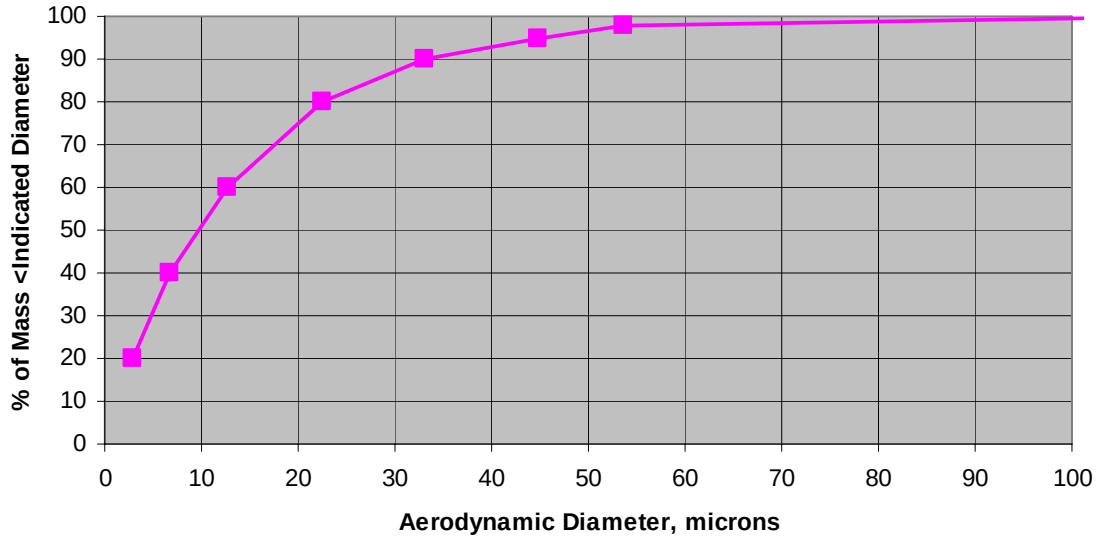
[2] http://www.epa.gov/eogapti1/module3/diameter/diameter.htm

Table DR5-1 Droplet Size Distribution and Calculated Solid Particle Size Distribution

Droplet Size[a] microns	Percent Mass Less Than Droplet Size[a]	Dry Particle Diameter[b]	
		Physical microns	Aerodynamic microns
15	20.0	2.0	2.9
35	40.0	4.6	6.8
65	60.0	8.5	12.7
115	80.0	15.1	22.4
170	90.0	22.4	33.2
230	95.0	30.2	44.9
275	98.0	36.2	53.6
525	99.5	69.0	102.4
700	100.0	92.0	136.5

(a) web.ead.anl.gov/bajatermoeis/documents/docs/BPPWG_AttachC_2003wet-dry_cooling_paper.pdf
(b) TDS = 5,000 ppm, particle density = 2.2 g/cm^3

Figure AQ5-1 Calculated Soild Particle SIze Distribution



Data Request 6:

Please provide the analysis supporting the proposed inter-basin/inter-pollutant trading ratio of 2.08 pounds of VOC ERCs from the South Coast air basin for each pound of project NOx emissions; and 1.3 pounds of VOC ERCs from the South Coast air basin for each pound of project VOC emissions.

Response:

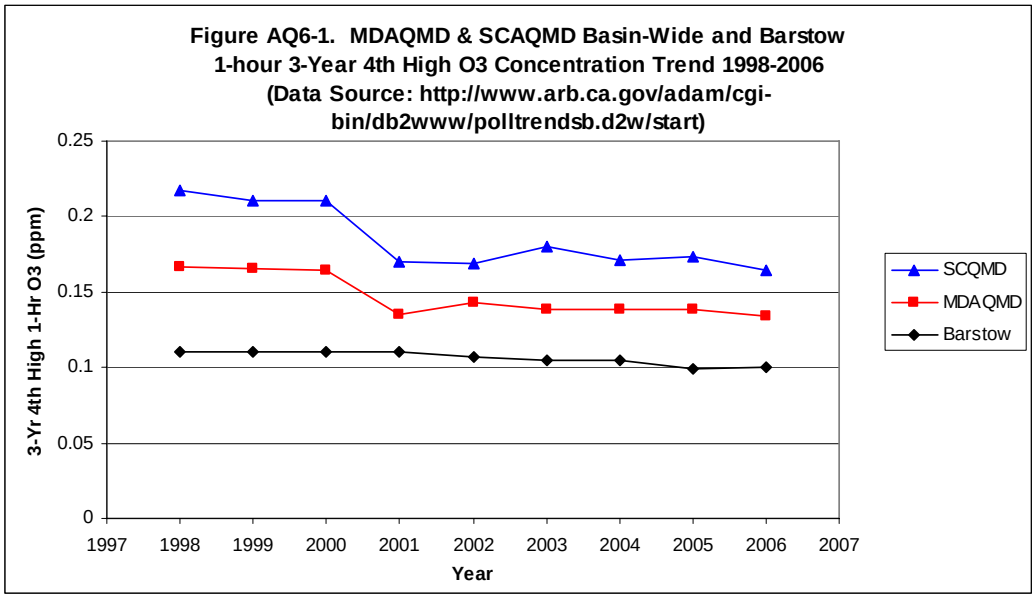
For the licensing of the High Desert Power Project (HDPP), two different analyses were performed in order to determine an acceptable trade ratio for South Coast Air Quality Management District (SCAQMD) VOC emission reduction credits (ERCs) for NOx emissions in Victorville. First, the Empirical Kinetic Modeling Approach (EKMA) graphical isopleth method was used and then an Urban Airshed Model IV (UAM-IV) photochemical modeling analysis was performed. Both of these analyses supported a VOC:NOx inter-basin/inter-pollutant trading ratio of about one to one (1:1). This ratio means that a reduction of 1.0 pound of VOC emissions (in the form of banked ERCs or Priority Reserve offsets) from the SCAQMD would be effective in offsetting 1.0 pound of NOx emitted in Victorville, as both are ozone precursors. The analysis showed that the molar ratios of the two precursors are at levels such that downwind ozone formation does not increase.

During the HDPP licensing process, the modeling-supported VOC:NOx trading ratio was increased in order to be more conservative to 1.6 to 1.0 for the inter-pollutant and inter-basin (distance) aspect. When combined with the 1.3 to 1.0 net air quality benefit ratio required under MDAQMD rules, the resultant ratio is 2.08:1. The requirement for a more conservative trading ratio was based in part over concern of the potential impact of the HDPP on ozone concentrations further downwind in Barstow, approximately 30 miles east-northeast of the HDPP (and outside the modeling domain). The conservative trading ratio of 2.08:1 for the HDPP was approved by the CEC, California Air Resources Board (ARB), U.S. Environmental Protection Agency, and MDAQMD for HDPP, and has subsequently been used for other projects in the MDAQMD.

The conditions existing in the Federal Ozone Non-attainment Area (FONA) of the MDAQMD and the SCAQMD have not changed appreciably since the permitting approval of the HDPP. This is demonstrated by the following:

- The photochemical modeling was based on a 2007 future year emissions scenario. Therefore, the modeling was based on the projected emissions for the current year and is thus representative of current emissions.

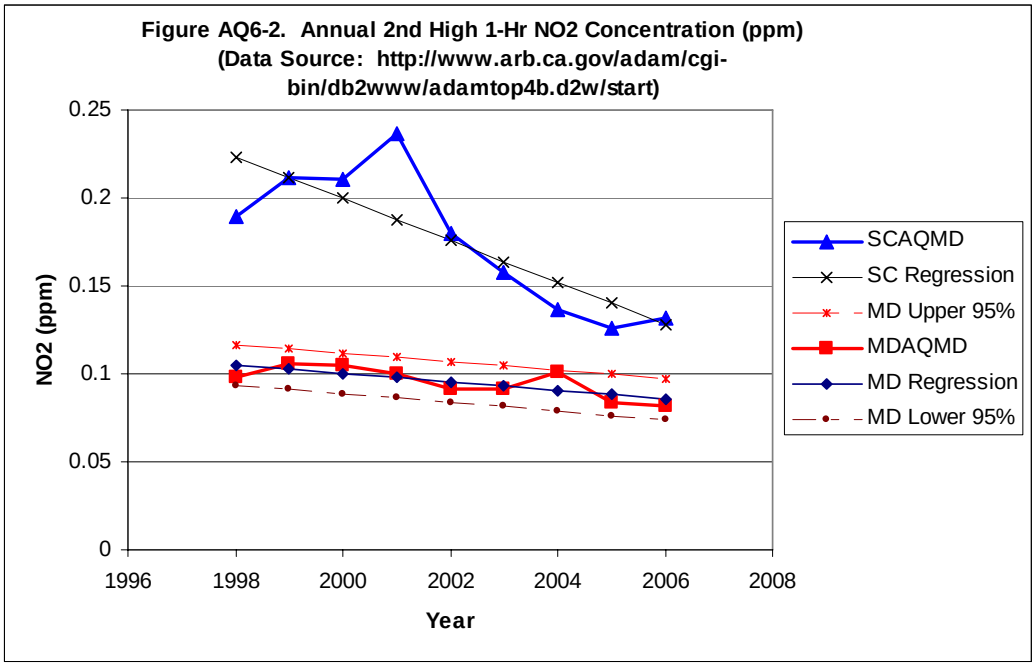
- Basin-wide peak (1-hr 3-year 4th high) ozone levels in the SCAQMD have not changed significantly in the period 2001-2006. See Figure AQ6-1.



- District-wide peak (1-hr 3-year 4th high) ozone levels in the MDAQMD have not changed significantly in the period 2001-2006. See Figure AQ6-1. (Note that the peak ozone levels in the MDAQMD, as discussed in the MDAQMD 2004 Ozone Attainment Plan, occur in the monitoring stations such as Victorville closest to the SCAQMD and represent transported ozone from the SCAQMD).

- The HDPP is a combined cycle power plant located approximately 2.4 miles south of the VV2 plant site. The HDPP began construction in 2001 and began operating in 2003. Over the period since 2003, the 1-hr 3-year 4th high ozone concentration at Barstow, downwind of the HDPP and the VV2 plant site, has decreased, not withstanding the commencement of operation of a major new upwind NOx source. See Figure AQ6-1.

- The District peak 1-hour NO_2 concentration has not changed significantly in the period 1998-2006, at the 95% confidence level (i.e., a line with no slope can be placed inside the 95% Confidence Limits for the regression line for the MDAQMD). See Figure AQ6-2.



- Emission reductions in the SCAQMD of both VOC and NOx have occurred, and are projected to continue to occur since the HDPP became operational, but the emission inventory VOC:NOx ratio is not projected to change, as indicated in Table DR6-1.

Table DR6-1. Inventory VOC:NOx Emissions Ratio for the SCAQMD, 2002-2014

Year	VOC (tpd)	NOx (tpd)	VOC:NOx	Source
2002	844	1,093	0.77	Table 3-1A
2007	712	910	0.78	Interpolated
2014	528	654	0.81	Table 3-3A
Source: SCAQMD 2007 Draft Final Air Quality Management Plan (AQMP)				

- Emission reductions in the MDAQMD of both VOC and NOx have occurred, and are projected to continue to occur in the period since the HDPP became operational, but the emission inventory VOC:NOx ratio is not projected to change, as indicated in Table DR6-2.

Table DR6-2. Inventory VOC:NOx Emissions Ratio for the MDAQMD, 2002-2007

Year	VOC (tpd)	NOx (tpd)	VOC:NOx	Source
2002	39.34	144.58	0.27	Appendix B
2007	34.08	128.81	0.26	Appendix B
Source: SCAQMD 2007 Draft Final AQMP, Appendix B, FONA Inventory				

The available ozone, NO_2 and emission inventory data for the MDAQMD indicates that the key parameters involved in ozone photochemistry in the MDAQMD (ozone and NO_2 peak

concentrations and the inventory VOC:NOx ratio) have not changed since the HDPP was permitted. This implies that the photochemical production potential in the area downwind of the VV2 Project has not changed since the HDPP began operation. In addition, ozone levels at Barstow have decreased over the same period, confirming the conservativeness of the technical analysis used as the basis for establishing the trading ratio for the HDPP. Consequently, it is logical to conclude that the photochemical modeling performed for the HDPP, and approved by the CEC and other agencies, is still representative of photochemical conditions in the MDAQMD and can be used as the basis to justify the proposed VOC:NOx offset ratio of 2.08:1.

Similar to the VOC:NOx ratio, a 1:1 trading ratio for SCAQMD VOC ERCs for MDAQMD VOC emissions was found to be adequate during licensing of the HDPP to offset the future VOC emissions from HDPP. This ratio was then increased to 1.3:1 as required by MDAQMD rules. Again, since the downwind ozone formation has decreased, this ratio is effective.

In conclusion, the analyses presented for licensing process for the HDPP supported a VOC:NOx offset ratio and a VOC:VOC ratio of 1:1. However, the final approved offset ratios for the HDPP were 2.08:1 and 1.3:1 in order to be conservative. As the photochemical potential in the MDAQMD has apparently not changed or has decreased since construction of the HDPP, and because of the demonstrated conservativeness of the prior photochemical modeling analysis, the VV2 Project's use of a trading ratio of 2.08:1 is conservative and justified by the observed ambient air and emission inventory analyses for the MDAQMD presented above.

Data Request 7:

If the above analysis cannot support the proposed trading ratios, please provide new inter-basin/inter-pollutant trading ratio analysis for the project's NOx and VOC emissions. The analysis should use the most recent emissions inventories and ambient air quality data and should take into account the specific location of the VOC emission reduction credits in relation to the location of the new facility and its NOx and VOC emissions.

Response:

As discussed above in the response to Data Request 6, the analyses performed and hence the ratios required for HDPP remain valid for the VV2 Project. As noted above, the modeling analyses actually supported a 1:1 ratio for VOC:NOx, and there was no specific basis for the additional conservatism added. The modeling domain still covers roughly the same area, so

modeling of Barstow and areas further downwind is essentially infeasible. The fact that the ratios of VOC and NOx emissions in both the SCAQMD and MDAQMD have remained essentially the same over the past five years are sufficient evidence that a significantly different modeling result would not be expected.

Furthermore, ozone is a regional pollutant that is produced from emissions throughout the South Coast Air Basin. It is a well established fact that precursor emissions and ozone are then primarily transported to the MDAQMD through a relatively narrow mountain pass. As such, it is irrelevant exactly where the specific VOC emission reductions occurred in the SCAQMD. Although the SCAQMD was not asked specifically where the VOC reductions were obtained for the Priority Reserve, it is believed[3] that these reductions come in small amounts from many sources throughout the South Coast Air Basin for an overall reduction in VOC emissions.

Data Request 8:

Please provide manufacturer information on the technology, control processes, and start-up and shutdown emission guarantees for the turbine/HRSG power units utilizing the Rapid Start Process.

Response:

During the startup of combustion and steam turbines in a combined-cycle plant there are equipment and process requirements that must be met in sequential order that constitute a critical path for starting the plant. Many of these items require holding the combustion turbine at loads where operation is inefficient and emissions are high. The best method for reducing total emissions during start is to reduce the combustion turbine start-up time, which is defined as the time from flame ignition to when the combustion turbine achieves its most efficient operating mode. The typical hold points for a combustion turbine of interest here are the heat recovery steam generator (HRSG) warm-up time, the time required to establish steam turbine seals and condenser vacuum, and the time required to warm the steam turbine.

The GE Rapid Start Process (RSP) is a new design that will be introduced on the VV2 Project. It is also not a specific technology, but rather is a redesign of many of the turbine components in order to enable a shorter startup time. As such, GE does not have published

[3] See letter to Terry O'Brien, CEC, from Mohsen Nazemi, SCAQMD, dated March 9, 2007 regarding the source of PM10 credits in the Priority Reserve, CEC Docket 06-AFC-4.

literature for the process. Therefore, various aspects of this new feature are described below.

OPERATION:

The primary source of startup and shutdown emissions is the cycling of the plant during certain periods of the year. The plant will experience frequent warm and hot starts, while cold starts are expected to be few. During daily cycling, the steam turbine generator (STG) will remain warm or hot and the combustion turbine hold for warming the STG will not be encountered. At the same time the HRSG temperatures will be maintained to the extent possible by closing valves and stack dampers. With the HRSG still hot on the next startup, the combustion turbine generator (CTG) hold for HRSG warm-up time will not be necessary or will be minimized. For daily cycling the auxiliary boiler will be used to maintain steam seals, and condenser vacuum.

PLANT EQUIPMENT:

- HRSG: The HRSG will be designed with rapid start in mind. As an example, the diameter of the High Pressure drum will be minimized to control the drum wall thickness, which is a primary driver of the HRSG ramp rate. The thinner the drum wall the higher the allowable rate of temperature rise in the drum.

- AUXILIARY BOILER: An auxiliary boiler and associated piping will be provided to maintain the STG steam seals, condenser vacuum and STG temperature after a shutdown to eliminate the CTG hold times that would be required to achieve these requirements on a warm or hot start during cyclic operation. The auxiliary boiler will be used to sparge the condenser, establish condenser vacuum and establish steam seals prior to starting the STG after longer shutdowns.

- GE OPTIFLEX: GE will provide a superior control system that will allow the CTG to achieve the most efficient and best emissions operating mode at lower loads than was previously possible resulting in reduced startup times.

The turbine & HRSG guarantees are provided in Table DR8-1below:

Table DR8-1. GE Startup and Shutdown Emissions Guarantees

Operation	Duration (minutes)	lbs per stack NOx as NO_2	lbs per stack CO	lbs per stack VOC
Hot & Warm Start	80	40	329	28
Cold Start	110	96	410	31
Shutdown	--	57	337	29

Data Request 9:

Please discuss whether these new processes and technologies will affect the type and duration of commissioning activities, and resulting air emissions.

Response:

Commissioning activities for the major components (CTG, STG, HRSG, Condenser, and Cooling Tower) are not expected to change significantly from a facility without the RSP design. All of the tests described in AFC Section 6.3.4.1.2 will still be needed, and the startup times during these tests are a relatively minor aspect. Some reductions in start times and emissions are expected to occur after the major components are commissioned; however, due to lack of experience with commissioning a plant with the GE rapid start system (since VV2 will be the first application), accurately quantifying these reductions is not currently possible.