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Dominion

July 27, 2010

Ms. Amy Owens
Director, Valley Regional Office
Virginia Department of Environmental Quality
4411 Early Road
Harrisonburg, VA 22801

Re: Request for Prevention of Significant Deterioration Permit –
Responses to BACT Questions
Virginia Electric and Power Company
Registration No. 81391
AIRS ID No. VA-187-00041

Dear Ms. Owens:

Virginia Electric and Power Company (Dominion) is pleased to provide detailed responses to your request for additional information dated July 8, 2010 related to the BACT analyses submitted for three turbine alternatives included in the subject application.

In the following responses, we have reprinted each of the Department's information requests in italics, followed by Dominion's response.

- *Proposed BACT Carbon Monoxide (CO) Emission Rates – After reviewing air permitting documents from similar facilities, DEQ requests Dominion to evaluate the costs and emission reduction benefits of installing a larger oxidation catalyst for the Mitsubishi and GE turbines in order that those units are capable of meeting the same CO emission rate as the Siemens turbine with and without duct burning.*

Response:

Dominion is not aware of any similar combined-cycle facility (regardless of turbine selection) that has demonstrated continuous compliance with a turbine only CO BACT limit lower than 2 ppmvd @ 15% O_2. As stated in the three BACT evaluations, the top level of control (equivalent to Lowest Achievable Emission Rate – LAER) for CO was determined to be 2 ppmvd @15% O_2 from the turbine only and about 3 ppmvd @15% O_2 from the turbine and duct burner combined. BACT levels of control for duct-fired projects include project specific variables such as the relative heat input capacity of the duct burners being permitted. As such, the combustion turbine CO limit in ppmvd is the more reliable basis for comparison, since the same oxidation catalyst controls CO from both the turbine and duct burner regardless of the duct burner's physical size or attributes. As identified in our application(s), we are aware of the Kleen Energy permit in CT (0.9 ppm without duct-firing, 1.9 ppm with duct-firing), however this facility is not constructed or operational, and has not yet demonstrated continuous compliance at these levels. Therefore, we believe that continuous compliance with CO BACT limits less than 2 ppm has yet to be demonstrated in practice on any

similar combined-cycle unit regardless of manufacturer. Based on the identification of the "top" level of control for evaluation of BACT for the subject Project at 2 ppm (turbine) and between 2-3 ppm turbine plus duct burner, we proposed CO BACT limits that are as stringent as, or more stringent than, the top level of control for the individual sources being evaluated.

The technology forcing aspect of top-down BACT also requires consideration of potentially lower emission limitations, and Dominion also evaluated beyond BACT levels of CO control in its analyses. This was based in part on the emission levels proposed by CPV Warren, numerical limitations proposed by Kleen Energy and accepted by the Connecticut Department of Environmental Protection (CTDEP) in the Kleen Energy permit, as well as awareness on the part of Dominion that actual measured emissions less than 2 ppm have been reported, particularly on natural gas projects when the catalyst is in new and "fresh" condition, and particularly under steady-state load conditions. In the previous applications, Dominion sought to identify 3-hr averaging time CO limits in ppm that were as low as they could be for the proposed equipment configurations, in every case being no less stringent than the top level of control. In the current application, these proposed limits were revised to 1-hr averaging, meaning that they became much more stringent in terms of demonstration of continuous compliance. To meet some of the same numerical limitations that were originally proposed now on a 1-hr average, means that the vendors will already likely plan for a larger oxidation catalyst in order for them to offer Dominion commercial performance guarantees.

The BACT limits proposed for the various Warren County turbines must be met continuously under all normal operating conditions for the life of the facility. Dominion must be able to demonstrate continuous compliance with the numerical BACT limit, meaning that some margin for variability must exist between the design control capability of the equipment and the numerical permit limitation. The proposed numerical BACT limits for Warren County are lower than BACT and lower than any CO BACT or LAER limitations that have ever been demonstrated in practice.

We have no information to support that higher levels of control on the Mitsubishi or GE turbines than those that have been proposed as "beyond BACT" could be continuously achieved in practice even with a larger oxidation catalyst. The hypothetical ability to do so is speculative, has not been demonstrated in operating facilities, and is not a valid basis for determination of enforceable BACT limits.

We are very familiar with the specifics of the Kleen Energy (CT) BACT determination. Our consultant for the Warren County project, AECOM, performed a detailed analysis for a GE7FA combined-cycle project in Towantic, Connecticut that was approved by CTDEP at 2 ppm CO after issuance of the Kleen Energy permit. CTDEP requested very similar information to VADEQs request above – specifically what would the cost effectiveness of adding additional catalyst be to further reduce CO from 2 ppm to 0.9 ppm (about 55% additional control). This question is very analogous to VADEQ's request to further control CO from 1.5 ppm (MHI, turbine only) to 0.9 ppm (Siemens turbine only), about 40% additional control. In that analysis, which was submitted to CTDEP, is a matter of public record and has been attached for your review, GE Energy provided incremental budgetary pricing of $2.2 million per HRSG and additional unit pressure drop of 0.8 inches H_2O. AECOM's cost effectiveness analysis determined the hypothetical overall cost effectiveness of reducing CO emissions by an additional 1.1 ppm would be $16,500/ton, and the hypothetical incremental cost effectiveness to be $27,000/ton. These cost effectiveness values would be even less cost effective for an additional 0.6 ppm reduction for the GE or MHI Warren County

alternatives to achieve 0.9 ppm (Siemens equivalent). This demonstration, which was accepted by CTDEP (the same agency that approved BACT at 0.9 ppm for the Kleen Energy Project) indicates that even if 0.9 ppm was achievable for the GE or MHI units by installing a larger catalyst, it would be far from cost effective and not representative of BACT for the Warren County GE or MHI equipment alternatives.

In summary, the proposed BACT limits for the three Warren County turbine options are technology-forcing "beyond BACT" limits, in that they are already lower than continuously demonstrated limits from any similar operating source. The hypothetical ability to further reduce CO from two of the proposed turbine options to equal another is highly speculative and not supported by any vendor's experience. It is even speculative as to whether CO CEM's can accurately discern between tenths of a ppm in an enforceable operating limit. Anecdotally, we have seen CO analyzers at operating facilities recording CO data at zero or even negative ppmvd @ 15% O_2. Finally, and in direct response to the question being asked, even if a larger catalyst could be installed to achieve a beyond-BACT limit of 0.9 ppm for the GE or MHI cases, as detailed above, the additional reductions would not be cost effective for CO (typically thought to have a cost effectiveness threshold well less than $1,000/ton).

- *Proposed BACT Volatile Organic Compound (VOC) Emission Rates – After reviewing air permitting documents from similar facilities, DEQ requests Dominion to evaluate the costs and emissions reduction benefits of installing a larger (or otherwise modifying the proposed) oxidation catalyst for the Siemens and GE turbines in order that those units are capable of meeting the same VOC emission rate as the Mitsubishi turbine with and without duct burning.*

Response:

Dominion is not aware of any similar combined-cycle facility (regardless of turbine selection) that has demonstrated continuous compliance with a VOC BACT limit lower than 1 ppmvd @ 15% O_2 (turbine only) and 2 ppmvd @ 15% O_2 as methane. Interestingly, the Kleen Energy permit in CT was approved with a VOC BACT limit of 5.0 ppm, despite having accepted the most stringent level of CO control in the country. Each of the Warren County turbine variations proposes VOC BACT limits that are much more stringent than those permitted as BACT for Kleen Energy.

All three Warren County turbines have a proposed turbine VOC BACT limit at 1 ppm or less (0.7 ppm for MHI and Seimens). This demonstrates that all three reflect either the top level of control or beyond BACT VOC limits that have yet to be demonstrated in practice on any similar combined-cycle unit regardless of manufacturer.

The differences in VOC noted are not related to the oxidation catalyst performance proposed (since all three are already being designed to meet a beyond BACT CO turbine only emission limit). VOC is not a homogenous pollutant, but rather is a collection of complex and unpredictable hydrocarbon chains, some of which are easily destroyed across a catalyst, and others of which are stable and minimally affected by the catalyst. Unlike CO, the overall destruction removal efficiency of the "soup" of organics classified as VOC depends on the specific organics present, and based on these variations, oxidation catalyst technology will provide varying levels of VOC destruction. There is no technical basis to document that lower VOC emission rates could actually be met by adding more

catalyst from different units with different firing temperatures, mixing kinetics, and combustor design. In this case, there is no vendor experience base to determine if some amount of additional catalyst applied to a GE 1 ppm VOC system could actually achieve the Seimens or MHI 0.7 ppm emission rate, or similarly if the duct-fired MHI emission rate of 1.6 ppm could be achieved by a 2 ppm GE system. There is no proven incremental catalyst modification to achieve 0.7 ppm VOC without duct-firing or 1.6 ppm with duct-firing on a GE system that is available.

The differences in duct-firing VOC limits are simply a function of different combustion parameters in the design of the turbines and fired HRSGs. Simplistically, one could ask why then the MHI combustors could not be employed on a GE project, however this is a bit like asking why a Ford transmission could not be employed in a Honda automobile to improve its highway gas mileage. The concept of Best Available Control Technology is founded on the basis that the control technology being evaluated be "available" to the permit applicant as a practical matter. The substitution of different combustion equipment to alter the mixture of unburned hydrocarbons from the process does not represent an available control alternative to reduce VOC emission from the Warren County alternative scenarios.

The VOC limits proposed for the three Warren County scenarios contained in our application, which are already "beyond BACT" limits, must be met continuously under all normal operating conditions for the life of the facility based on case-specific factors, one of which is variations in uncontrolled VOC emissions inherent to multiple potential manufacturers. The individual manufacturer's knowledge of what level of VOC will be present and emitted with their particular design including some level of manufacturers margin to ensure that the limit can be met at all times, including under worst case operating conditions. Dominion must be able to demonstrate continuous compliance with the numerical BACT limit, meaning that some margin for variability must exist between the design control capability of the equipment and the numerical permit limitation. BACT is not intended to re-define the source being permitted, and in this case the "source" is defined as either of the MHI, GE, or Siemens combined-cycle units as proposed in the application.

While VOC, as a precursor to ozone formation, would be assessed at a higher cost effectiveness threshold than CO, we note that in this hypothetical case, the same costs for additional CO catalyst evaluated for the Towantic Project would also apply, however in the case of VOC for only an incremental 0.3 ppm reduction. Thus, the dollars per ton for the incremental reduction on VOC would be twice what was estimated for CO. The Towantic Project showed an incremental cost in dollars per ton VOC removed of more than $34,000 per ton to reduce VOC emissions from 1.2 ppm to 0.7 ppm. Clearly, installing a larger oxidation catalyst to incrementally reduce VOC emissions from either the GE or Siemens alternative would not be cost effective, and would not represent case-by-case BACT for this particular project. In summary, the proposed BACT limits for the three Warren County turbine options within our permit application are already technology-forcing "beyond BACT" limits, in that they are already lower than continuously demonstrated BACT limits from any similar operating source, with or without duct-firing. The hypothetical ability to further reduce duct burner VOC from two of the proposed turbine options to equal another is highly speculative and not supported by any vendor's experience. It is even speculative if VOC compliance can be tracked in real time at tenths of a ppm in an enforceable operating limit, since the current permit for the Warren facility specifies compliance to be based on proper operation of the turbine CO catalyst and a "loose" correlation with periodic VOC stack test data with CO ppm. Since the equivalent level of turbine VOC control is already being proposed, and since there is no known

lower BACT limit for VOC that has actually been achieved in practice on an equivalent GE or Siemens unit, any cost effectiveness evaluation of alternative catalyst configurations would be pure speculation and not a valid basis to establish top-down BACT. Based on scaling from the Towantic CO evaluation, however, it is clear that the addition of a larger catalyst to the GE or Siemens units (even if such additional catalyst would perform as expected) would not be cost effective and not representative of BACT for the proposed project alternatives.

- *Proposed BACT Particulate Matter ($PM/PM_{10}/PM_{2.5}$) Emission Rates – DEQ staff has reviewed source testing data from a number of similar combined-cycle facilities, which showed average particulate emissions of 4.58 lb/hr, with a high of 10.65 lb/hr. This emission limit includes all filterable and condensable particulate emissions. In addition, a PM emission rate of 9.5 lb/hr was required for a recently permitted Siemens SGT6-5000 engine at Carlsbad Energy Center in Carlsbad, CA. Please investigate why the proposed turbines cannot meet these lower emission rates for $PM/PM_{10}/PM_{2.5}$.*

Response:

There is no known $PM/PM_{10}/PM_{2.5}$ control for natural gas-fired combined-cycle combustion turbines. There is no design change or add-on control technology to evaluate for cost-effectiveness as an available BACT control alternative. Once a facility is operating, there is no method for the operator to reduce particulate emissions if they are above the established limit. A BACT limit must be continuously achievable in practice, including under worst-case conditions, for the life of the unit. A BACT limit for $PM/PM_{10}/PM_{2.5}$ when there is no add-on control must include sufficient margin to ensure continuous compliance which Dominion will have to certify. The range of values DEQ staff has reviewed reflects that those particular hours out of an entire operating year of 8,760 hours happened to capture a low emission rate. That does not imply that a different result would not be recorded some other day under different operating conditions.

The mass emission rate for the Carlsbad project is specific to that particular project. Dominion does not have access to their basis for proposing those values and test data does not exist since it is not yet operational and thus not demonstrated. However, mass emission limits vary with natural gas quality and fuel consumption. Application documents for the Carlsbad project show a lower maximum baseload heat input (2,080 MMBtu/hr) compared to 2,248 MMBtu/hr for Warren County Siemens turbine due to milder ambient temperatures during winter. Combustion turbines have higher maximum fuel heat inputs (and associated particulate emissions) with decreased ambient temperatures. In addition, fuel consumption by two machines of identical design will vary with their elevation above sea level, ambient humidity, dispatch profile, etc. No controls are proposed for the Carlsbad project by the California Energy Commission other than use of low-sulfur pipeline natural gas. Natural gas sulfur content and gross calorific value (GCV) varies from pipeline to pipeline, and is most dependent on the particular source of the natural gas being delivered. LNG supply from overseas adds yet another variable. Thus, two identical engines on two opposite coasts can easily exhibit different $PM/PM_{10}/PM_{2.5}$ mass emissions and both be subject to the same stringency of top-down BACT.

In the 2008 Desert Rock Energy Facility Responses to Public Comments, EPA rejected the argument that stack test data from operating facilities should be used to establish BACT limits and noted the distinction between "emissions data at one point in time and an emissions limitation placed in a PSD

permit which must be met continuously for the entire life of the facility." The source testing data from other operating units is anecdotal and not a valid basis to establish BACT limits for particulate from the Warren County combined-cycle units.

Since all similar turbines use precisely the same fuel and combustion technology to limit emissions of particulate, there is no basis to determine that the actual annual emissions from any one turbine will be any more or any less than for any other equivalent engine. Regardless of the numerical BACT limit selected for the Warren County combined-cycle projects, in actual operation they will emit no more or less PM, PM_{10} or $PM_{2.5}$. The application of BACT for this class of air pollutants is really the work practice standard of limiting the turbine fuel to natural gas, coupled with a numerical emission rate as required for PSD that can be met on a continuous basis for the life of the Project. Accepting a lower limit would not result in lower emissions.

Notwithstanding EPA's responses to the Desert Rock public comments, Dominion is searching for a way to commit to "beyond BACT" emission limits less than those supported by MHI or GE. We are having further discussions with our vendors to see if further reductions from those proposed can be justified for the Warren facility. Due to the lack of information to support lower limits and the lack of any control device to achieve lower limits, we are having a difficult time developing a logic that leads to lower limits. In the interest of time, we are providing this response today and intend to follow up with you concerning the results of our investigation next week.

- *Proposed Ammonia Emission Rates – A permit issued June 15, 2009 to Kleen Energy Systems LLC in Connecticut limits the Siemens SGT6-5000F turbine to 2.0 ppmvd ammonia as a one-hour average during steady-state operation when burning natural gas. Please evaluate the feasibility of achieving 2.0 ppmvd (1-hour average) during steady state operation (i.e. operation above 60% load) for the Siemens, GE and Mitsubishi turbines.*

Response:

Ammonia (NH_3) is not a criteria air pollutant, but has been aggressively regulated in CT, MA, and CA as a precursor to regional haze formation. We identified several operating combined-cycle units of various models and manufacturers, that have permit limits of 2 ppmvd ammonia (1-hr average), and have significant operating experience demonstrating compliance with those limits, although there are key differences regarding those facilities as noted below. We note that two sites in MA operating MHI 501G units at 2 ppmvd NH_3 are steam-cooled units that are not well-suited for daily cycling duty, whereas the MHI units potentially to be installed at Warren County are air-cooled and designed for daily cycling. In addition, these units may be dispatched in the PJM transmission region in the Regulation or Automatic Generation Control Market which will turn operating control of the units over to PJM so that loads on the electric grid can be stabilized and managed for reliability.

Contact with our vendors indicates the ability to achieve 2 ppm NH_3 during steady-state conditions, however, at additional capital and O&M costs for additional catalyst and housing, a finer NH_3 injection grid, more precise computer controls, and potentially shortened SCR catalyst life. All of these factors will also require additional maintenance materials and cost to ensure that catalyst or injection nozzle plugging does not occur, which would lead to increased NH_3 emissions.

The incremental cost to achieve a 2 ppmv NH_3 for the MHI turbine option is estimated at $6,920/ton to control an additional 157.9 tons of NH_3. This difference is not considered to be cost-effective to control a non-criteria, non-HAP pollutant. The costs for GE and Siemens turbines are expected to be similar to the costs developed for the MHI turbine, but even less cost-effective based on less mass of NH_3 controlled to achieve the same reduction in slip. Therefore, Dominion does not believe that it is cost-effective to further reduce NH_3 emissions below the proposed level of 5.0 ppmv.

For purposes of permit limits and compliance, Dominion defines "normal" operation as at or above 60% load for Siemens and MHI turbines and at or above 50% load for GE turbines, but that steady-state operation is based on a steady load for the duration of the CEMs hour; for example, defined as less than a 5% rate of change per hour.

Conclusion

We believe that we have fully provided all of the additional information requested in your July 8th, 2010 letter request with the exception of our final analysis of particulate emissions. We also believe that the attached materials related to the very similar Towantic Energy (CT) project will be of value in providing additional detail to substantiate and further explain our responses. Importantly, the Towantic evaluation was approved by the same CTDEP that had previously approved the Kleen Energy permit.

We intend to follow up with you concerning our particulate emission evaluation next week. Please contact Andy Gates at 804-273-2950 or andy.gates@dom.com if you have questions concerning this information.

Sincerely,

Robert M. Bisha
Director, Environmental Business Support

Enclosures: Towantic Energy Center BACT Recertification
Cost-effectiveness calculations for reduced ammonia slip

cc: (via e-mail) Mr. Janardan Pandey, Valley Regional Office Air Permits Manager
Ms. Anita Riggleman, Senior Environmental Engineer
Ms. Tamera Thompson, Director, Permitting, DEQ Central Office