Virginia City Hybrid Energy Center
Response to Data Request
Bruce Buckheit, Member, Virginia Air Pollution Control Board

Question (Page No. 2):

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[1]." There has been substantial 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[2] that has not been cleaned. If coal cleaning[3] is merely a "control technique" that the agency may or must[4] 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.

[1] "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."

[2] 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.

[3] 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.

[4] 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.

Response:

Dominion understands the comment to request information about the benefits of coal washing in the context of the VCHEC. Additionally, consideration of a BACT analysis for coal washing is requested.[1] We note that Dominion would not wash coal on-site due to the lack of available water (VCHEC incorporates dry cooling due to lack of water) and there is inadequate suitable space for coal cleaning facilities and associated retention infrastructure. Additionally, fuel cleaning typically occurs at the mouth of, or adjacent to, the coal mine to minimize handling issues and transportation costs. Thus, Dominion would purchase washed run of mine (ROM) coal instead of operating a coal cleaning facility on site. An analysis of using washed coal is provided below. Please note that Dominion provided an analysis of alternative coals in its submittal to the Board on March 6, 2008. This information is summarized in Section B below.[2]

A. Coal Washing Analysis

VCHEC's design is based on using locally available fuels—a blend of (ROM) coal, waste coal and biomass, which can only be burned by a CFB boiler. Of these proposed fuels, only ROM coal would be washed. Waste coal is the product of washing ROM coal, so the impurities that will be removed by washing have already been removed. Preprocessing of biomass does not reduce impurities in the feedstock.

Coal washing typically removes impurities from the run of mine coal such as ash, sulfur and metals by using the specific gravity differences between the coal and the impurities being removed. In order to separate the impurities from the coal, it is first crushed followed by washing, using the relative density of coal and rock to separate them. The amount of reduction achieved depends on the chemical nature of the impurity. In some cases, coal washing will not significantly reduce the unwanted impurities.

Sulfur is present in coal in two forms, elemental and pyritic. Elemental sulfur has a specific gravity similar to coal so is not readily removed by coal washing. Pyritic sulfur,

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[1] See Attachment 7 to Dominion's March 6, 2008 submittal to DEQ for additional information.

[2] The presence of the term "clean fuels" in the BACT definition does not mean that such fuels are required in each case. Congress added the reference to "clean fuels" to the BACT definition in 1990, with the intent that the "cleanliness" of the fuel proposed by the applicant be considered in the BACT analysis. Congress did not intend the BACT analysis to require a fuel other than that proposed by the applicant. S. Rep. No. 101-228, at 338 (1989); *reprinted in 5 A Legislative History of the Clean Air Act Amendments of 1990*, 103rd Cong., 1st Sess., S. Prt. No. 103-38, at 8678 (1993) ("The Administrator may consider the use of clean fuels to meet BACT requirements if a permit applicant proposes to meet such requirements by using clean fuel. In no case is the Administrator compelled to require mandatory use of clean fuels by a permit applicant.)

however, has a higher specific gravity than coal and is easier to remove. The pyritic sulfur content of southwest Virginia coal typically is less than in other coal regions (e.g., Northern Appalachian and Illinois basin) so coal washing of southwest Virginia coal will result in less sulfur reduction than washing of other coals. Washing of southwest Virginia coal will increase sulfur on a percent by weight basis and have little impact on the lbs per mmBtu content. In contrast, the sulfur reductions from coal washing Northern Appalachian or Illinois basin coal will be higher. Based on the form of sulfur found in southwest Virginia coals, coal washing would not be as effective at removing SO_2 as the CFB and dry scrubber control technologies proposed for the VCHEC (Attachment 1).

Dominion's understanding is that washing of Virginia coal may reduce its mercury content by 5-30% (depending on the seam, mining technology, size distribution, differences in specific gravity, etc.). The reason that washing can reduce mercury at all is that some of the mercury present in ROM coal is bound in the rock (rock mercury) that is separated from coal during washing. Mercury that is contained in the structure of the coal itself is not affected by washing. Please note that BACT is not required for mercury.

Coal washing also results in additional non-air quality environmental impacts as a result of the waste coal piles generated. One of the goals of VCHEC is to build a CFB which can burn waste coal or "gob". According to the Virginia Department of Mines, Minerals and Energy; there are currently hundreds of waste coal piles in southwest Virginia. These waste coal piles pose environmental risks of water quality degradation, as well as potential fire hazards. Run off from coal waste piles causes water pollution in the form of sedimentation of streams. Appalachian Technical Services (ATS) conducted a study of the water quality impacts from these waste coal sites and it is our understanding that the sediment loading from just one of these sites is contributing over 17,000 pounds per acre of sediment loading annually since the waste coal was deposited on the surface. This is just an example of one waste coal site. There have been significant comments in support of the VCHEC, because it will facilitate the use of waste coal piles in the region reducing sediment loading to streams and tributaries. See response to comment number 7 for a further discussion from ATS as well as the Department of Mines Minerals and Energy of the environmental benefits of waste coal reclamation on the Clinch River. Coal washing does not alter the overall amount of ash material placed into the environment. It only changes its form; coal washing leaves the "ash" material in GOB piles at the prep plant; burning ROM coal places the ash in a state of the art landfill. Moreover, coal processing requires additional water in an area that is already constrained. Using ROM coal rather than processed coal is consistent with VCHEC's commitment to minimize water consumption related to its operations (as evidenced by the use of air-cooled rather than water-cooled condensers).

In addition, these unreclaimed waste coal piles pose air quality problems if they ignite spontaneously. When a waste coal pile catches fire, uncontrolled emissions of sulfur dioxide, particulates, nitrogen oxides and mercury are released into the environment. Combusting the waste coal piles utilizing well-controlled, clean coal technology will reduce the potential for significant air emissions should these unreclaimed waste coal piles catch fire accidentally.

As mentioned above, coal washing would require additional water, which is constrained in the area. Coal washing also potentially results in adverse energy impacts. Processing coal requires energy expenditures to operate the prep plant, to transport the coal to the prep plant, and to transport the washed coal from the prep plant to the power plant. Not only is substantial energy required to process the coal, about 15 to 20% of the coal mined ends up as coarse and fine coal waste. To recover the energy in that coal waste a CFB is required. It is possible to estimate the energy in the carbon bearing materials that would be disposed of during coal processing. As an example, research conducted by Miltech Energy Services, Inc. at the Moss 3 mine waste coal piles indicate that there is about a 50% yield in converting ROM coals (~7,000 Btu/lbs) to higher grade processed coal having a heat content of approximately 12,000 Btu/lb. Coal processing refuse consists of 85% coarse coal, refuse containing about 2,000 Btu/lb and about 15% fine coal refuse containing about 4,000 Btu/lb. Therefore:

ROM Btu/lb = (0.50 x 12,000 Btu/lb) + (0.50 x 0.85 x 2,000 Btu/lb) + (0.50 x 0.15 x 4,000 Btu/lb) = 7,150 Btu / lb

ROM Btu Recovery % = (7,150 Btu/lb - 12,000 Btu/lb x 0.5) / (7,150 Btu/lb) x100 = 16%

Based on the data from Moss 3, this example shows that about 16% of the heat content contained in the ROM coal is lost in the coal cleaning process to refuse piles. This same heat content could be recovered to produce electricity by a CFB combusting the 7,150 Btu/lb ROM coal.

Dominion does not have any specific data regarding the cost of washing ROM coal and the actual reduction in sulfur content and other impurities. Processed Central Appalachian (CAPP) coal will be used as a surrogate for washed ROM coal in the economic analysis. We assumed the uncontrolled lb/mmBtu of SO2 would be reduced from 5.86 to 1.2 by using washed CAPP coal and that an additional 98 percent removed would be achieved by the CFB and dry scrubber technology. Because the draft VCHEC permit has short term SO2 limits (3-hour and 24-hour), it is appropriate to look at the effect of coal washing in its maximum design sulfur content. The following table provides the fuel characteristics assumed in the coal washing cost analysis. We used the maximum sulfur content of 2.28% for the ROM to conservatively determine the reduction in SO_2 emissions if CAPP were used instead.

Fuel	Heating Value (Btu/lb)	Sulfur (%)	Sulfur (lb SO_2/mmBtu)	Delivered Cost ($/ton)
ROM	7,782	2.28	5.86	$48.05
CAPP	12,500	0.75	1.2	$109.52

Based on the characteristics of the ROM and CAPP fuels, the heat input of each boiler of 6,264 mmBtu/hr and the cost of each fuel per ton delivered, the annual cost can be determined on a per boiler basis.

Fuel	Coal Usage (tons/year)	Annual Cost ($)	Incremental Cost ($)
ROM	3,525,613	$169,405,705	Base
CAPP	2,194,906	$240,386,105	$70,980,400

NOTE – The annual costs were calculated from an excel spreadsheet. There will be small differences due to rounding.

As shown in the table, the fuel cost would increase by $70,980,400 per year if washed coal (CAPP) was used instead of ROM. Expected emissions reductions per pollutant are shown below. As shown, washing the coal only reduces the SO_2 and H_2S0_4 criteria pollutant emissions. Emissions of NO_x, CO and PM_{10} are not reduced on a lb/mmBtu basis. The washed coal value was assumed to be equivalent to the lowest SO_2 BACT level for the purposes of this demonstration. Reductions in coal sulfur content do not necessarily translate into lower SO_2 emissions.

Pollutant	Proposed Limit (lb/mmBtu)	Washed Coal (lb/mmBtu)	Annual Reduction (tons/year)
NO_x	0.07	0.07	--
SO_2	0.12	0.022	2,689
CO	0.15	0.15	--
H_2SO_4	0.005	0.0024	71
PM_{10}	0.012	0.012	--

Using the annual emission reductions and the incremental cost to use washed coal, the cost per ton of pollutant removed can be determined as shown in the following table.

Pollutant	Potential Emission Reduction (Alternative Coal vs. Design Fuel)	Cost ($/ton)
NO_x	0	--
SO_2	2,689	$26,399
CO	0	--
H_2SO_4	71	$999,801
PM_{10} (total)	0	--
All (sum)	2,760	$25,720

NOTE – The annual costs were calculated from an excel spreadsheet. There will be small differences due to rounding.

As noted above, the use of the 2.28% design sulfur content is conservative. The target average sulfur content of the ROM coal is 1% sulfur or 2.57 lb SO_2/mmBtu. If that sulfur content is used in the analysis, the incremental cost per ton of SO_2 removed would increase to $94,389,

Based on the above discussion, coal washing would not be considered cost effective for reducing criteria pollutants.

Dominion conducted the following control cost analysis for mercury removal on the basis of coal washing. The analysis is based on a comparison of the design coal which is 7,782 Btu/lb and a typical washed coal of 12,500 Btu/lb, and assuming a 0.3511 ppm mercury content (basis for the proposed limit of 49.46 lbs/yr) for the design coal and 0.2458 ppm mercury content (30% reduction from 0.3511) for the washed coal.

VCHEC Coal	Parameter	Washed Coal
7,782	Coal Heat Content (Btu/lb)	12,500
6,264	Boiler Rating (mmBtu/hr)	6264
3,525,613	Potential Annual Coal Consumption (tons)	2,194,906
0.3511	Coal Mercury Content (ppm)	0.2458
98.00%	Mercury Removal Efficiency	98.00%
2,476	Uncontrolled Mercury Emissions (lbs/yr)	1,079
49.5	Controlled Mercury Emissions (lbs/yr)	21.6
2,426	Mercury Removed (lbs/yr	1,057
$48.05	Cost of Coal ($/ton)	$109.52
$169,405,705	Annual Fuel Cost ($)	$240,386,105
$69,829	Average Cost of Mercury Removal ($/lb)	$227,423
	Incremental Cost of Mercury Removal ($/lb)	$2,544,100

As shown in the table, the cost of mercury removal for the washed coal scenario is $227,000/lb compared to less than $70,000/lb for the proposed VCHEC blend. Making the assumption that lowering the mercury concentration in the coal would have a direct relationship to lower mercury emissions, the cost to reduce controlled emissions from 49.5 lbs/yr to 21.6 lbs/yr goes to over $2.5 million/lb of mercury removed. $227,000/lb and $2.5 million/lb far exceed the commonly used benchmark of $35,000/lb.

B. Analysis of Alternative Coals

Dominion is also providing a cost effectiveness analysis evaluating the use of alternative clean fuels. Dominion identified washed Central Appalachian (CAPP) coal, Powder River Basin (PRB) coal, Indonesian sub-bituminous coal and South American bituminous coal. The cost of CAPP coal is discussed above in the coal washing analysis. The characteristics of the design ROM fuel and alternative fuels are as follows (based on the information provided in the March 6 Attachment 3, Exhibit 7):

Fuel	Heating Value (Btu/lb)	Sulfur (lb SO_2/mmBtu)	Delivered Cost ($/ton)
CAPP	12,500	1.2	$109.52
Design ROM	7,782	5.86	$48.05
Indonesian	9,400	0.191	$175

PRB	8,800	0.795	$81
South American	11,300	1.204	$166

Based on the characteristics of the alternative fuels, the heat input of the facility is 6,264 mmBtu/hr and the cost of each fuel per ton delivered, the annual cost of switching from the design fuel to an alternative fuel can be determined.

Fuel	Coal Usage (tons/year)	Annual Cost ($)	Incremental Cost ($)
CAPP	2,194,906	$240,386,105	$70,985,859
Design ROM	3,525,613	$169,405,705	Base
Indonesian	2,918,757	$510,782,553	$341,376,848
PRB	3,117,764	$252,538,884	$83,133,179
South American	2,427,993	$403,046,825	$233,641,120

The following table shows the potential emission reductions as a result of using a different fuel assuming emissions are reduced from the draft permit allowables down to the lowest BACT determination Dominion is aware of for any CFB boiler[3] with the exception of CO emissions as it is unlikely that using different grades of coal would significantly affect CO emissions. The analysis focuses on Central Appalachian coal because it is the least cost of the various alternative fuels considered and results in the lowest incremental cost.

Potential Emission Reductions from Fuel Switching

Pollutant	Proposed Limit (lb/mmBtu)	Lowest BACT (lb/mmBtu)	Annual Reduction (tons/year)
NO_x	0.07	0.07	--
SO_2	0.12	0.022	2,689
CO	0.15	0.15	--
H_2SO_4	0.005	0.0024	71
PM_{10}	0.012	0.012	--

Based on the calculated cost for the design ROM and PRB coal and the emission reductions described above, the cost estimates, in dollars per ton of additional pollutant removed annually can be calculated. The results are shown in the following table.

Annualized Cost of Potential Emissions Reductions
Due to Fuel Switching

[3] The cost analysis provided in Attachment 3, Exhibit 7 of the March 6, 2008 submittal to DEQ analyzed the cost associated with reducing SO_2 emissions only. That analysis assumed that 98% SO_2 reduction could be achieved for the various alternative fuels and concluded that the alternative fuels were cost prohibitive for VCHEC.

Pollutant	Potential Emission Reduction (Alternative Coal vs. Design Fuel)	Cost ($/ton)
NO_x	0	--
SO_2	2,689	$26,399
CO	--	--
H_2SO_4	71	$999,801
PM_{10} (total)	0	--

It is not clear that a switch in fuel would actually result in a decrease in CO as discussed in the response to comment 38. It is also possible that coal washing will increase the heat content of the fuel resulting in higher bed temperatures and higher thermal NOx.

Based on the above cost analysis, Dominion concluded that use of an alternative clean fuel would be cost prohibitive as a BACT option.