To: David Paylor, Director, VADEQ
Richard Langford, Chairman VAPCB
Vivian Thomson, Vice-Chairman VAPCB
Hullihen Williams Moore, Member VAPCB
John Hanson, Member VAPCB

From: Bruce Buckheit, Member VAPCB

Date: April 14, 2008

Subject: Further Data Gathering Activities In Support of VAPCB Consideration of Permit Applications Respecting the Virginia City Hybrid Energy Center

On March 20, 2008, the Virginia Air Pollution Control Board ("the Board"), voted to assume responsibility for issuing the permits (NSR and 112(g) MACT) needed to authorize construction of the Virginia City Hybrid Energy Center ("VCHEC").

At that time Board members were asked to provide specific guidance to DEQ staff and interested parties concerning the scope and timing of additional activities that needed to occur to facilitate consideration of those permits in a timely manner. This memorandum is intended to set out my thinking with respect to information I need to help me decide how I will vote on certain issues. This memorandum is prepared in my capacity as an individual Board member and not as an act of the Board[1]. It also represents my preliminary thoughts, created at the outset of the Board's assertion of authority over the subject permit and should not be interpreted as an indication of how I will vote on any matter brought before the Board. The comment period has not closed on the proposed MACT permit and I have not yet reviewed all of the comments submitted on the NSR permit. Of course, this permit will be decided not by me alone, but by the full Board.

For business reasons Dominion has requested that the Board complete its deliberations as soon as practicable and, if at all possible before July 1, 2008. I assume that the commenters agree with this request and note that prompt consideration of permits is good public policy and consistent with recent legislation regarding permits issued by the Board. Substantial information about this project has been developed and it is my hope and expectation that the data gathering and presentation efforts set out below will be completed within 30 days of the posting of this memorandum, so that the matter can be taken up at the next meeting of the Board.

Dominion has phrased the issue as whether the DEQ or the Board may alter its choice of fuels -- "run of mine" coal, coal waste and gob[2]." There has been substantial

[1] Earlier drafts of this memorandum were provided to DEQ and to each of the Board members. Two Board members provided individual comments. I have incorporated the comments received in this document.
[2] "Gob" is an acronym for "garbage of bituminous". There is a question as to whether this material is a "fuel" in the ordinary sense, or a "waste."

comment in the record as to the authority of the Board in this regard and some of the inquiry below and by other members of the Board addresses issues that suppose that Dominion's phrasing of the issue is correct.

However, it appears that another reading of the matter is at least plausible and that an evaluation based on that reading is warranted. This other potential reading of the situation revolves around the argument that "run of mine" coal is simply coal[3] that has not been cleaned. If coal cleaning[4] is merely a "control technique" that the agency may or must[5] require as part of a BACT process, arguments about the authority of the agency to force a change in fuels may be irrelevant. A decision on which reading is appropriate will be made by the Board at a later date. The Board has indicated its intention to carefully review all available options within broad scope of the policies laid out in Virginia Energy Policy. Facts needed to advance the arguments of either side should be included so that the Board can evaluate the impact of accepting or rejecting a given argument. The parties may advance their theories and arguments in their comments. The Board will, of course, solicit and be attentive to the advice of DEQ as to the merits when the time for final decision approaches. This exercise is intended to acquire information and identify the assumptions that the information is based on. I welcome the suggestions of DEQ and the parties as to the most efficient way to gather the information as well as suggestions to alter the information sought. I recognize that much of this information is already scattered throughout the record.

In making this request I am not seeking the creation of extensive consultants' reports. In the interest of expediting this review and the objective nature of the inquiry, I would suggest that it may be possible that the parties (and their consultants) agree with DEQ as to a sharing of effort to acquire and present this information and not have each side conduct their own inquiry on each of these issues.

THE DEVIL IS IN THE DETAILS

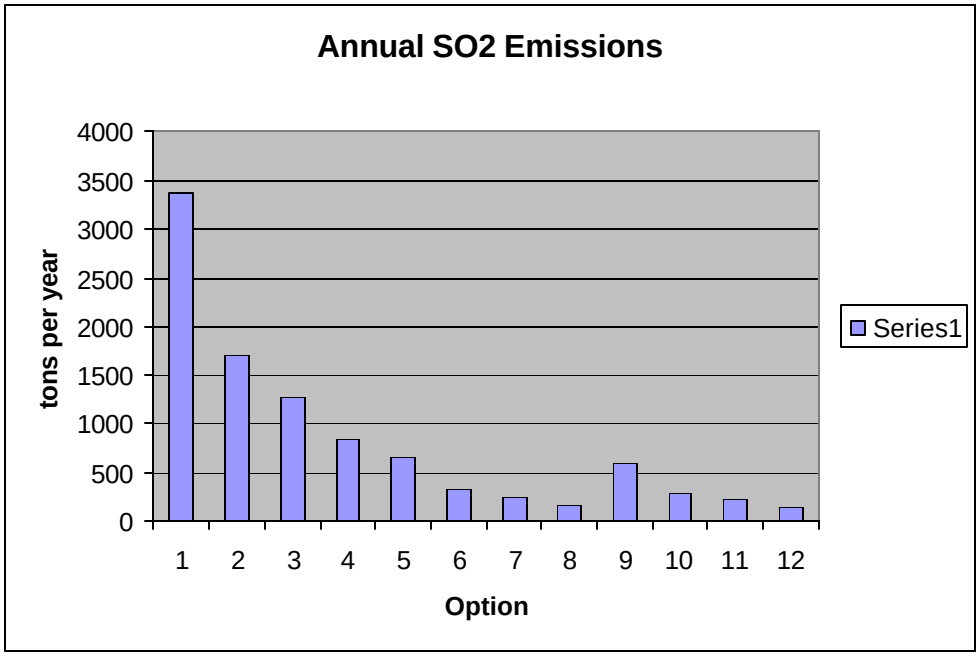
My review over the past three weeks leads me to believe that detail issues in the Dominion proposal that have not been examined may be environmentally significant. As part of my evaluation process I examined plausible assumptions concerning control device efficiencies for the combination of circulating fluidized bed and spray dryer absorber[6] ("CFB/SDA") SO_2 controls as proposed by Dominion. I have made some "what if" calculations, based on the technology choices made by Dominion and

[3] While details of the coal in the vicinity of Virginia City are being evaluated, I note that as a state, Virginia has among the best quality coal in the nation. This is not to suggest that all of Virginia's coal must be cleaned; much of it is relatively low in sulfur and other contaminants.
[4] Coal cleaning appears to involve placing "run of mine" coal in a bath of water and surfactants such that the less dense coal may be separated from heavier soils, minerals and other contaminants.
[5] If the agency either may or must require coal cleaning, it would follow that the agency may or must prohibit consideration waste coal in establishing the BACT limit.
[6] A spray dryer absorber is one form of "dry scrubber".

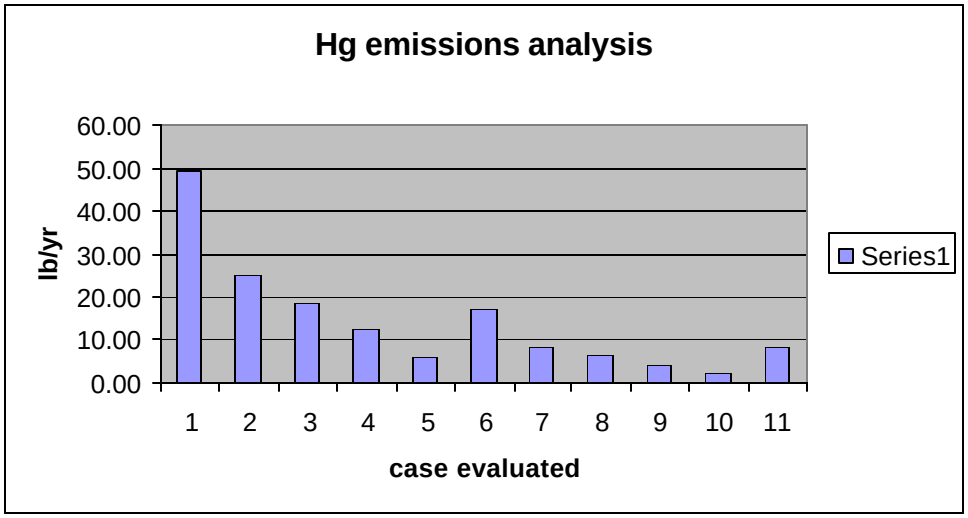
published information concerning their effectiveness. These emission estimates are far below what has been suggested by Dominion and accepted by DEQ and yet, in many applications outside of the United States, a CFB without a follow on dry scrubber is considered an acceptable pollution control system. It follows that one could expect extraordinary performance if one combines a dry scrubber and a CFB. It also appears that a significant portion of the environmental impact of the proposed project is associated with the suggestion to use unwashed coal and coal wastes. If, at the end of this process it can be determined that emissions may be limited as suggested in these calculations, much of the public's concern about the VCHEC SO_2 and Hg emissions may abate.

EFFECT OF FUEL CHOICE AND ASSUMED CONTROL DEVICE EFFECTIVENESS

Option	SO_2 concentration	SO_2 control efficiency	annual emissions
unwashed coal	5.127	98	3369.1
unwashed coal	5.127	99	1684.55
unwashed coal	5.127	99.25	1263.41
unwashed coal	5.127	99.5	842.28
clean coal	1	98	657.13
clean coal	1	99	328.5
clean coal	1	99.25	246.38
clean coal	1	99.5	164.25
clean coal	0.9	98	591.42
clean coal	0.9	99	295.71
clean coal	0.9	99.25	221.78
clean coal	0.9	99.5	147.86



Option	Hg concentration	control efficiency	annual emissions
Unwashed coal/coal wastes	0.3511	98	49.46
Unwashed coal/coal wastes	0.3511	99	24.73
Unwashed coal/coal wastes	0.3511	99.25	18.55
Unwashed coal/coal wastes	0.3511	99.5	12.37
Unwashed coal/coal wastes	0.3511	99.75	6.19
clean coal	0.12	98	16.90
clean coal	0.12	99	8.45
clean coal	0.12	99.25	6.34
clean coal	0.12	99.5	4.23
clean coal	0.12	99.75	2.11
Mecklenberg	0.12	98.7	8.42



While I and the other members of Board will examine other technologies, the record concerning the broad issues raised by competing technologies is reasonably complete. The focus of my near term information gathering requests will be (1) issues associated with the use of coal washing; (2) gaining an accurate understanding of the performance of the control systems proposed by Dominion and (3) acquiring information relating to the broader issues that must be evaluated when a permit applicant attempts to demonstrate that the "most effective control technology" is "infeasible." Of course, should the assumptions underlying these calculations prove to be significantly in error, the Board will have other options that it may adopt.

EVALUATION OF EFFECTIVENESS OF COMPETING ALTERNATIVES

- The overall goal is to produce a spreadsheet that will enable a determination of "the most effective control technology" for the Top Down BACT process as well as to collect information to evaluate the technology selected. The process is set out in EPA's 1990 New Source Review Workshop Manual.
http://www.epa.gov/region07/programs/artd/air/nsr/nsrmemos/1990wman.pdf.

- Assumptions about control device efficiencies may alter ranking of control device strategies and so should be explored and presented as the technical review progresses.

- Results should be presented on an input basis and on an output basis.

- Costs should be presented on the basis of competing assumptions, but based on sound science. Thus, when comparing control costs the results should be normalized to account for the fact that existing units incur a cost for purchasing cleaned coal that is not reflected in the classic BACT figures employed by agencies.

- Any "worst case" estimates should be accompanied by the most accurate estimate. Where a review is requested, please identify sources the reviewed, incorporate the relevant materials in the rulemaking record and briefly summarize the relevant facts.

- The analysis should include each of the major options suggested by commenters.

- Major[7] candidate technologies should include
  -Dominion's proposal – CFB/SDA/FF
  -washed coal/CFB/SDA/FF
  -IGCC
  -SCPC
  -SCCFB[8]
  -PC

Direct impacts (per EPA manual)

-control effectiveness (percent pollutant removed)
-expected emission rate (lb/mmbtu; lb/MwH & tpy);
-expected emission reduction (tons per year);
-direct energy impacts[9] (BTU, kWh);
-direct environmental impacts (other media and the emissions of toxic and hazardous air emissions)
-total cost effectiveness[10]

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[7] One could always examine other combinations and permutations. Here, most of the relevant information is in the record – it simply needs to be pulled together on a spreadsheet.

[8] I recognize that construction has not yet been completed on the Lagisza supercritical CFB facility (see below) but the technology is "commercially available" and so must be considered. Smaller scale units have operated for a number of years, the Lagisza unit is the first in this size range.

[9] *Steam* references the fact that coal washing improves boiler efficiency. Here, the project assumes that 2,000,000 tpy of ash (that otherwise would not be injected into the boiler) will be heated to 1500 degrees F. There will be an increase in emissions of CO_2, hazardous and criteria pollutants associated with the extra combustion needed to accomplish this heating of the ash. This energy is wasted as this material then literally "warms" the globe as it is left to cool after being discharged from the boiler and overall boiler efficiency is decreased. (see below) I assume there is also an energy impact associated with coal washing. This impact should be estimated and compared as well.

-incremental cost effectiveness

Indirect impacts (per EPA manual) – Where the applicant attempts to demonstrate that the most effective technology is not feasible in a given application.

- Summarize readily available **data** concerning adverse environmental impacts of gob and coal waste piles, especially as that data may distinguish between newly generated waste piles and historic waste piles. If there is no such data, simply indicate that fact.

- Identify current management practices for newly generated coal waste and gob. If they are being properly managed there would not seem to be an environmental benefit to allow Dominion to burn unwashed coal.

- A better environmental argument might be made where coal waste and gob have not been well managed in the past and are causing a specifically identifiable problem in the community. Blending limited amounts of such materials might be appropriate depending on the overall emission performance of the control devices. If there are specific locations where coal waste and gob might be causing an environmental harm that is significantly greater for the waste piles generally, a specific exclusion for such wastes might be appropriate. Please identify any such locations and estimate the quantities involved as well as any relevant time frames when cleanup of those specific locations might occur. Again, if there is no readily available data, simply report that fact.

- Examine the fate of the mercury and other metals if waste coal is allowed to be combusted – the mercury and the other toxic metals will not be destroyed in the egu, some will be emitted and the majority will move with the ash in the limestone bed and in the contaminated scrubber limestone. A short memorandum should suffice here and, except for the Hg dispersion issue, I suspect the only hard data may be with a report on how Dominion intends to handle limestone wastes at this facility, how others in the industry manage such wastes and what legal constraints may apply under Federal or state law.

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[10] In this respect care must be taken when evaluating total and incremental cost effectiveness to provide an "apples to apples" comparison with other facilities that incur costs to procure washed coal but may not have those costs reflected in the BACT analysis. Please examine the most recent Virginia egu NSR permit to evaluate this issue. Second, it is important to distinguish between "cost" and "price." Coal is a commodity, like oil and coffee, whose price will vary over time with market conditions. Over the long term one would assume that the price for unwashed coal would differ from the price of washed coal by no more than the cost of washing the coal. I recognize that coal wastes are likely to be available at no cost. This issue should be included, but analyzed separately. Additionally, as coal washing provides emission reductions for PM, $PM_{2.5}$, SO_2, Hg and a range of toxic metals, the cost of coal washing should be apportioned among those pollutants rather than allocating the full cost to each pollutant.

- Will the ash generated by VCHEC operations be managed in a quantifiably improved manner than the current materials? If this issue cannot be quantified, simply indicate that fact.

- Is there any legal constraint as to where the contaminated limestone bed & spray dryer blow down will go? That is, other than engineering specifications for products such as wallboard, are there constraints that would preclude uses in which the materials might become more bioavailable than is currently the case. For example, what would prevent the mercury contaminated limestone materials from being sold as the pelletized lime I use on my lawn and by others to lime streams or lakes to address acid rain issues?

- Presumably (but not necessarily) the toxic metals that are emitted will be more bioavailable than they were in the waste piles. Please quantify if possible and, with respect to mercury provide modeling estimates of the increase in Hg dispersion in the local environment (within 75 miles of the plant) associated with burning unwashed coal and waste materials at the rates suggested by Dominion and as those might be affected by the control efficiency issue discussed above.

- To what extent are the waste coal and gob in Wise County "orphan wastes" as that term is used in the Superfund context? Where there is no financially viable party that is responsible for waste materials different public policies may apply. Here, it may be that the effect of permitting burning waste materials is a shift of long term cost for management of waste materials from coal mine operators to the ratepayers. If there is no readily available information, simply identify that fact.

- I believe there has been ample discussion of the qualitative health impacts from $PM_{2.5}$ emissions from the plant. However, there have been a number of studies by EPA and others that enable a general quantification of the health based economic impacts of $PM_{2.5}$ emissions. Using such generalized information, please prepare a spreadsheet that contains estimates of such costs associated with each of the options and assumed emission levels.

- Similarly, the record is fairly complete as to impacts on the environment generally associated with emissions of the pollutants at issue here. You may wish to simply incorporate parts of the comments into the BACT analysis by reference, but I would ask for a short (2 page) summary addressing acid rain issues in this region. Acid Rain impacts were first identified in the northeast, largely because the soils in that area had little buffering capacity. Many may assume that the problem is either limited to or concentrated in the northeast. It is reported that the combined effects of the Acid rain and CAIR programs are showing measurable improvement in that region. However, it is now recognized that that the Southern Appalachian region, with its greater buffering capacity, has absorbed so much acid deposition that absent significant SO_2 reductions beyond the Acid Rain and CAIR programs, measurable progress may not be achievable for decades. As of a year ago TVA's website reported that agency's assessment that remediation of the resource was impossible. According to TVA, the best approach would

be to try to limit any further damage rather than make efforts to recover the resource. NAPAP[11] has issued a comprehensive report on this matter, http://ny.cf.er.usgs.gov/napap/Information/NAPAP%20Report%208-22-05.pdf. To the extent that DEQ has conducted an assessment of this issue, it may be sufficient to reference that effort.

- There needs to be some assessment of whether the possible adoption of minimum biomass requirements will cause adverse environmental effects. There are a number of large industrial boilers operating in this country that operate either entirely with wood as a fuel or utilize a mix of wood or coal and so there may be information available that discusses the issue. Specific attention should be paid to any local impacts that might be unique to the area, and I assume the information obtained could be summarized in a few pages. However, given available biomass resources in the Wise County area (see below) it appears that this issue will not significantly impact estimates of annual emissions.

- Coal washing might increase the cost of fuel to Dominion, which would be passed on in some fashion to ratepayers within Dominion's service area. Those ratepayers will experience an economic benefit associated with reduced health care costs. In addition, some portion of the cost of coal washing and use of biomass is labor. Please address the effect on employment of these options and the secondary economic effects on the area economy. Here, a visit or call to one or more local coal washing stations is likely all that is needed for direct employment per million tons of coal washing and average salary, with a standard multiplier for indirect costs. Alternatively, a state agency may already have information on this issue. I imagine that the results of this inquiry could be summarized in one or two pages.

- Coal washing and the use of biomass will affect CO_2 emissions, and of course this issue is part of the discussion respecting IGCC. The cost analysis associated with each of these options should include some discussion on the impact of a Federal carbon tax. The discussion need not attempt to resolve the issue of what an appropriate tax might be, but merely lay out a short (two page) discussion the basis for the major competing proposals for the level of tax that might be imposed and a spreadsheet illustrating the effects of the different proposals on the assumed costs for coal washing and biomass. There may be materials in the record or in the open literature that could be cited in lieu of creating a new summary. Under a grant from NETL, Cornell University has developed a model for comparing GHG emissions see, http://www.iecm-online.com/iecm_dl.html, and http://www.iecm-online.com/PDF%20Files/Rubin%20et%20al,%20NETL%20CSS%20May%202001.pdf. Cornell

[11] The National Acid Precipitation Assessment Program (NAPAP) coordinates federal acid rain research and monitoring under the auspices of the National Science and Technology Council (NSTC) Committee on Environment and Natural Resources (CENR).The NAPAP member agencies are the U.S. Environmental Protection Agency, the U.S. Department of Energy, the U.S. Department of Interior/U.S. Geological Survey, the U.S. Department of Interior/National Park Service, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration. This assessment involved many individuals from across the federal agencies representing numerous scientific disciplines

also maintains a listing of over 45 relevant technical papers http://www.iecm-online.com/publications.html

- The evaluation should also include an examination of the effect of Virginia's electric rate incentive for "carbon capture compatible" technology on the cost of the competing alternatives.

- A shortage of electric supply can cause significant adverse economic impacts. More importantly, such a shortage could also cause significant health impacts, particularly among the elderly, if summer shortages cause air conditioning use to be curtailed. Please prepare a short evaluation of the impact on the schedule for completion of the project if any of the competing alternatives were selected. I assume that adopting several of the alternatives might delay completion of the project for several years. The most recent EIA/NERC projections for electricity demand and supply in the Region should also be provided so the Board can take these into account. Conservation programs can do much to lessen demand, but may take several years to implement. This factor may be incorporated in the EIA/NERC estimates. However, if it is not, please prepare a short document summarizing the estimates of government agencies, as well as the business, scientific and environmental communities as to the degree of conservation that can be accomplished by 2012-2015.

Facts relevant to establishing BACT limits for PM, SO_2 and Hg.

- Identify the lowest permit limits for comparable units[12] (PC, SCPC, CFB, IGCC)

- Identify emission levels achieved in practice for the cleanest units – including AES Puerto Rico (EPA Region II), the CFB units cited in the Wayland memo[13], Oak Creek, Seward Station and Craig Station (EPA Region VIII) to obtain stack test data and CEM data as available[14].

- Review stack test and CEM data (including PM CEM data at Virginia units that have such monitors) for cleanest CFB units and for Virginia units to determine variability of control device performance (with respect to establishing short and long term limits) and the degree to which the BACT limit underestimates the performance of the unit.

- For SO_2 control – evaluate CFB and SDA performance capability (see below) to determine whether it is consistent with "best achievable levels" and the extent to which the device meets removal levels achieved elsewhere, document performance level that can be expected to be achieved.

- For PM control, evaluate air to cloth ratio and proposed filtration media[15] see below)

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[12] I assume the comments will provide this, but suggest a call to EPA Region III and OAQPS as well.
[13] www.epa.gov/ttn/atw/utility/**NSPS**-053106.pdf
[14] If any of the comments have identified other clean units, those units should be included as well.
[15] ICAC can identify vendors who presumably can provide specification sheets for their offerings.

SO_2 Emissions performance of the CFB

CFB boilers have naturally low emissions for SO_2. This is because the fluidized bed contains limestone, the same material used in the scrubber to remove SO_2. The literature confirms that CFB boilers can remove in excess of 90 per cent of the sulfur in the fuel. The capture rate within the CFB boiler is a function of the calcium to sulfur ratio in the bed.[16] A representative value for such performance would be in the range of 92 per cent[17] see attached documents. Based on this level of control, there have been plants permitted in the past where no additional controls were required. Dominion has proposed to incorporate a "spray dryer absorber or "dry scrubber" that it asserts will remove 95 per cent of the sulfur that is not captured in the limestone bed of the CFB. On paper, the combined removal efficiency of this two-part system is 99.6%[18]. DEQ acknowledges that dry scrubbers "typically" attain a 95% removal rate, but, without stating a specific underlying value for the CFB contribution, assigns an overall removal efficiency of 98% to the system. This leads DEQ to assign a permit limit that is five times greater than the theoretically achievable rate.

Back calculating from the overall efficiency and the claimed 95% removal efficiency for the SDA, reveals that DEQ's proposed emission level assumes only a 60% capture rate for the CFB portion of the system, far less than the literature would suggest[19]. There are occasions where the capture efficiency of a control device is fixed and so an error in the emission limit might not affect real world emissions. However, where CFB contribution to overall performance is dependent on the amount of calcium injected and spray dryer performance is dependent on the rate of limestone injection an overly lax emission limitation could lead to increased emissions. The chart below illustrates the emission levels that have been achieved by existing units and does not necessarily establish what those units could achieve[20].

An issue can arise where inlet loadings to a pollution control system are so low that the system can no longer achieve the percentage removal levels[21] that might be

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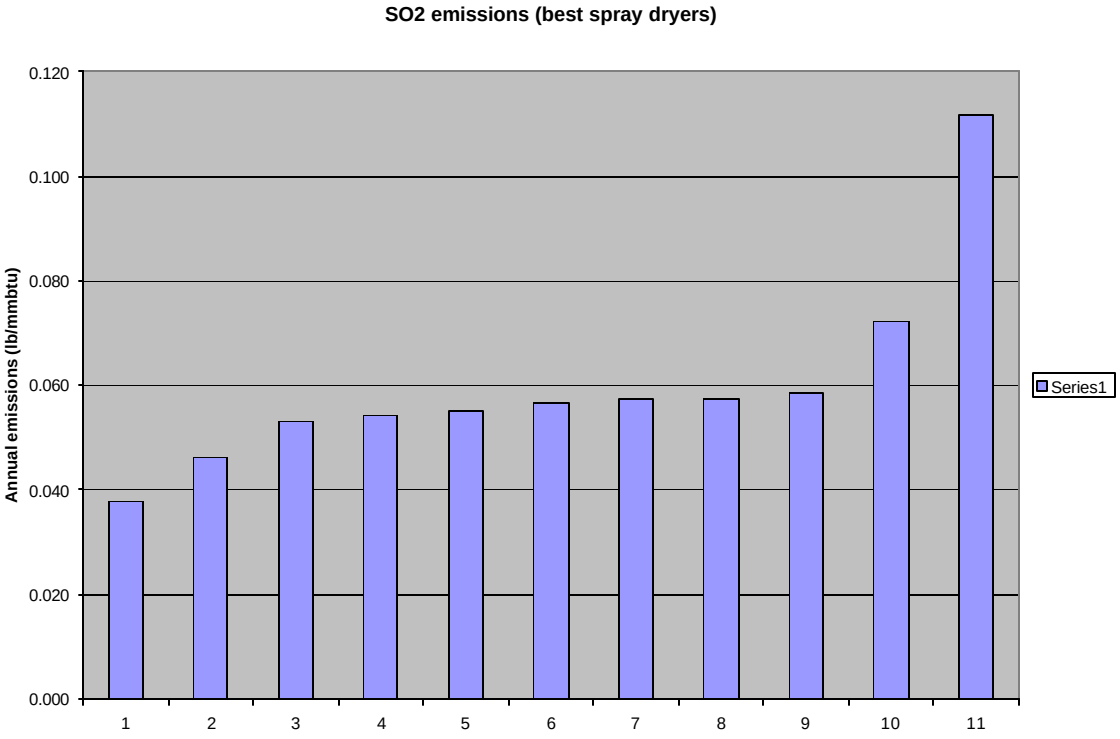
[16] See, *Steam*< Id. at 29-5 which provides the formulae to calculate sulfur capture in a given design.
[17] http://www.fosterwheeler.com/publications/tech_papers/files/TP_CFB_06_01.pdf; http://www.fosterwheeler.com/publications/tech_papers/files/TP_CFB_05_04.pdf; http://www.fosterwheeler.com/publications/tech_papers/files/TP_CFB_03_02.pdf

[18] If 100 pounds of sulfur were introduced into the CFB boiler, 92 pounds would be bound up in the limestone bed and 8 pounds would be introduced into the dry scrubber. At a 95 per cent removal rate 7.6 pounds of the sulfur would be captured by the SDA and 0.4 lb released to the atmosphere. In this example, the overall capture rate would be 99.6%.
[19] The designer may have established a calcium injection rate or bed size to meet a target emission rate assuming the existence of the SDA rather than seeking optimal performance from each component of the system. This may be easily ascertainable by a review of the procurement documents.
[20] This is because the units are easily achieving permit limits.
[21] Actual emissions will still be reduced, but not at as great a percentage as if the inlet loading was greater.

expected at higher loads. I suspect that the dry scrubber might not be able to achieve 95% efficiency[22] in this application, and if this is the case the permit should reflect this fact. These issues may be resolved by reviewing existing documentation maintained either by Dominion or the system vendor concerning the design and performance of the CFB itself and of the dry scrubber system. In particular, those portions of the procurement documentation concerning three narrow points may be sufficient to resolve the issue: (1) the design of the atomizer system (are rotary atomizers employed?); (2) the anticipated SO_2 inlet loading to the SDA; and (3) the overall SO_2 system performance (a) requested in the RFB;(b) set out in the contract; and (c) any guaranteed performance for the system.



In this regard I would also request that DEQ evaluate the short term variability of SDA system performance based on CEM data for existing units. Please also contact EPA to obtain similar CEM data for the Craig Station facility. I would also appreciate the opportunity to review whatever **data** is intended to support the flat lining of the SO_2 limit at loads below 50%, seemingly unrelated to startup and shutdown? This limit would appear to raise "intermittent control" issues as well as BACT issues unless it is

[22] Note that in this calculation the efficiency of the CFB is the more important factor – reducing the efficiency of the dry scrubber by 50% (to 90%) still yields a system efficiency of 99.2%.

based on data reflecting the performance capability of the system. In particular, is this limit designed to allow the relaxed performance requirement when the system is operating only one unit, even if that unit is operating at 90% or more of rated load? What emissions increase is associated with this proposed permit term?

Mercury BACT

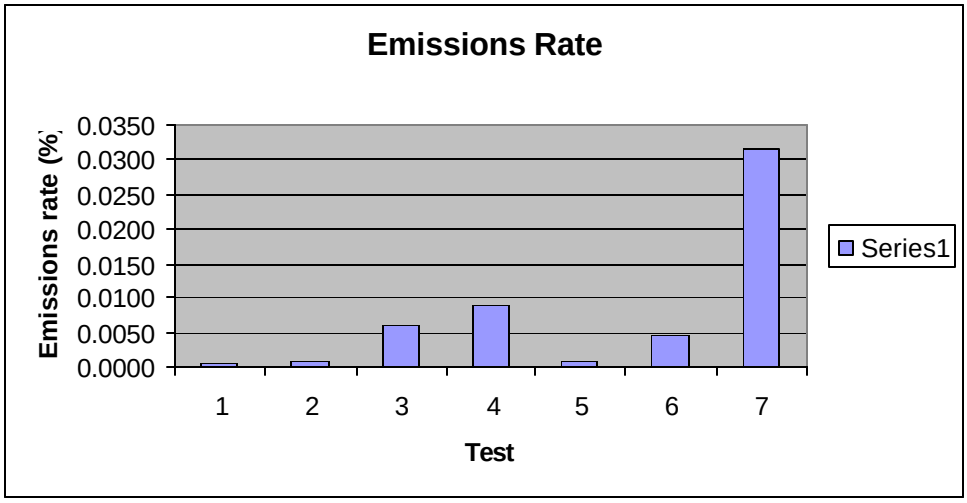
The mercury controls considered by DEQ are a combination of spray dryer absorber, activated carbon injection and a fabric filter PM removal system. Again, DEQ provides no rationale as to why the most effective control strategy did not include use of coal washing techniques.

The BACT Analysis references Dominion's view that such a system is capable of capturing 98% of the incoming mercury and proposes to set MACT and BACT limits based on that capture efficiency and the mercury content of unwashed coal and waste coals suggested by Dominion. Dominion cites a specific EPA memorandum in support of this estimate ("the Wayland memo"), which is specifically cited elsewhere in this memorandum. A review of the underlying data demonstrates that far better performance has been achieved in similar units and that further evaluation of this issue is warranted. See also, http://www.arippa.org/members_plants.asp for generalized information about these units.

Kline Township Cogen Waste Anthracite FBC/FF	99.95
Scrubgrass Generating GEN 1 Waste Bituminous FBC/FF	99.92
Cambria Cogen Facility GEN 1 Waste Bituminous FBC/FF	99.41
Colver Power Plant COLV Waste Bituminous FBC/FF	99.10
Ebensburg Power (2004) GEN 1 Waste Bituminous FBC/FF	99.91
Ebensburg Power (2005) GEN 1 Waste Bituminous FBC/FF	99.55
Scrubgrass Generating (2005) GEN 1 Waste Bituminous FBC/FF	99.24
Wheelabrator Frackville GEN 1 Waste Anthracite FBC/FF	96.85
Average percent reduction	99.24

The Frackville unit, for whatever reason appears to have unusually low efficiency. It is a different design than the others and somewhat smaller. In addition, the unit may have been burning lower quality fuels or injecting less than optimal quantities of limestone than its peers. With the data for this unit removed from the calculation the average is 99.56 and the standard deviation falls from 1.02% to 0.351%. However, each of these units is substantially smaller than the VCHEC and may not be representative of the performance that can be expected from VCHEC. Data for operations at Seward Station[23], which is in the same size class and employs similar technology and proposed feed stocks, should be obtained if available.

[23]See, http://www.energyonline.com/Industry/News.aspx?NewsID=6826&Reliant_Dedicates_Seward_Coal_Plant



This data compares differences between units and so it may overstate the variability of the expected performance. Nonetheless, if we assume that these results are a series of tests for a unit to look at the limits that would be appropriate for VCHEC. Using EPA's statistical approach, but discarding the Wheelabrator test[24] would give a short term average of 99.05% - suitable for setting a three hour average such as would be appropriate for a BACT determination. However, for purposes of determining whether annual mercury emissions meet a MACT floor or for setting MACT itself, variations tend toward the mean[25], suggesting that an efficiency of 99.5% or higher[26] might be a more valid representation of the Dominion system. There may be additional data available at this time, including Hg CEM data which may provide additional information.

PM, $PM_{2.5}$

[24] The notes reference that there may have been operational difficulties during some of the tests and that some of the units may still have been in a shakedown period. It may also be the case that the Wheelabrator unit was of a substantially different design. To fully evaluate this issue, the stack test reports should be reviewed and the appropriate statistical tools employed to evaluate the statistical validity of the including the Frackville data in the calculation.

[25] See, the Central Limit Theorem of statistics.

[26] The new source MACT floor is to be set at the level achieved by the best source It should also be noted that these units were combusting coal wastes with a higher concentration of Hg than would be the case at VCHEC, particularly if coal washing is required, and so control efficiencies might be lower.

Dominion's proposed mix of coal and coal wastes has markedly higher ash content than washed coal. DEQ did not provide a rationale for why the most effective control strategy for PM and $PM_{2.5}$ control did not include coal washing[27].

By what amount, given the currently designed bag house system design criteria, would allowing the use of unwashed coal and coal wastes increase emissions of PM, $PM_{2.5}$, CO and hazardous air pollutants, including, but not limited to mercury? Based on the reported ash content of Dominion's proposed mix, an increase in emissions of PM and metal HAPs such as antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel and selenium would appear to be possible[28]. It would also appear to be reasonable to assume that coal washing would be even more effective in removing hazardous metals that have specific densities much greater than coal.

A fabric filter (or baghouse) is similar in concept to a home vacuum cleaner where particulate matter from the suction action of the device is captured by a membrane or bag. The most significant difference is that of scale. Because of the vastly increased volumes associated with an egu a typical bag house is a mechanical structure that supports several thousand bags, each of which is typically six inches to one foot in diameter and 20 to 30 feet long. These bags are made of different materials depending on the application and, as with most things in life, there are differences in performance that are reflected in the price of the bag. However, *Steam* asserts that well designed filters routinely achieve greater than 99.9% particulate removal[29]. Other literature suggests an even greater efficiency.

The BACT Analysis does not reflect that any attempt was made to evaluate the control efficiency of the specific design proposed by Dominion or that the control efficiency of that system was considered in determining the proposed limit. However, in this instance the Engineering Analysis did reject limits proposed by Dominion, did not adjust the limits upward to reflect the lower quality fuels and did select a BACT limit within the range of other CFB boilers known to the engineer at the time.

The MACT Analysis assumed that 99.9% control efficiency for cobalt and lead; 99.8% for arsenic, beryllium and manganese; 99.7% for antimony (and lesser amounts for other metals) were needed for compliance with MACT limits. It then determined that particulate matter is "an excellent surrogate for metal HAP and has been used in several promulgated MACT standards" and determined to use the PM, PM_{10} and $PM_{2.5}$ limitation for all metal HAP. However, I have found nothing in the record that translates the assumed 99.9% control efficiency into a PM MACT limit or evaluates the proposed PM limits from this facility as against the MACT metal limits discussed above.

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[27] *Steam*, by Babcock and Wilcox identifies "coal cleaning" first in its listings of particulate control technologies and SO_2 control technologies, noting that it also provides more uniform coal feed (see my comment on variability of feedstock with respect to mercury control efficiency).

[28] It is plausible to assume that coal wastes may contain higher concentrations of these materials than washed coal. Accordingly, this issue should be examined.

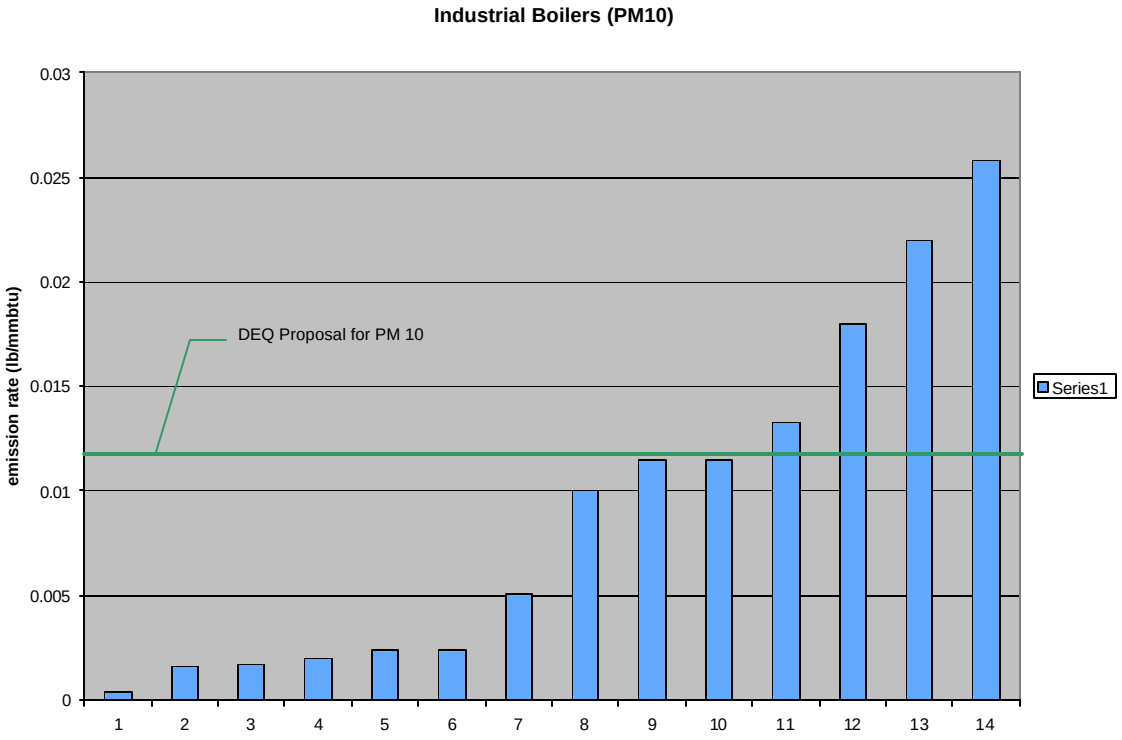
[29] *Id*.sec. *33-.9*

To my knowledge, the best bag houses have an air to cloth ratio of less than 2:1. The increased bag surface area permits lower gas velocities and better capture of fine particulates. If the proposed Dominion design does not specify a air to cloth ratio in this range, please document equivalent performance or proceed with Top Down procedures for determining that a control technology option is infeasible.

The BACT Analysis does not reflect that any attempt was made to evaluate the proposed limits against stack test data for existing units. As you know, for the past several months under a consulting agreement with NACAA[30] I have been compiling and evaluating data regarding the performance of industrial boilers as part of an effort to develop a model rule to assist states in developing MACT permits for that source category. Your staff has been participating in the work group regarding this effort[31]. While final rollout of this effort is still a month or more away, NACAA has shared the results of its initial data gathering efforts with EPA, the industry (CIBO) and environmental groups (NRDC and Earth Justice). This data is helpful in evaluating proposed limits under this permit and illustrates why I believe it is important to look beyond historical permitting activities in evaluating the performance of a new unit. Some effort should be made to gather stack test data for existing egus with fabric filters. This is encompassed in my request (above) for stack test data for the most relevant units and the most recent stack test data for Virginia units.

[30] The National Association of Clean Air Administrators is the professional association of state and local air program managers.

[31] DEQ staff did not have this data available to them at the time the January 7, 2008, Engineering Analysis was performed



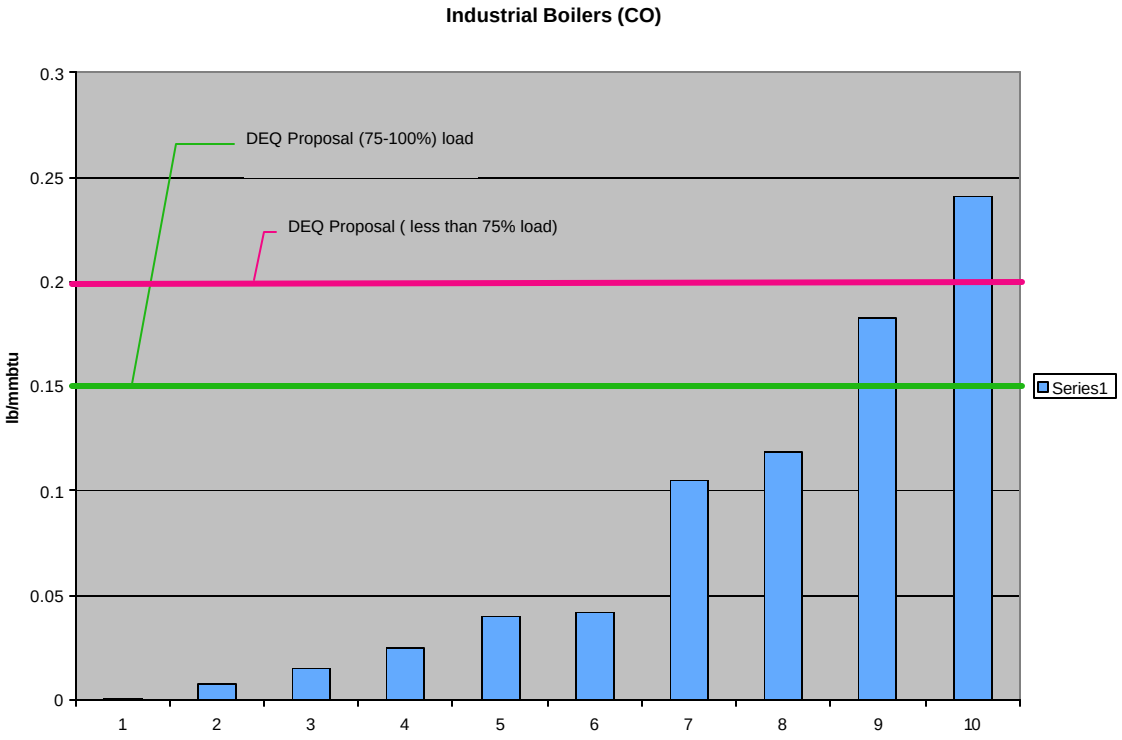
NOx

The record concerning the NOx rate in terms of lb/mmbtu seems reasonably complete. Please address the impact, if any, in terms of tons per year using the Dominion proposed fuel rather than nominal Virginia coal. This could be accomplished much as I have attempted in this memo - on a page or two that displays the calculation, sets out the assumptions and identifies the source for the assumption.

CO and HAZARDOUS AIR POLLUTANTS

Low CO is a measure of good combustion and is used to evaluate the completeness of the combustion of organic hazardous air pollutants within the boiler. While CO emissions might not be of particularized and direct concern as a criteria pollutant, in the MACT process CO emissions are used as a surrogate for emissions of ethyl benzene, xylene, benzene, hexane, formaldehyde and polycyclic organic matter. Please perform an analysis of any CO impacts and perform a top down CO BACT analysis if the most effective control strategy for organic HAPs is not employed[32]. A CO evaluation for MACT purposes is also required. This is also true for the acid gas HAPs in the exhaust.

[32] Catalysts that are specific to the oxidation of CO and do not provide for more complete combustion of organic HAPs are not helpful in this regard.

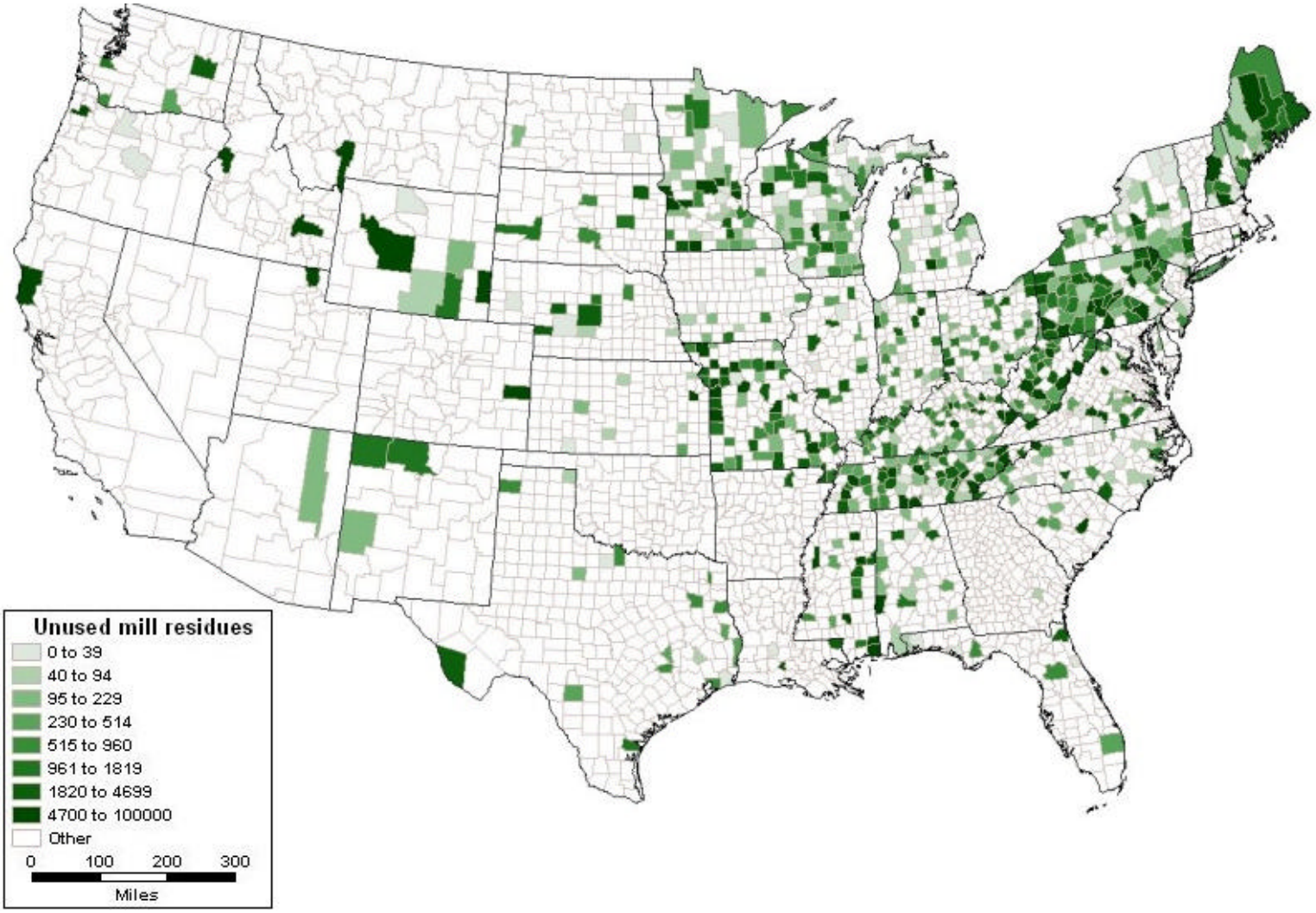


BIOMASS COMBUSTION

The ability of the VCHEC to burn up to 20 per cent biomass was widely discussed and considered at the time of the development of the Virginia Energy Plan. It is clearly set out in the discussion of the design of the Plant. However, there are several million "flex fuel" vehicles on the road today that have never run on any fuel other than gasoline. The hybrid capability of the plant does nothing to enhance the environment until and unless it is used. The DEQ analysis did not consider establishing a minimum biomass fuel requirement. Such a requirement would seem to be within the scope of the project as outlined by Dominion and would reduce emissions of sulfur, mercury and other pollutants of concern. However, given the level of biomass resources available in the area (see map), a substantial impact on annual plant emissions is not anticipated.

Please review available information concerning the biomass resources of the local area and any (adverse or beneficial) environmental impacts that may be associated with this issue. http://devafdc.nrel.gov/pdfs/9840.pdf; http://cta.ornl.gov/bedb/pdf/Biomass_Energy_Data_Book.pdf

Unused Mill Residues in the U.S. by County



Source: Bioenergy Resource and Engineering Systems Program, Oak Ridge National Laboratory https://cta.ornl.gov/bedb/index.shtml;

HIGH EFFICIENCY CFB

In its response to the Board's preliminary inquiries Dominion correctly observed:

"per the definition of BACT, technologies considered in the BACT analysis are those that are available and demonstrated. *See, e.g., Prairie State*, slip op. at 45. To be commercially available, a technology must be offered for sale through commercial channels. *Id".*

Just as supercritical[33] PC boilers have greater fuel efficiency than subcritical PC boilers; supercritical CFB boilers also have greater fuel efficiency than subcritical CFB boilers such as VCHEC. Demonstration of the technology has proceeded over the years under DOE funding and this technology reached the "commercially available" stage with the awarding of a commercial contract for construction of the Lagisza 460 MWe supercritical CFB electric generating unit ("egu") to Foster Wheeler, one of the largest U.S. suppliers of a variety of boiler technologies.[34] The initial contract was awarded in December, 2002. Construction is scheduled to be completed in March of next year. I understand that Foster Wheeler has entered into contracts for two additional units. According to the referenced technical paper,

> "With supercritical once through technology CFB boilers are able to provide a basis for a high efficiency, fuel flexible, environmentally sensitive power plant with reduced emissions, including CO_2. The CFB boiler for Lagisza power plant will utilize a wide range of coals and is also able to burn coal wastes in the form of coal slurry and granulates while co-firing biomass...The boiler design for 460 MWe Lagisza power plant is based on proven solutions that are already used in other large CFB boilers delivered by Foster Wheeler only a modest scale-up has been required. It can be concluded that CFB technology is today commercially viable to boiler sizes of 500 MWe and programs exist for the rapid scale-up of the technology to 800 MWe."

The plant is designed to achieve a net plant efficiency of 41.6 per cent (HHV basis). This technology would represent a net efficiency improvement of 21.6 per cent over typical CFB efficiency. This suggests that use of a commercially available supercritical CFB would reduce emissions of hazardous and criteria pollutants as well as greenhouse gases by over 20 percent compared to the current subcritical design. Please follow up with the vendor(s) of this technology (perhaps through CIBO or ICAC) to obtain whatever specific information is available about the current state of technical development, commercialization and number of pending orders and incorporate this information for consideration by the Board.

EFFICIENCY IMPACT OF PROPOSED FUEL MIX

In order to evaluate whether examination of this issue might be significant, I performed what I would style "an order of magnitude" calculation based on published data. The "run of mine coal" has an ash content of greater than 40% (nominally 44%). In addition, Dominion proposes to use substantial amounts of waste goal and gob. Dominion's application discloses that it intends to use 3,525,000 tons/yr of "coal." Total

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[33] Supercritical PC boilers operate above certain temperature and pressure thresholds where better thermal efficiencies can be achieved while subcritical PC boilers operate below those thresholds.

[34] See http://www.fwc.com/publications/tech_papers/files/TP_CFB_07_08.pdf. Foster Wheeler asserts that its design is based on 283 CFB reference units. Note that the design claims a 94% reduction of SO_2 in the CFB unit itself.

fly and bed ash production is given at 2,600,000 tons/yr – of which 350,000 tons/ yr. can be assumed to be limestone. The ash content for the mix then would appear to be 63.8%. Ash content is for clean coal is assumed to be in the range of 7 – 10%. Using the specific heat for "soil" (0.25 btu/lb ^{o}F)[35] and assuming that in order to assure complete combustion of coal, the ash must be brought from "room temperature" to the operating temperature of the boiler (nom 1500 ^{o}F) the energy required is calculated.

At 10% ash content annual ash generation would be 352,500 tons; at 7% it would be 246,750 tons. Thus if we assume 7% ash content for clean coal, the difference in the amount of ash that would have to be heated to 1500 ^{o}F is (2,250,000-246,750) = 2,003,250 tons/yr

(2.0 x 10^{6} tpy) x (2.0 x 10^{3} lb/ton) x (0.25 btu/ lb^{o}F) x 1500 ^{o}F = 1.50 x 10^{12} btu or 1.50 x 10^{6} mmbtu

In its application Dominion apparently asserted that the heat rate for the plant is 10,800 btu/kwhr; while at a Board meeting the Dominion representative stated that the heat rate was slightly less than 10,000 btu/kwhr[36]. This needs to be clarified, in the long term, for purposes of this order of magnitude calculation I use 10,400 btu/kwhr. I assume a nominal 90% unit availability.[37]

Total heat:

(10,400 btu/kw/hr) x (1x 10^{3} kw/MW) x (668 MW) x (.9) x (8760 hr) = 5.47 x 10^{13} mmbtu or 54.7 x 10^{6} mmbtu.

(1.50 x 10^{6} mmbtu) / 54.7 x 10^{6} mmbtu x 100 = 2.74%

Repeating this calculation assuming 63.8% ash content for Dominion's proposed fuel and 10% ash content for cleaned fuel yields a result of 2.60%.
This calculation suggests that nominally 2.7% of the annual energy consumption of the plant is associated with simply heating the excess ash to 1550 degrees F. While this may appear small to some, according to the literature achieving gains of this magnitude are considered quite significant within the industry. From an environmental perspective the potential significance of this issue may be analogized to the amount of biomass farming that would be required to offset a 3% decrease in efficiency. Based on the Cary Institute calculations incorporated in the questions of Vice-Chair Thomson, it can estimated that a 50 square mile tree farm (slightly more than 10% of the land area of

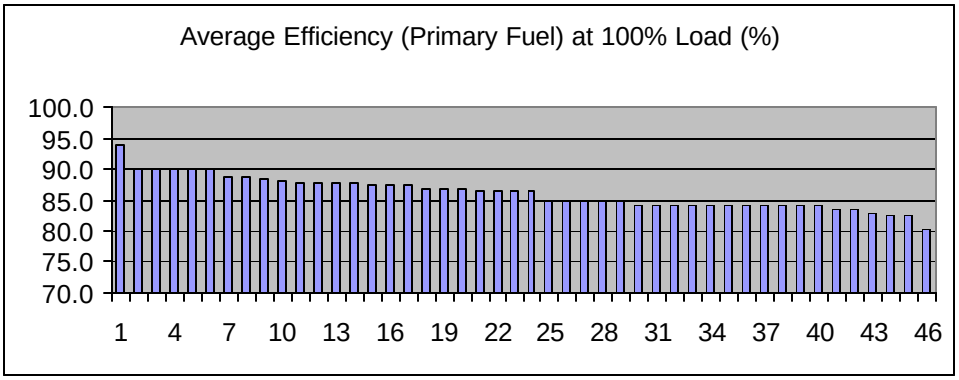
[35] http://www.ac.wwu.edu/~vawter/PhysicsNet/Topics/Thermal/HeatCapTable.htm , citing Tipler, Paul A., Physics for Scientists and Engineers, 4th Ed., W.H. Freeman, (1999).

[36] I suspect that this may be due to differences in calculating the heat rate at HHV (higher heating value) versus the figure for LHV (lower heating value).

[37] I have not examined the assumptions underlying Dominion's calculation of coal consumption and ash generation.

Wise County) would have to be created and maintained to offset even this level of decrease in efficiency.

I recognize that boiler design is a complex matter and that more detailed calculations may be necessary to examine in detail the impact of Dominion's proposed fuels from a design perspective. Please ask Dominion to provide the design boiler efficiency, net plant heat rate and net plant efficiency (1) for the current proposed fuel and (2) assuming nominal values for commercially available Virginia coal. In addition, data concerning efficiency of other CFB's operating on commercial coal in the U.S. is readily available. I have compiled data available from DOE's National Energy Technology Laboratory[38].



Plant Name	Service date	Average Efficiency	Firing Rate (tons/h)
Rumford Cogeneration	12/1/1990	86.7	415
	12/1/1990	86.7	415
Seward[39]	**3/1/2004**	**86.5**	**230**

[38] See, www.netl.**doe**.gov/energy-analyses/pubs/database/NETL%20**CPPDB**%202007%20-%20Public.xls and the user manual http://www.netl.doe.gov/energy-analyses/pubs/database/User%20Manual%20-%20CPPDB%202007%20-%20PUBLIC.pdf . This data base is a very large file. I have created a subset of the most relevant information, see attached. The most efficient units appear to be very small units, with only the Northside Generating station unit (about half the size of the VCHEP units) at or above 90% efficiency. However, even very old CFB units can have relatively high efficiencies when burning quality fuels. The five Barry units were installed in 1959 and 1971 and show boiler efficiencies of 88% and 89% respectively.

[39] The Seward facility is of special interest since it is described as burning "waste coal" and is approximately the same size as VCHEC. However, the general literature maintains that the Seward unit is a mine mouth unit located on top of an abandoned anthracite mine and does not indicate the coal quality as burned.

	3/1/2004	**86.5**	**230**
Red Hills Generating Facility	3/1/2002	82.4	210
	3/1/2002	82.4	210
Twin Oaks Power One	9/1/1990	83.4	121
	10/1/1991	83.4	121
H L Spurlock	4/1/2005	88.4	120
Northside Generating Station	5/1/2002	90.0	96
AES Warrior Run Cogeneration Facility	2/1/2000	88.9	90
	8/1/2001	86.9	89
Colver Power Project	5/1/1995	87.0	84
Marion	5/1/2003	88.7	80
Northampton Generating Company	8/1/1995	85.0	74
R M Heskett	11/1/1963	80.3	68
	2/1/2001	86.9	67
	5/1/1997	87.5	66
Shawnee	12/1/1990	88.0	66
ACE Cogeneration Facility	6/1/1990	33.1	58
Nucla	1/1/1991	88.3	58
AES Hawaii	9/1/1992	87.6	42
	9/1/1992	87.6	42
Cedar Bay Generating LP	1/1/1994	90.0	41
	1/1/1994	90.0	41
	1/1/1994	90.0	41
AES Thames	3/1/1990	87.8	39
	3/1/1990	87.8	39
Archer Daniels Midland Cedar Rapids	10/1/1988	84.0	33
	11/1/1988	84.0	33
	3/1/1989	84.0	33
	10/1/1994	84.0	33
AES Shady Point	1/1/1991	84.8	28
	1/1/1991	84.8	28
	1/1/1991	84.8	28
	1/1/1991	84.8	28
	12/1/1991	84.0	28
	3/1/1996	84.0	28
Archer Daniels Midland Decatur	2/1/1987	84.0	25
	4/1/1987	84.0	25
	7/1/1987	84.0	25
	7/1/1987	84.0	25
	12/1/1987	84.0	25
Manitowoc	6/1/1990	94.0	11
Green Bay West Mill	6/1/1992	64.0	0
P H Glatfelter	9/1/1989	82.7	0

Moreover, the construction of the Seward unit was accompanied by the retirement of three existing coal fired units and represented a plant betterment project that may not have required a BACT determination. http://www.fluor.com/ias/pow/projects.asp#aes

4/1/2008	88.0	0
5/1/2002	90.0	0

Even though they are relatively new units, the AES Cogeneration facility and the Green Bay West Mill CFB's have significantly lower efficiencies than the other units shown. I suspect this may be because of the nature of the fuels they combust. Examining the combustion efficiency of these units and the recently permitted waste coal combustors identified in the Wayland memo may provide useful information.

IGCC

The record is reasonably complete concerning the IGCC discussion. I would only add that I met with the managers of the facility 15 months ago and received a one-on-one tour with the plant manager, who was quite pleased with the facility and detailed the steps the company had taken over they years to improve reliability. I also note the fact that TECO has the most experience of operating an IGCC in the U.S. and recently proposed to build another IGCC unit at the Polk facility. TECO withdrew its proposal, not because of any concerns about the unit's reliability, but because of opposition by the Governor and the legislature to ***any*** new coal generation in the state. Note, also the water use issues associated with TECO's decision to abandon IGCC and the biomass capabilities of its existing IGCC unit. See, http://www.tbo.com/news/nationworld/MGBT0WS5E7F.html and http://www.coaltechnologies.com/Polk%20Power%20Plant%20Tour.html. http://blogs.theledger.com/default.asp?item=2177208. http://www.treepower.org/TECO/polk-cofiring-testburn.pdf

The record is not nearly as complete with respect to CO_2 separation and sequestration. AES Shady Point (a coal fired CFB egu) has employed CO_2 stripping technology to produce dry ice[40]. As with most other technology issues, the issue is not whether it can be done, but whether it can be done at a sustainable price. Dry ice costs over a dollar per pound at retail and, while concentrated, the CO_2 is not sequestered. Many are optimistic that CO_2 separation and sequestration can be accomplished on a national utility scale, others are not. http://www.nrdc.org/globalWarming/coal/mit.pdf; http://web.mit.edu/coal/; http://www.netl.doe.gov/technologies/carbon_seq/index.html. I assume the commenters may have submitted or be willing to submit literature on this point. I request that staff prepare a two page memorandum summarizing the views on either side so the Board may consider this issue in evaluating the collateral benefits of IGCC technology.

In addition, it has been represented that the VCHEC is "carbon friendly" because it is located near future potential sequestration sites. If true, however, this fact might argue in favor of constructing an IGCC plant in that infrastructure issues that might

[40] http://www.co2captureandstorage.info/project_specific.php?project_id=22.

constrain CO2 sequestration elsewhere might be less of a challenge for a plant in Wise County. I understand that this issue is being evaluated by researchers at Virginia Tech. Please review the literature and request a assessment from the Virginia Tech researchers on this issue. Review area geology and identify sites in the area of Virginia City that are considered potential sequestration sites. See, http://dpor.virginia.gov/dporweb/geo_2007_2008Newsletter.pdf; http://energy.er.usgs.gov/health_environment/co2_sequestration/co2_illustrations.html. Please also prepare short summary of potential greenhouse gas options for CFB boilers, see e.g.; http://www.fwc.com/publications/tech_papers/files/TP_CCS_07_02.pdf

THE MACT FLOOR FOR NEW SOURCES –

I have not conducted a careful review of all potential sources that might be construed as the "best performing similar unit" for purposes of evaluating the new source MACT floor. DEQ's inquiry was limited in ways not permitted by the statute and so DEQ should broaden its inquiry. Please contact EPA (Peter Tsirigotis) to determine what emissions data may be available. I suspect the comments may provide also relevant information and I may have additional questions after reviewing the draft MACT permit comments. In particular, there may now be Hg CEM data that could be useful that was not available as recently as two years ago.

The best performing similar unit may be within the group of CFB units identified in the Wayland memorandum, AES Puerto Rico – or Seward Station. If so, MACT would seem to be achievable within the technological envelope of the proposed design. I have never heard of a situation where the next generation of a design performs worse than its predecessors. However, it would seem that PC boilers as well as CFB boilers, operating on cleaned coal, may be within the definition of "similar sources", since VCHEC has the capability of operating on cleaned coal. As I have need for this data for other purposes, I have placed a call to EPA to acquire the underlying stack test data for the Wayland memorandum units and Seward Station. I will forward a copy to you and the docket when it arrives.

Facts relevant to whether "coal waste" or "garbage of bituminous (gob)" is from an engineering perspective a commercial[41] "fuel" or more akin to a "waste"

- Review relevant ASTM, or other specifications for commercial fuels (heat content, sulfur content, heavy metals content etc).
- Review relevant technical data respecting specifications for solid wastes.

[41] This is a narrow inquiry. I understand that according to the dictionary anything that burns is a fuel –but most people would not consider a $20 bill as "fuel." I also understand that there are a number of facilities that burn wastes (including agricultural waste, municipal waste and, yes, coal waste) to make electricity.

- Review EPA BIF rulemaking, “sham recycling” materials and other criteria for establishing whether a material is considered a fuel or a waste.

Additional References http://www.fwc.com/publications/tech_papers/files/TP_CCS_07_04.pdf
http://www.fwc.com/publications/tech_papers/files/TP_CFB_07_08.pdf
http://www.fwc.com/publications/tech_papers/getpapers.cfm?cat=3
http://www.fosterwheeler.com/publications/tech_papers/files/TP_CFB_02_02.pdf
http://www.fwc.com/publications/tech_papers/files/TP_PC_07_01.pdf
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http://www.gasification.org/Docs/News/2006/EPA%20-%20IGCC%20cf%20PC.pdf
http://www.ucsusa.org/clean_energy/renewable_energy_basics/offmen-how-biomass-energy-works.html
http://www.gasification.org/Docs/Workshops/2006/Bismarck%2006/06Jenkins.pdf
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http://www.sourcewatch.org/index.php?title=Coal_plants_cancelled_in_2007#List_of_Cancelled_or_Shelved_Plants%20
http://www.treepower.org/cofiring/main.html
http://www.ucsusa.org/assets/documents/clean_energy/cofiring.pdf
http://puc.sd.gov/commission/dockets/electric/2006/el06-018/endrizzi.pdf
http://www.etapro.com/clients/case_studies/rankine.asp
http://www.powerthefuture.net/projects/ocpp.htm
http://www.we-energies.com/home/OakCreek.pdf
http://www.jsonline.com/story/index.aspx?id=279557
http://iea.org/Textbase/work/2004/zets/apec/presentations/zongrang.pdf