NPS Comments on Best Available Retrofit Technology (BART) Analysis of Control Options for Public Service Company (PSCo) – Hayden Station
November 15, 2010

The facility is located four miles east of Hayden in Routt County, and consists of two BART-eligible boilers. Unit #1 is rated at 190 MW and is dry-bottom, wall-fired. Unit #2 is rated at 275 MW and is tangentially-fired. The Hayden boilers burn Colorado coal that primarily comes from two different mines in northwestern Colorado, the Twenty Mile Mine and the ColoWyo Mine. Coal characteristics are very similar from both of these mines. ColoWyo coal is ranked as sub-bituminous while the Twenty Mile coal is ranked as bituminous. According to CDPHE, PSCo performed an analysis to demonstrate that the more appropriate rating for ColoWyo coal is bituminous.

Remaining Useful Life

PSCo asserts that the remaining useful life of Hayden Units 1 and 2 are each in excess of 20 year, which is the maximum amortization period allowed in the BART analysis. Thus, this factor does not influence the selection of controls.

Sulfur Dioxide (SO_2)

Hayden installed Lime Spray Dryers (LSDs) in connection with baghouses on Hayden Units 1 and 2 in 1998 and 1999, respectively. EPA's BART Guidelines for electric generating units (EGUs) with existing controls achieving removal efficiencies of greater than 50% recommend that one should evaluate scrubber upgrades. We commend CDPHE for the evaluation of several options, but note that the baseline emission rate calculation by CDPHE applies AP-42 incorrectly. Instead, it would be more appropriate to use actual pre-scrubber emissions, which, for 1995 – 1997, averaged 0.764 and 0.659 lb/mmBtu for Units #1 & #2, respectively. Compared to those uncontrolled emission rates, it appears that the current scrubber configurations would need to achieve 83% and 80% for Units #1 & #2, respectively, to meet the proposed BART limit. These levels of control are well within the capabilities of modern LSD systems, and we question whether the Hayden scrubbers are currently being utilized to their fullest capabilities. We would typically expect a modern LSD to remove at least 90% of the uncontrolled emissions, in this case achieving about 0.07 – 0.08 lb/mmBtu.

The only option fully evaluated by CDPHE that would achieve 0.07 lb/mmBtu is addition of a scrubber module to each unit. (We suggest that CDPHE investigate addition of one module to be shared by the two boilers.) According to CDPHE, "PSCo provided to the Division upon additional request (July 14, 2010) additional information stating that an additional scrubber module (i.e. atomizer) would be required for each unit as well as additional spare parts and maintenance personnel in order to meet a lower emission limit." Because no information was provided to support the PSCo cost estimates, we must accept them at face value for now. Based upon the annual cost of $4.1 million and the estimated 0.14 dv improvement at Rocky Mountain National Park, the cost-effectiveness

of adding a scrubber module to Hayden #1 is $29.2 million/dv. Likewise, the annual cost at Hayden #2 is $4.8 million and the 0.26 dv improvement yields a cost-effectiveness of $18.5 million/dv. Compared to the $14 - $18 million/dv average cost-per-deciview of improvement proposed by states and sources, as well as the $27.5 million/dv proposed by CDPHE for LSD on Drake #6, adding a module to Hayden #2 is quite reasonable. And, if the benefits of improving visibility at the other Class I areas had been considered, it is likely that the cost-effectiveness of adding a module to both Hayden units would have been much more favorable.

A more thorough analysis of the costs of adding scrubber modules and the benefits to all of the Class I areas currently impacted by Hayden is likely to lead to cost-effectiveness results that are comparable to those accepted by other states, and by Colorado. However, we believe that it may well be possible for Hayden to meet a 0.07 lb/mmBtu limit with the existing equipment, and suggest that CDPHE not specify how such a limit should be met.

Filterable Particulate Matter (PM_{10})

CDPHE: Based on recent BACT determinations, the state has determined that the existing Unit 1 and Unit 2 reverse-air fabric filter baghouses and emission limit of 0.03 lb/MMBtu (PM/PM_{10}) represents the most stringent level of available control for PM/PM_{10}.

NPS: CDPHE's conclusion is valid only if it is referring to total PM_{10}. Recent BACT decisions have consistently limited filterable PM_{10} to 0.010 – 0.015 lb/mmBtu, and total PM_{10} to the 0.030 lb/mmBtu cited by CDPHE. Furthermore, the Hayden stack test results clearly show that the current baghouse are limiting filterable PM_{10} 0.004 – 0.006 lb/mmBtu. BART should reflect the true capabilities of the Hayden baghouses.

Nitrogen Oxide (NO_x)

CDPHE: SCR: PSCo stated in their April 20, 2010 submittal that Hayden Units 1 and 2 can meet a 30-day rolling limit of 0.08 lb/MMBtu and 0.07 lb/MMBtu respectively by installing SCR on each boiler. Therefore, the control effectiveness for SCR on Unit 1 is 83.2% and Unit 2 is 81.0%. These control efficiencies are consistent with EPA's AP-42 emission factor tables, which estimate SCR as achieving 75 – 85% NO_x emission reductions and also with a recent AWMA study citing SCR as achieving 80 – 90% reduction.

NPS: While we commend PSCo and CDPHE for proposing SCR, operational evidence from SCR retrofits on eastern EGUs (see our general comments) clearly indicates that SCR on boilers similar to those at Hayden can achieve 0.05 lb/mmBtu or lower on an annual basis. (The "recent" studies cited by CDPHE are vintage 1998 and 2005, and do not reflect current capabilities of SCR.) For example, we found eight dry-bottom boilers and 12 tangentially-fired boilers operating at or below 0.05 lb/mmBtu in 2009.

CDPHE has assumed that 30-day rolling average SCR emissions would be 0.01

lb/mmBtu higher than the corresponding annual average emission rate, and we agree. We looked at monthly data for 28 EGUs with SCR's operating at or below 0.05 lb/mmBtu on an annual average (see our general comments) and found that, of the 228 months of data, 214 were at or below 0.06 lb/mmBtu. When we looked at wall-fired EGUs, we found that 73 of 77 were at or below 0.06 lb/mmBtu. For tangentially-fired EGUs, we found that 84 of 89 were at or below 0.06 lb/mmBtu. We conclude that SCR at Hayden can achieve 0.05 lb/mmBtu on an annual basis and 0.06 lb/mmBtu on a 30-day rolling average basis.

CDPHE: SCR: Recent NESCAUM studies estimate SCR retrofits on tangentially fired boilers achieving NO_x emission rates of 0.10 – 0.15 lb/MMBtu and emission reductions of 75 – 85% as costing $2,600 - $5,000 per ton of NO_x reduced, depending on initial capital costs and capacity factor. In reviewing PSCo's estimates, the Division found that the ratio of annual costs to the total costs for LNBs, which at 17% is higher than an EPA assessment that concluded that other facilities in Arizona, New Mexico, and Oregon presented annual costs that ranged from 12 – 15% of total capital investments. However, PSCo's cost estimates are within the NESCAUM study ranges, so the Division concludes that PSCo's cost estimates for SCR are reasonable.

NPS: Because annual costs are strongly related to the amount of NOx to be removed, we instead prefer methods established by the EPA Control Cost Manual (Cost Manual).We are providing information from electric utility industry studies that shows that the Total Capital Investment (TCI) costs for adding SCR to utility boilers larger than 100 MW are less than $300/kW, with most costing around $200/kW. Our review of the SCR cost estimates provided by CDPHE leads us believe that TCI costs of $325 and $265/kW for units #1 and #2, respectively, are overestimated. Specifically, TCI costs are overestimated when compared to the Cost Manual's 1.41:1 ratio of TCI to Total Direct Cost. And, when we apply the Cost Manual method to estimate Direct and Indirect Annual costs, we see much greater evidence that these critical annual costs have been overestimated. Therefore, we are providing SCR cost estimates summarized below **(and provided in Appendix Hayden SCR)** based upon methods described by the Cost Manual.

SCR Cost-benefit Analysis

Unit	1	**2**	
Control Efficiency	88%	85%	OAQPS Control Cost Manual
Controlled emissions (lb/mmBtu)	0.05	0.05	calculated
Controlled Emissions (tpy)	478	620	calculated
Emissions Reduction (tpy)	3,608	3,605	OAQPS Control Cost Manual
Capital Cost	$ 45,758,888	$ 52,759,780	OAQPS Control Cost Manual
Capital Cost ($/kW)	$ 241	$ 192	calculated
Annualized Cost	$ 6,102,434	$ 7,012,786	OAQPS Control Cost Manual
Cost-Effectiveness ($/ton)	$ 1,691	$ 1,945	OAQPS Control Cost Manual

Application of the Cost Manual methods shows that SCR can reduce NO_X emissions at $1,700 - $2,000/ton, which is much less than the $3,400 - $4,100/ton estimated by CDPHE.

Step 5: Evaluate Visibility Results

CDPHE Table 20 indicates that SCR can improve visibility at Mt. Zirkel by 1.12 dv (Unit #1) and 0.85 dv (Unit #2). This does not include visibility benefits at other Class I areas impacted by Hayden.

Step 6: Select BART Control

CDPHE: Based upon its consideration of the five factors summarized herein, the state has determined that NO_x BART is selective catalytic reduction controls at the following NO_x emission rates:
Hayden Unit 1: 0.08 lb/MMBtu (30-day rolling average)
Hayden Unit 2: 0.07 lb/MMBtu (30-day rolling average)

For SCR, the cost per ton of emissions removed, coupled with the estimated visibility improvements gained, falls within the guidance criteria presented in Chapter 6 of the Regional Haze State Implementation Plan.

- Unit 1: $3,385 per ton NO_x removed; 1.12 deciview of improvement
- Unit 2: $4,064 per ton NO_x removed; 0.85 deciview of improvement

The dollars per ton control costs, coupled with notable visibility improvements leads the state to this determination. The NO_x emission limits of 0.08 lb/MMBtu (30-day rolling average) for Unit 1; and 0.07 lb/MMBtu (30-day rolling average) for Unit 2; are technically feasible and have been determined to be BART for Hayden Units 1 and 2.

NPS: We commend CDPHE for its determination that SCR represents BART at Hayden, and note that it has estimated the cost-effectiveness of its proposed SCR at $9.5 million/dv for Unit #1 and $14.4 million /dv for Unit #2, consistent with the $14 - $18 million/dv average cost-per-deciview of improvement proposed by states and sources. However, we have shown that SCR can provide greater NO_X reductions and at lower costs than assumed by CDPHE. We recommend that both Hayden units meet limits not to exceed 0.06 lb/mmBtu on a 30-day rolling average basis.