SANTEE COOPER

CASE-BY-CASE MACT PERMIT APPLICATION

PROPOSED PEE DEE COAL-FIRED FACILITY

RECEIVED
JUN 30 2008
BUREAU OF
AIR QUALITY

Submitted to:
South Carolina Department
of Health and Environmental Control
June 30, 2008

TABLE OF CONTENTS

1.0 Introduction 1

2.0 Applicability of Case-By-Case MACT Requirement 2

3.0 Framework for Setting Case-By-Case MACT Standards 3

3.1 Definition of MACT 3
3.2 Two-Part Methodology for Case-by-Case MACT Determination 4
3.3 Form of the MACT Standard 5
3.4 Use of Surrogates for Regulating Non-Mercury HAPs 6
3.5 Consideration of 2004 Utility MACT Proposal 8
4.0 Requirements for MACT-Floor Analysis 10

4.1 Subcategorization 11
4.1.1 Broad Authority for Subcategorization 12
4.1.2 EPA's Past Practice on Subcategorization 13
4.1.3 Classification of the Pee Dee Facility 15
4.1.3.1 Coal Type: Bituminous 16
4.1.3.2 Process Type: Pulverized Coal Boiler 17
4.2 Accounting for Variability 20
5.0 Requirements for the "Beyond-the-Floor" Analysis 25

5.1 Determination of Maximum Emission Reduction Achievable 25
5.2 Application of Three-Factor Test 26
5.2.1 Cost 26
5.2.2 Non-Air Health and Environmental Impacts 27
5.2.3 Energy Requirements 28
5.3 Consideration of Available Information 28
6.0 MACT Determination for Mercury 29

6.1 MACT Floor Analysis 30
6.1.1 Determining Which Sources Are Similar to the Pee Dee Facility 30
6.1.2 Identifying Candidates for Best Controlled Similar Source 34
6.1.3 Developing Reasonable Estimates of Performance 37
6.1.4 Selecting the Best Controlled Similar Source and Setting the MACT Floor Emission Rate 40
6.1.5 Assessment of Mercury Emissions Data for the Cross Units 40
6.2 Beyond-the-Floor Analysis 41
6.2.1 Estimation of Mercury Reductions by Proposed Control Technologies 41
6.2.2 Identification of Potential Control Technologies 44
6.2.3 Evaluation of Sorbent Injection 45
6.2.4 Evaluation of Non-Thermal Plasma 50
6.2.5 Summary of BTF Determinations 51
7.0 MACT Determination for Non-Mercury Metal HAPs 51

8.0 MACT Determination for Acid Gas HAPs 52

9.0 MACT Determination for Organic HAPs 54

TABLE OF APPENDICES

Appendix A:
Estimates of Potential HAPs Emitted from the Pee Dee Facility 59
Appendix B:
Differences Between FBC and PC Power Plants That Are Relevant To
Mercury Emissions 61
Appendix C:
Information Sources Reviewed for Case-by-Case MACT Determination
for the Proposed Pee Dee Facility 65
Appendix D:
Sample Calculations for Variability Analyses for the Mercury MACT Floor 72
Appendix E:
Beyond the Floor Cost Analysis for Controlling Mercury By Sorbent
Injection Technology 79
Appendix F:
Application Requirements for a Case-By-Case MACT Analysis 81

TABLE OF ACRONYMS

BACT:	Best Available Control Technology
BTF:	Beyond-the-floor
CAA:	Clean Air Act
CAMR:	Clean Air Mercury Rule
CEMS:	Continuous Emissions Monitoring
DHEC:	Department of Health and Environmental Control
DOE:	Department of Energy
ECO:	Electro catalytic oxidation
EPA:	Environmental Protection Agency
ESP:	Electrostatic precipitators
FBC:	Fluidized bed combustor
FGD:	Flue gas desulfurization
HAP:	Hazardous air pollutant
ICR:	Information Collection Request
IGCC:	Integrated gasification combined cycle
MACT:	Maximum achievable control technology
NACAA:	National Association of Clear Air Agencies
NSPS:	New Source Performance Standards
PC:	Pulverized coal
PSD:	Prevention of Significant Determination
RBLC:	RACT/BACT/LAER Clearinghouse
SCPC:	Supercritical pulverized coal
SCR:	Selective catalytic reduction
tpy:	tons per year
TRI:	Toxic Release Inventory

CASE-BY-CASE MACT PERMIT APPLICATION
PROPOSED PEE DEE COAL-FIRED FACILITY

1.0 Introduction

South Carolina Public Service Authority (Santee Cooper) is submitting this application for a case-by-case maximum achievable control technology (MACT) determination for the proposed Pee Dee facility (referred to as "MACT Permit Application) pursuant to SC Regulation 61-62.63 and section 112(g) of the Clean Air Act (CAA or Act). The proposed Pee Dee facility will consist of two identical coal-fired supercritical pulverized coal (SCPC) boilers, each having a maximum heat input capacity of 5,700 MMBtu/hour and a gross electrical capacity of 660 MW. Both SCPC boilers will burn a range of eastern bituminous coals that have a sulfur content of up to 3.5%, along with petroleum coke in quantities up to 30% by weight. The proposed facility will be located near Kingsburg, South Carolina and is necessary to meet increasing electricity demand in the coastal areas of South Carolina served by Santee Cooper and the electric cooperatives of South Carolina.

Santee Cooper submitted an application for a Prevention of Significant Determination (PSD) permit to construct the proposed Pee Dee facility in June 2006. After extensive public outreach, including multiple public meetings, on the details of the proposed facility, South Carolina Department of Health and Environmental Control (DHEC) issued a draft PSD permit on October 9, 2007. DHEC also provided an extended public comment period, which ended on January 22, 2008 and provided approximately 3 ½ months for interested parties to submit written comments on the draft PSD permit for the proposed Pee Dee facility.

The PSD application for the Pee Dee facility proposed to equip the two SCPC boilers with state-of-the-art air pollution control technology to minimize potential emissions of both criteria air pollutants and hazardous air pollutants (HAPs). These state-of-the-art

control technologies included low-NO_x burners, a two-level separated overfire air system, a selective catalytic reduction (SCR) system, a wet limestone flue gas desulfurization (FGD) system, and electrostatic precipitators (ESPs). In an effort to enhance and maximize the control of mercury and other HAP emissions from the two Pee Dee boilers, Santee Cooper is now proposing to employ a fabric filter, instead of an ESP, pursuant to the case-by-case MACT analysis presented in this MACT Permit Application. Each of the Pee Dee boilers will be equipped with a fabric filter, in lieu of the originally planned ESP.

2.0 Applicability of Case-By-Case MACT Requirement

On February 8, 2008, after the close of the public comment period on the draft PSD permit for the Pee Dee facility, the United States Court of Appeals for the District of Columbia Circuit issued a decision vacating and remanding the final Clean Air Mercury Rule (CAMR) to the U.S. Environmental Protection Agency (EPA). Among other things, CAMR established stringent new source performance standards (NSPS) for limiting mercury emissions from new coal-fired electric utility boilers pursuant to section 111 of the CAA. Although the appeal process has not yet been completed, the court's decision to vacate CAMR potentially could have important permitting implications for the proposed Pee Dee facility. Specifically, the court's decision – if upheld – could make the NSPS requirements for mercury no longer applicable and, instead, may subject the Pee Dee facility to case-by-case MACT requirements under section 112(g) of the Act. In light of these implications and in an effort to expedite the permitting process,[1] Santee Cooper is submitting this application for a case-by-case MACT determination for mercury and other appropriate HAPs in accordance with SC Regulation 61-62.63 and section 112(g) of the CAA.

[1] By submitting a case-by-case MACT application for the proposed Pee Dee facility, Santee Cooper is not conceding the applicability of section 112(g) of the CAA to the Pee Dee facility. The extent and manner that mercury and other HAPs may be regulated under section 112 remain uncertain until there is final court disposition and, if appropriate, EPA issues guidance on the implementation of such requirements.

3.0 Framework for Setting Case-By-Case MACT Standards

A brief review of the applicable requirements for DHEC setting case-by-case MACT standards under section 112(g) of the Act is presented below. Where appropriate, Santee Cooper provides a description on how these requirements were applied in performing the case-by-case MACT analysis for the proposed Pee Dee facility.

3.1 Definition of MACT

South Carolina regulations contain the following definition of MACT for new sources:

> "Maximum achievable control technology (MACT) emission limitation for new sources" means the emission limitation which is not less stringent than the emission limitation achieved in practice by the best controlled similar source, and which reflects the maximum degree of reduction in emissions that the Department, taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements, determines is achievable by the constructed or reconstructed major source.[2]

This definition is substantially identical to the federal provisions that are set forth in the section 112(d) of the CAA and codified into federal regulations by U.S. EPA.[3] Notably, the same MACT definition applies in two related, but distinct, regulatory contexts for controlling HAP emissions. The first is the generic nationwide MACT standards that EPA must adopt pursuant to section 112(d) of the CAA. EPA is required to adopt such generic standards for every listed major source category of HAP emissions pursuant to notice and comment rulemaking. The second is case-by-case MACT standards that permitting authorities must adopt for a proposed new (or reconstructed) major source of HAP emissions pursuant to section 112(g) of the CAA. Permitting authorities are required to adopt such case-by-case standards in those instances when EPA has not yet established a generic MACT standard that applies to the proposed new (or reconstructed) source.[4] This latter case-by-case permitting review is the regulatory context that potentially applies to the Pee Dee facility and is addressed pursuant to this submittal.

---

[2] SC Regulation 61-62.63, Section 63.41.
[3] 40 C.F.R. §63.41(corresponding federal regulatory definition).
[4] Section 112(j) of the CAA also requires permitting authorities to adopt case-by-case MACT standards for existing major sources of HAP emissions in those cases in which EPA has failed to promulgate generic MACT standards for the source category in accordance with prescribed time frames.

3.2 Two-Part Methodology for Case-by-Case MACT Determination

South Carolina regulations adopt the two-step federal framework for setting MACT standards under section 112(g) of the Act. The first step entails DHEC making a determination on minimum emission control level below which the MACT standard may not fall. This minimum control level is referred to as the "MACT floor." In the case of a new source like the proposed Pee Dee facility, both the CAA and South Carolina regulations require that the MACT floor level be based on "the emission control that is achieved in practice by the best controlled similar source."[5] A discussion of key requirements for setting the MACT floor is presented in Section 4 of the MACT Permit Application. This discussion includes an analysis of appropriate steps that DHEC should consider taking in exercising its permitting discretion in performing the MACT floor analysis for the Pee Dee facility.

The second step of the MACT standard-setting process is referred to as the "beyond-the-floor" (BTF) analysis. The BTF analysis entails an evaluation on whether it is appropriate to set a MACT standard that is more stringent that the applicable floor level of control determined under the first step. DHEC is authorized to set a MACT standard stricter than the applicable floor level based on an evaluation of available methods and technologies for further limiting emissions, as described in Section 5 of the MACT Permit Application.

Finally, Santee Cooper presents detailed case-by-case MACT determinations for mercury and other non-mercury HAPs that are potentially emitted from the proposed Pee Dee facility. MACT determinations are provided in this application for mercury in Section 6, non-mercury metal HAPs in Section 7, acid gas HAPs in Section 8, and organic HAPs in Section 9. Finally, Appendix F of the MACT Permit Application (attached hereto)

[5] Section 112(d)(3) of the CAA.

provides the general information that is required for a case-by-case MACT application, as prescribed by the South Carolina regulations.[6]

3.3 Form of the MACT Standard

DHEC has considerable discretion in selecting the format of case-by-case MACT standards established under section 112(g) of the Act. South Carolina regulations authorize DHEC to adopt a MACT performance standard that is a numeric emission limitation expressed in terms of either a maximum allowable emission rate or a minimum removal efficiency.[7] If such a performance standard is "not feasible to prescribe or enforce," DHEC also has authority to set "alternative limits," such as a "specific design, equipment, work practice, or operational standard, or a combination thereof."[8]

In the case of mercury, Santee Cooper proposes that DHEC select the "numeric emissions rate" format that EPA adopted for coal-fired boilers in the 2004 Utility MACT proposal.[9] The format in that instance was an output-based performance standard expressed in terms of lbs/MWh gross, based on a 12-month average.[10] Santee Cooper also proposes to adopt a numeric emissions rate format for non-mercury HAPs that are potentially emitted from the Pee Dee facility. Specifically, DHEC should adopt emissions rate limits that apply to PM_{10}, SO_2, and CO, as surrogates for non-mercury metal HAPs, acid gas HAPs (*i.e.*, collectively hydrogen chloride and hydrogen fluoride), and organic HAPs respectively. As discussed in greater detail in Section 3.4 and Section 7.0 of the MACT Permit Application, the surrogate rate limits should apply to filterable PM_{10} emissions based on a 3-hour average stack test, and SO_2 and CO based on a 30-day average of continuous emissions monitoring (CEMS) data.

---

[6] SC Regulation, 61-62.63, Section 63.43(e)(2). *See also* 40 C.F.R. § 63.439(e)(2) (corresponding federal application requirements for case-by-case MACT determinations).
[7] SC Regulation 61-62.63, Section 63.43(d).
[8] SC Regulation 61-62.63, Section 63.43(d).
[9] *Proposed National Emission Standards for Hazardous Air Pollutants; and in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units; Proposed Rule,* 69 Fed. Reg. 4.652 (January 30, 2004). As described in Section 3.5 of the MACT Permit Application, EPA proposed to adopt in 2004 generic MACT standards for new and existing electric utility steam generating units and this rulemaking proposal is commonly referred to as the 2004 Utility MACT proposal.
[10] 69 Fed. Reg. at 4,667-68.

3.4 Use of Surrogates for Regulating Non-Mercury HAPs

The 2004 Utility MACT rulemaking proposed to establish MACT standards only for mercury and not to regulate other non-mercury HAPs that are listed in section 112(b) of the Act.[11] Notably, EPA concluded – based on a thorough analysis of the statute and relevant legislative history – that MACT regulation of non-mercury HAPs was not "appropriate and necessary" pursuant to CAA section 112(n)(1)(A).[12] This determination in the 2004 Utility MACT proposal – at a minimum – leaves open the question of whether DHEC is required under federal CAA to adopt MACT standards for non-mercury HAPs emitted from the Pee Dee facility.

Notwithstanding this uncertainty, Santee Cooper has proposed MACT standards for non-mercury HAPs that are potentially emitted from the Pee Dee facility. These HAPs can be classified into three broad groups: non-mercury metal HAPs, acid gas HAPs, and organic HAPs. Table 1 below provides estimates of the annual maximum potential emissions from each of these three HAP groupings for each of Pee Dee units. Detailed estimates of individual non-mercury HAPs within each category are presented in Appendix A of the MACT Permit Application (attached hereto).

Table 1
Estimated Annual Non-Mercury HAP Emissions
(Each Pee Dee Boiler at Full Load and 8,760 Hours Per Year)

HAP Category	Potential Emissions (tons per year)
Non-Mercury Metal HAPs	3.4
Acid Gas HAPs	76.6
Organic HAPs	10.4

With respect to each of these HAP categories, DHEC has legal authority to use an appropriate surrogate to regulate HAPs under section 112 of the Act. Courts have repeatedly confirmed the use of surrogates in setting MACT standards "if it is reasonable

[11] 69 Fed. Reg. at 4,660.
[12] 69 Fed. Reg. at 4,659-61.

to do so."[13] Furthermore, the courts have provided clear guidance to DHEC on whether the use of surrogates is reasonable in setting MACT standards. In *National Lime Association v. EPA*, the D.C. Circuit ruled that PM is a reasonable surrogate for metal HAPs for the following reasons:

> The EPA contends, however, that it justified surrogacy adequately by demonstrating that "where this is cement kiln PM, HAP metals are always in it, and when cement kiln PM is removed from emissions, HAP metals are always with it." ... The agency's analysis is not unreasonable. If HAP metals are *invariably present* in cement kiln PM, then even if the ratio of metals to PM is *small and variable, or simply unknown*, PM is a reasonable surrogate for metals – assuming, as both EPA and the NLA appear to do, that PM control technology *indiscriminately captures HAP metals* along with other particulates. [14]

The D.C. Circuit in *Sierra Club v. EPA* has affirmed the ruling on the use of surrogates in *National Lime*. Notably, the court held the use of PM as a surrogate was reasonable given that EPA demonstrated "strong direct correlations ... between the emissions of total particulate matter and metal HAP compounds" and that the MACT "limits established to achieve good control of total particulate matter will also achieve good control of metal HAPs." [15]

Santee Cooper believes that the use of PM_{10} (filterable), SO_2, and CO, as surrogates is reasonable for non-mercury metal HAPs, acid gas HAPs, and organic HAPs respectively. In each case, the surrogate is closely tied to the respective HAP grouping. First, metal HAP compounds will invariably be a component of the PM emissions from the Pee Dee units. The same is true with the other two categories of non-mercury HAPs emitted from

---

[13] *Sierra Club v. EPA*, 353 F.3d 976, 982 (D.C. Cir. 2004) (herein referred to as *Sierra Club II*). *See National Lime Association v. EPA*, 233 F.3d 625, 637-40 (affirming the use of PM as a surrogate) (herein referred to as *National Lime*). *See also Dithiocarbamate Task Force v. EPA*, 98 F.3d 1394, 1399 (D.C. Cir. 1996) (holding that EPA may attribute characteristics of a subclass of substances to an entire class of substances if doing so is scientifically reasonable); *Natural Resources Defense Council v. EPA*, 822 F.2d 104, 125 (D.C. Cir. 1987) (holding that EPA may regulate a pollutant indirectly when its emissions are controllable by regulation of other pollutants).
[14] *National Lime*, 233 F.3d at 639 (emphasis added).
[15] *Sierra Club II*, 353 F.3d at 985.

the Pee Dee units. Acid gas HAPs and SO_2 are always part of the total acid gas emissions, and organic HAPs and CO are always part of the incomplete combustion emissions. Second, the control technology selected for reducing surrogates will indiscriminately control the corresponding HAP emissions from the Pee Dee units. The baghouse for controlling PM_{10} emissions will necessarily reduce the HAP metals that combine with the particulate matter. Similarly, the wet FGD for controlling SO_2 will reduce the HAP acid gases, specifically hydrogen chloride and hydrogen fluoride in reaction to the alkaline material during the wet FGD capture process. And finally, the good combustion practices for limiting CO will minimize organic HAP emissions since CO is a good indicator of incomplete combustion and there is a direct correlation between CO emissions and the formation of organic HAP emissions.

In conclusion, DHEC has clear legal authority to use surrogates and a strong factual basis exists for doing so in the case of non-mercury metal HAPs, acid gas HAPs, and organic HAPs that will be emitted from the Pee Dee units. In light of these considerations and the many practical difficulties in setting separate MACT emission standards (including effective monitoring protocols) for a myriad of non-mercury HAPs, the use of surrogates is not only a permissible exercise of DHEC's permitting discretion, but also the most appropriate and effective way for DHEC to regulate the non-mercury metal HAPs, acid gas HAPs, and organic HAPs emitted from the Pee Dee facility.

3.5 Consideration of 2004 Utility MACT Proposal

South Carolina regulations require DHEC to consider certain specified information (if available) in setting case-by-case MACT standards under section 112(g) of the Act. In particular, the information that DHEC must consider includes the "MACT emission limitations and requirements of the proposed standard or presumptive MACT determination" that applies to the relevant source category.[16] As already noted, EPA proposed on January 30, 2004 a rule to establish MACT standards for new and existing electric utility steam generating units. This rulemaking – referred to as the 2004 Utility

[16] SC Regulation 61-62.63, Section 63.43(d)(4). *See also* 40 C.F.R. 63.43(d)(4) (corresponding federal regulation).

MACT proposal – proposed to establish generic MACT standards for coal-fired electric utility units.[17] To Santee Cooper's knowledge, EPA has not developed a "presumptive MACT determination" for coal-fired electric utility units and thus this latter MACT benchmark has no relevance in setting the MACT standard for the Pee Dee facility.

DHEC is under no obligation to adopt the MACT standard that EPA proposed for mercury in the 2004 Utility MACT proposal. South Carolina regulations only require that DHEC "consider[ ]" the Utility MACT proposal as a benchmark in setting the mercury MACT standard for the Pee Dee units.[18] Nowhere does this regulatory provision require DHEC to adopt the proposed MACT standard. DHEC therefore has authority to deviate from this benchmark standard to the extent it concludes that such changes are necessary and appropriate, and are adopted in accordance with the general regulatory framework established for setting case-by-case MACT standards. This interpretation is confirmed by the fact that the proposed Utility MACT standard is not a <u>final</u> emission standard. Rather, the Utility MACT proposal is just that – a <u>proposed</u> emission standard that was never finalized by EPA. By definition, such a proposed MACT standard can neither supersede DHEC's permitting discretion nor impose a binding control requirement on the Pee Dee units.

Although imposing no binding limitation on DHEC's permitting discretion, the 2004 Utility MACT proposal does provide DHEC with useful information on available pollution control technologies and other relevant technical information that DHEC may consider in making its case-by-case MACT determination for mercury. Such information includes emission data on performance of the best performing similar sources within the source category.[19] Notably and as discussed later, this is information that Santee Cooper

---

[17] *Proposed National Emission Standards for Hazardous Air Pollutants; and in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units; Proposed Rule,* 69 Fed. Reg. 4.652 (January 30, 2004).

[18] In particular, the plain language of the South Carolina regulation only requires that DHEC "shall have considered" the two MACT benchmarks – that is an applicable MACT proposal or a presumptive MACT determination. SC Regulation 61-62.63, Section 63.43(d)(4).

[19] This interpretation also is confirmed by EPA's statements on the purpose of presumptive MACT determinations – the other benchmark used for making case-by-case MACT determinations. In the case of a presumptive MACT determination, EPA states that "it serves as a statement of current knowledge of

has carefully reviewed and analyzed in making its MACT floor determination for mercury.

Viewed in this context, DHEC's obligation in the current permit proceeding is only to review and consider the MACT emission standards and other requirements that EPA proposed in the 2004 Utility MACT rulemaking. DHEC is neither required to adopt the proposed Utility MACT standards, nor adhere to the specific methodology that EPA used for developing those proposed standards. Rather, DHEC is authorized to exercise its permitting discretion in developing MACT standards for mercury and other HAPs emitted from the Pee Dee units based on the consideration of all relevant information, including – but not limited to – the 2004 Utility MACT proposal.

To this end, Santee Cooper has prepared a detailed MACT analysis that carefully reviews and evaluates the 2004 Utility MACT proposal and other available information relevant for setting MACT standards for the Pee Dee units. Where appropriate, this analysis provides a reasoned explanation for deviating from the 2004 Utility MACT proposal on certain specific matters and therefore provides DHEC with a well-developed body of information for exercising its permitting discretion in setting appropriate case-by-case MACT standards for the Pee Dee boilers.

4.0 Requirements for MACT-Floor Analysis

A clear regulatory framework exists for how DHEC should exercise its permitting authority in setting an appropriate MACT floor level for the proposed Pee Dee facility. First, the statute and implementing regulations require that the MACT floor for new sources be based on the HAP emission control levels achieved by "the best controlled

---

maximum achievable control technologies and a basis for a [future] decision on how to develop the emission standard for the source category involved." EPA Guidance on Presumptive MACT for Polyether Polyols Production at page 1; 60 Fed. Reg. 16,088, 16,089 (March 29, 1995). The presumptive MACT is part of the MACT Partnerships program that EPA developed to assist states in developing case-by-case MACT standards under sections 112(g) and (j) of the Act. According to EPA, "The first phase involves the development of a presumptive MACT that will provide a clear benchmark for states in efficiently setting such case-by-case MACT standards for many source categories during the second phase of the program." *See* 60 Fed. Reg. at 16,089.

similar source."[20] DHEC has broad authority to "distinguish among classes, types, and sizes of sources" in identifying and evaluating the performance of similar sources for the MACT floor analysis.[21] This step of the analysis – referred to as subcategorization – is a critical first step for setting the MACT floor for the Pee Dee facility given the wide range of combustion processes, control technologies, unit sizes, and coals consumed by electric generating units within the electric utility source category. Second, section 112(d)(3) of the CAA requires that the MACT floor levels be based on HAP control levels that are "achieved in practice" by the source selected by DHEC to be the best controlled similar source. Courts repeatedly have interpreted this statutory language, which also is incorporated in the implementing regulations, to require that MACT floors be set at a level that reflects what that best performing source can "achieve under the worst foreseeable conditions."[22]

Each of these requirements is briefly discussed below and, where appropriate, the discussion also explains on how these requirements apply to the case-by-case MACT determination for the Pee Dee facility.

4.1 Subcategorization

The first step in determining the MACT floor is to identify the best controlled similar source, as compared to the design, operational, and performance characteristics of the proposed Pee Dee facility.[23] As noted above, this process – referred to as subcategorization – is a critical first step given the wide range of combustion processes, control technologies, unit sizes, and coals consumed within the electric utility source category.

---

[20] Section 112(d)(3) of the CAA.
[21] Section 112(d)(1) of the CAA. This statutory basis for subcategorization was clearly articulated in the Judge Williams' concurring opinion in *Sierra Club v. EPA*, 479 F.3d 875, 884-85 (D.C. Cir. 2007) (hereinafter referred to as "*Sierra Club III*").
[22] *Sierra Club v. EPA*, 167 F.3d 658 (D.C. Cir. 1999) (herein after referred to as "*Sierra Club I*").
[23] The statute requires that MACT floor for new sources be based on "the emission control that is achieved in practice by the best controlled *similar source*." Section 112(d)(3) of the CAA.

4.1.1 Broad Authority for Subcategorization

The federal CAA provides DHEC with broad authority to establish categories and subcategories of sources to which the MACT standards apply – including case-by-case standards developed under section 112(g) of the Act. In particular, the statute provides that the MACT floor for new sources shall be based on "the maximum degree of reduction in emissions that is deemed achievable for new sources in a *category or subcategory*" (emphasis added).[24] The statute further provides that EPA or the permitting authority (as the case may be) "may distinguish among classes, types, and sizes of sources within a category or subcategory" when setting the MACT floor levels.[25] This statutory language clearly signals Congress' intent to provide DHEC with broad discretion to distinguish among sources for purposes of making floor determinations and setting MACT standards.

Conferral of this discretionary authority also is reflected in the use of the term "best performing *similar source*" in CAA section 112(d)(3) (emphasis added). This terminology unmistakably suggests that subcategorization is necessary for developing a MACT standard that applies each group or class of sources with similar design, operational, and performance characteristics for controlling HAP emissions. This interpretation is confirmed by the legislative history for the provision. The Senate Report, for example, expressly states that subcategorization is appropriate "to take into account" differences in "facility size, type or process and other characteristics which are likely to affect *the feasibility and effectiveness of air pollution control technology*."[26] Without such authority to subcategorize, permitting authorities could not set MACT standards that meet the explicit statutory objective – namely establish a MACT standard

[24] Section 112(d)(3) of the CAA. This authority also is generally reflected in section 112(c)(1), which provides EPA with broad authority to develop "a list of categories and subcategories" of sources that are subject to MACT regulation under section 112 of the Act.
[25] Section 112(d)(1) of the CAA. Authority to establish case-by-case MACT standards is provided to states pursuant to section 112(g)(2) of the Act and 40 C.F.R. 63.55(a)(3).
[26] S. Report No. 228, 101st Cong., 1st Session at 166 (emphasis added). *See also*, House Report No. 101-490, Part 1, at 328 (confirming that EPA may subcategorize by distinguishing among classes, types, and sizes of sources within a category or subcategory).

for each new source based on "the emission control that is achieved in practice by the best controlled similar source."[27]

Finally, both federal and state regulations confirm that DHEC has broad discretion to subcategorize. Specifically, both define the term "similar source" to mean "a stationary source or process that has comparable emissions and is structurally similar in design and capacity to a constructed or reconstructed major source such that the source could be controlled using the same control technology."[28] In effect, this language provides DHEC with broad discretion to tailor MACT standards in order to take into account such differences in design and capacity among sources.

4.1.2 EPA's Past Practice on Subcategorization

EPA has subcategorized sources within a general source category in many past MACT rulemakings.[29] For example, EPA has used its discretionary authority to subcategorize where different types, classes, or sizes of sources emit different types or concentrations of uncontrolled HAP emissions, or such differences affect the applicability and performance of control technology for reducing HAP emissions.[30] EPA also has subcategorized

---

[27] Section 112(d)(3) of the CAA.
[28] 40 C.F.R. §63.41 (definition of similar source). Notably, the EPA regulations for case-by-case MACT standards for existing sources under section 112(j) define "similar source" to mean "equipment or collection that by virtue of its structure, operability, type of emissions and volume and concentration of emissions is substantially equivalent to the new affected source and employs control technology for control of emissions of hazardous air pollutants that is practical for use on the new affected source." 40 C.F.R. §63.51 (definition of similar source).
[29] *See e.g.,* 67 Fed. Reg. 9155 (Feb. 27, 2002) (leather finishing); 64 Fed. Reg. 27450 (May 20, 1999) (ferroalloys); 61 Fed. Reg. 46906 (Sep. 05, 1996) (polymers and resins); 61 Fed. Reg. 48208 (Sep. 12, 1996) (polymers and resins); 64 Fed. Reg. 57572 (Sep. 26 1999) (publicly owned treatment works); 61 Fed. Reg. 27132 (May 30, 1996) (printing and publishing); 63 Fed. Reg. 18504 (April 15, 1998) (pulp and paper); 62 Fed. Reg. 49052 (Sep. 18, 1997) (steel pickling); 64 Fed. Reg. 31358 (June 10, 1999) (phosphoric acid manufacturing and phosphate fertilizers production); 64 Fed. Reg. 52828 (September 30, 1999) (hazardous waste combustors); 58 Fed. Reg. 62566 (Nov. 29, 1993) (halogenated solvent cleaning); 60 Fed. Reg. 32587 (June 23, 1995) (secondary lead smelting); 64 Fed. Reg. 564393 (Oct. 20, 1999) (metal can surface coating); 58 Fed. Reg. 57898 (October 27, 1993) (coke oven batteries).
[30] *See e.g.,* 64 Fed. Reg. 27450 (May 20, 1999) (ferroalloys); 64 Fed. Reg. 57572 (Sep. 261999) (publicly owned treatment works); 61 Fed. Reg. 27132 (May 30, 1996) (printing and publishing).

sources based on size of the emission unit, where size differences affect the performance of control technologies.[31]

Notably, EPA has recognized that subcategorization is necessary and appropriate to account for the dissimilarities among sources within the electric utility steam generating source category. In its "Notice of Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units," EPA stated:

> "[T]he EPA intends to develop a record to facilitate consideration of subcategorization of the source category in setting the 'floor.' Based on the information that EPA has to date, the EPA anticipates that a factual record will allow EPA to propose appropriate subcategories for this source category. In developing standards under section 112(d) to date, the EPA has based subcategorization on considerations such as: the size of the facility; the type of fuel used at the facility; and the plant type. The EPA may also consider other relevant factors such as geographic conditions in establishing subcategories."[32]

In the 2004 Utility MACT proposal, EPA affirmed its broad discretion to subcategorize based on the same criteria noted above (*i.e.*, "size of the facility, type of fuel used, and plant type"). In addition, the Agency provided further guidance by stating that "EPA also is free to consider other relevant factors, such as geographic factors, process design or operation, variations in emission profiles, or differences in the feasibility of application of control (APCD or work practices)."[33]

Most importantly, EPA exercised its discretion by proposing to adopt five separate subcategories for coal-fired electric utility boilers in the 2004 Utility MACT proposal.

---

[31] *See e.g.,* 58 Fed. Reg. 62566, 62568 (Nov. 29, 1993) (halogenated solvents cleaning, subcategorized based on size of cleaning machines); 59 Fed. Reg. 25004, 25013-14 (May 13, 1994) (marine tank vessel loading and unloading, subcategorized based on size); 69 Fed. Reg. at 55230 (combustion boilers subcategorized based on boiler size and attributes of large and small boilers in Boiler MACT); 73 Fed. Reg. at 3577 (stationary reciprocal internal combustion engines subcategorized based on size, measured by HP rating, in RICE MACT).

[32] 65 Fed. Reg. 79825, 79830 (December 20, 2000).

[33] 69 Fed. Reg. 4652, 4664 (January 30, 2004). In its "Notice of Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units," EPA provided similar statements on its

Four of these subcategories were based on the rank of the coal burned – namely bituminous (including anthracite), subbituminous, lignite, and coal refuse in all forms.[34] The fifth subcategory was based on the process type, specifically the unique combustion process that the IGCC technology employs to convert coal into electricity.

EPA's approach – as stated in its December 2000 finding and proposed in its 2004 Utility MACT rulemaking – provides a clear benchmark for DHEC in the selection of a best performing similar source. Most importantly, it provides DHEC with a general framework for assessing the similarities and dissimilarities among coal-fired utility units based upon the above criteria.

4.1.3 Classification of the Pee Dee Facility

As discussed above, DHEC has the responsibility of setting the MACT floor for the Pee Dee facility based on "the emission control that is achieved in practice by the best controlled *similar source*." Furthermore, the preceding discussion indicates that DHEC has broad discretion to eliminate from the MACT floor analysis those coal-fueled generating units that it deems to be *dissimilar* based on a wide range of considerations. These considerations – each of which EPA has specifically recognized in the 2004 Utility MACT proposal and confirmed in other MACT rulemakings – include the following parameters: size of the facility, type of coal combusted, plant type, geographic factors, process design or operation, variations in emission profiles, or differences in the feasibility of application of control (*e.g.*, use of add-on control device vs. work practices).

The discussion below provides a summary of the technical basis for classifying the Pee Dee facility in terms of the following two parameters: (1) type of coal combusted or used; and (2) process type, including combustion configuration. Classifying the Pee Dee facility in terms of these parameters provides strong justification for DHEC to exclude from the MACT floor analysis those coal-fired electric generating units that –

[34] EPA's subcategorization based on waste coal tends to support a subcategorization for FBC units given that all units in the coal waste subcategory were FBC units.

- burn a fuel other than bituminous coal, or
- have a combustion configuration that deviates significantly from the pulverized coal (PC) boiler design proposed for the Pee Dee facility.

4.1.3.1 Coal Type: Bituminous

Coals are classified by "rank," a term that relates to the carbon content of the coal, heating value, and other related fuel characteristics, as defined by the American Society for Testing and Materials (ASTM). In the United States, coal-fired electric generating units primarily combust the following three ranks of coals: bituminous, subbituminous, and lignite, along with lesser amounts of anthracite and waste coals.

In the 2004 Utility MACT proposal, EPA recognized that coal rank has a "significant impact on the overall plant design," including the "boiler components" and "emissions control equipment."[35] Coal rank determines the design and spacing of critical components in a boiler system, including the heat transfer system (furnace, superheater, reheater, boiler bank, economizer, and air heater), the coal handling system, and the ash handling system. When designing the heat transfer system, engineering calculations are completed based on air flow volumes, heat release rates, and ash slagging specific to the coal type. Even when physically possible, using a coal other than the design coal results in reductions in boiler efficiency from the design case, and thus increases the amount of fuel combusted (and thus the associated pollution) per unit of power generated.[36]

Based on these considerations, Santee Cooper proposes to follow EPA's approach to subcategorize by coal rank, as proposed in the 2004 Utility MACT rulemaking.[37] This approach provides DHEC with a sound technical basis for including in the MACT floor analysis only those coal-fired electric generating units that burn bituminous coal.[38]

---

[35] *See* 69 Fed. Reg. at 4665. *See* 69 Fed. Reg. at 4664-4666 (providing general discussion on subcategorization of the electric utility steam generating source category).
[36] *See* 69 Fed. Reg. at 4666 (describing the "significant modification or retooling" required for switching from one coal rank to another coal rank).
[37] *See* 69 Fed. Reg. at 4666.
[38] In addition to excluding electric generating units that burn subbituminous and lignite coals, it also is appropriate to exclude from the MACT floor analysis those units burning western bituminous coal based on

4.1.3.2 Process Type: Pulverized Coal Boiler

In the 2004 Utility MACT proposal, EPA recognized two combustion processes that are fundamentally different from the SCPC process that will be employed at the Pee Dee facility. One combustion process is "fluidized bed combustor" (FBC) technology that, according to EPA, has a "unique firing design" and "employs a fundamentally different process for combusting coal."[39] The other combustion process is the integrated gasification combined cycle (IGCC) technology that combusts a synthetic coal gas produced by a coal gasification process that involves "no coal … [being] directly combusted in the unit during operation."[40]

Santee Cooper proposes to follow EPA's approach in the 2004 Utility MACT proposal to define IGCC as a separate subcategory from PC units, based on process type.[41] In addition, Santee Cooper agrees with EPA's assessment in the proposal that "FBC units employ a fundamentally different process for combusting coal."[42] Instead of introducing

---

"geographic conditions" – which is another consideration that EPA identified for subcategorization (as previously noted). Notably, the 2004 MACT Utility proposal referenced geographic conditions as one reason for the subcategorization of units burning lignite coals. Specifically, EPA stated:

> Further, the choice of coal ranks to be burned for a given unit is based on economic issues, including *availability of the coal within the region or locale*. A number of coal-fired units, including all known lignite-fired units, are "mine mouth" (or near mine-mouth) operations (*i.e.*, the unit is constructed on or near the coal mine itself with coal transport often being done by conveyor directly from the mine) and many do not have the infrastructure in place (*e.g.*, interstate rail lines) to import other ranks of coal in quantities sufficient to replace all lignite coal combusted.

See 69 Fed. Reg. at 4666 (emphasis added). While western bituminous coal is technically of the same rank as eastern bituminous coals from the Appalachian and Illinois basins, limitations on the supply and transport of the western bituminous coal to the eastern power plants (including the Pee Dee facility) could justify the exclusion of units burning western bituminous coal. However, reliance on such "geographic conditions" is not essential for the MACT floor analysis for the Pee Dee facility given that there are independent grounds (as discussed in this MACT Permit Application) for not selecting units burning western bituminous coal as the best performing source. For similar reasons, Santee Cooper could have established a basis for excluding from the floor analysis those utility units burning bituminous coals imported from Columbia or other foreign countries.

[39] *See* 69 Fed. Reg. at 4666.
[40] *See* 69 Fed. Reg. at 4666.
[41] *See* 69 Fed. Reg. at 4666.
[42] *See* 69 Fed. Reg. at 4666.

pulverized coal and air into the middle of the boiler,[43] the fluidized bed process introduces relatively large coal particles to a bed of sorbent or inert material at the bottom of the boiler through which sufficient air flow is introduced to result in the mixture becoming fluidized.[44]

Although a separate subcategory for FBC units was not established in the 2004 Utility MACT proposal, a sound technical basis exists for DHEC exercising its discretion to exclude both FBC and IGCC units from the MACT floor analysis for the Pee Dee facility. The following discussion provides a brief summary of key design differences between FBC and conventional PC units[45] that also justify the exclusion of FBC units:

- FBC units are designed for combustion to take place in a fluidized bed of solids. This bed of solids typically contains materials for absorbing SO_2, such as limestone and ash from the combustion of coal. In contrast, conventional PC boilers simply mix fuel and atmospheric air, and burn fine, widely dispersed coal particles in a suspension of air and combustion product gases.

- The combustion temperatures are much lower in a FBC boiler than PC boiler. The temperatures for a FBC boiler typically range from 1,500 F° to 1,650 F°, as compared to the temperatures of a conventional PC boiler, which tend to be around 2,500 F° or higher. At full-load operation of a PC boiler, peak combustion temperatures in the immediate flame zone can reach 3,500 F°.

- Unlike conventional PC boilers, coal ash does not become molten in FBC boilers. This difference results in vastly different ash properties and ash handling systems. Most notably, a large portion of ash particles pass immediately out of conventional PC units, while the ash particles in FBC units are actually recirculated back into the unit for further combustion. Normal pulverized coal

[43] Specifically, coal is pulverized in a mill to a fine consistency, approximately the consistence of talcum powder. That pulverized coal is entrained in air, then blown through burners to the furnace, where it is fired in the middle of the furnace. This process results in widely dispersed fuel particles burning extremely quickly and at extremely high temperatures in suspended air.
[44] S.C. Stultz and J.B. Kitto, *Steam: Its Generation and Use*, 40th Edition, at page16-3 (Babcock & Wilcox). Notably, coal particles introduced into FBC boilers are sometimes as large as 1.25 inches in size – which is much larger than talcum-powder-size coal particles for pulverized coal units. Sufficient air flow is introduced from the bottom of the boiler – which results in the coal/sorbent (inert) mixture becoming fluidized. "Fluidization" refers to the condition in which solid materials are given free-flowing fluid-like behavior. As a gas is passed upward through a bed of solid particles, the flow of gas produces forces that tend to separate the particles from one another and suspend them, "floating," in the combustion chamber.
[45] Reference to PC units includes units with any type of conventional combustion boilers (*e.g.*, subcritical, SCPC, and Ultra-SCPC), as well as units with stoker- or cyclone-fired boilers.

flyash is a glasslike sphere, resulting from solidification of molten (liquid) ash particles, whereas FBC ash has a highly irregular shape with greater surface area. These differences may be a key to mercury capture performance because the FBC ash particles will have a much greater surface area for adsorption of mercury, thereby making them act more like activated carbon, and because a much longer residence time provides an increased opportunity for mercury gases to interact with the ash particles.

- PC boilers typically achieve in excess of 99.5% combustion efficiency (also referred to as "carbon burnout"). This high carbon burnout rate is likely due to low solids density (*i.e.*, fineness of the pulverized coal particles) and the fact that most of the carbon burnout occurs in the vicinity of the burner flame. In contrast, the degree of carbon burnout for FBC boilers is in the range of 97-98% for bituminous coals and petroleum coke. Nearly all unburned carbon exiting the FBC boiler is believed to have higher porosity due to lower combustion temperatures, as compared to the unburned carbon exiting the PC boiler that has higher combustion temperatures. The higher porosity of greater amounts of unburned carbon offers a greater uptake of mercury in FBC boiler through a different process than what may possible in a PC boiler. To put in other words, FBC units tend to have higher unburned carbon levels than conventional PC boilers. This unburned carbon in the flyash behaves much like activated carbon and helps adsorb mercury.

- In FBC units, the SO_2 control is part of the process itself, which is a critical distinction for typical Eastern bituminous coal. In an FBC unit, lime or limestone is introduced into the bed of solids. This continuous addition of limestone to the bed of a FBC unit for SO_2 control insures that a major portion of the bed solids are limestone particles (or lime, since limestone "burns" to become lime at approximately 1,550 °F). Most of the sulfur in the coal chemically reacts with the lime or limestone and is neutralized, thereby releasing very little SO_2 emissions from the combustion chamber. This process also eliminates SO_3 emissions that can interfere with mercury absorption on flyash or activated carbon when higher sulfur eastern bituminous coals are burned in a pulverized coal system. In addition, the proportion of limestone-derived particles in typical coal-fired FBC boilers ranges from 50-95%. The active quantity of calcium oxide (lime-CaO) available in a FBC boiler is therefore orders-of-magnitude greater than compared to a PC boiler, whose alkalinity is derived solely from the coal's mineral content. Significantly higher CaO can alter the process chemistry in the boiler, including the oxidation levels of mercury.

- Although the reasons are not well- understood, it is clear that the process for capturing mercury is different for FBC units, as compared to conventional PC units – even when the same particulate controls are used. Whatever occurs within the FBC boiler itself, however, clearly cannot be replicated in PC boilers because of the fundamentally different technology that is used in the two types of units.

Because the chemical reactions that occur within the FBC units cannot be replicated in any conventional PC boiler, it is reasonable to conclude the control technology used in a FBC unit may *not be applicable* to conventional PC boilers.

- FBC units are much smaller in size the PC boilers. While PC boilers have been manufactured in sizes up to 1,300 MW, FBC boilers currently have a maximum size of 300-350 MW gross, depending on the manufacturer. Only 4 FBC units in the U.S. exceed 300 MW, and no FBC unit is commercially available or proven in the size needed for the Pee Dee facility (660 MW gross).

- FBC technology is much less efficient than PC technology and would be about 8 to 9% less efficient than the levels that will be achieved by the SCPC design proposed for the Pee Dee facility.

In further support of excluding both FBC units from the MACT floor analysis, Santee Cooper is providing in Appendix B of the MACT Permit Application (attached hereto) a detailed technical paper that documents key differences between FBC and conventional PC units.

4.2 Accounting for Variability

Once the best controlled similar source is identified for a particular source category or subcategory, a key next step involves accounting for the variability that is possible over time under the full range of foreseeable operating conditions at that best performing similar source. DHEC's obligation to account for this variability is established, in part, by the CAA requirement that the MACT floor determination be based on "the emission control that *is achieved in practice* by the best controlled similar source."[46] Courts have interpreted this statutory provision not only to allow DHEC to consider variability in MACT floor determinations,[47] but also to "set[ ] the floors at a level that is a reasonable estimate of the performance of the 'best controlled similar unit' under the worst reasonably foreseeable circumstances."[48] The emission rate achieved by the lowest emitting unit, after taking into account this variability, would become the MACT floor.

---

[46] Section 112(d)(3) of the CAA (emphasis added).
[47] *Mossville Environmental Action Now v. EPA*, 370 F.3d 1232 (D.C. Cir. 2004).
[48] *Sierra Club I*, 167 F.3d at 665. The D.C. Circuit has held repeatedly that EPA may use reasonable means to estimate the performance of best performing similar sources, and may account for a source's variability in doing so. *Cement Kiln Recycling Coalition v. EPA*, 255 F.3d 855, 865-66 (D.C. Cir. 2001); *Mossville*,

As a general matter, EPA has identified two types of variability in assessing a source's performance over time. One is "run-to-run variability" and the other is "test-to-test variability." Run-to-run variability encompasses the variability occurring in individual runs comprising compliance tests, and includes uncertainties in correlation of monitoring parameters and emissions, and imprecision of stack test methods and laboratory analyses. According to EPA, "run-to-run variability can be appreciable" and the failure to consider such variability "could seriously underestimate a source's emissions over time."[49] Test-to-test variability results from variability in such factors as the design and performance of the pollution control device(s), the amount of mercury in the fuel, or other fuel characteristics over time. Testing for a short time may not reveal the range of emissions that would occur over extended time periods due to these factors. Normal changes in operating conditions or in fuel characteristics may affect emission levels over time. For example, an increase in mercury content of the fuel may tend to increase the mercury emission rate even though the removal efficiency of the pollution control equipment remains constant. Similarly, mercury emission rates may also change with unit loads due to changes in the gas flow rate that may, in turn, affect the effectiveness of the pollution control equipment.

EPA has used multiple approaches for determining the variability in emissions associated with foreseeable circumstances. In the 2004 Utility MACT proposal, for example, EPA considered the full range of coals that were burned at each of the candidate best performing similar units, instead of evaluating its performance based on the coal burned only when the unit was being stack-tested.[50] In the Hazardous Waste Combustor MACT, EPA relied on several approaches to account for variability in performance at best performing similar sources. One such approach involved the consideration of emission data generated during "trial burn tests and RCRA compliance testing" when hazardous waste incinerators operate under worse case conditions by spiking metals and chlorine in

---

370 F.3d at 1240; *National Lime Association v. EPA*, 627 F.2d 416, 431 n. 46, 443 (D.C. Cir. 1980). *See also Sierra Club III*, 479 F.3d at 881-82.
[49] 72 Fed. Reg. 54,875, 54878 (September 27, 2007).
[50] 69 Fed. Reg. at 4,652.

the waste feed."[51] Notably, the D.C. Circuit has upheld this approach as a reasonable exercise of EPA's discretion to estimate performance of best performing similar sources.[52]

The National Association of Clean Air Agencies (NACAA) has recently published guidance for state permitting authorities to use when setting MACT limits for industrial boilers.[53] The NACAA guidance includes a "variability factor" to be applied to candidate best performing units to establish an emission performance estimate that is based on variability in performance tests, as indicative of process control variability. The variability factor was calculated based on a 90% to 99% confidence interval for the mean of the test data.

In practice, there are often limitations on the adequacy of available data to capture fully the variability in emissions due to "reasonably foreseeable circumstances." For example, in the 2004 Utility MACT rulemaking, both data and theory showed that some types of air pollution control technologies were generally more effective (higher percentage of mercury removal) on coals with higher chlorine content, but for some technology configurations there was insufficient information to quantify the relationship with confidence. For those configurations, EPA did not include process control variability in the determination of "worst foreseeable circumstances." For other technology configurations where the data were more obliging, EPA did include the effect of chlorine content on process control variability. These limitations led EPA to conclude in the 2004 Utility MACT proposal that the "approach selected by EPA is not the only approach that could be appropriate for evaluating emissions from best performing units."[54]

---

[51] *Cement Kiln*, 255 F.3d at 867.
[52] *Cement Kiln*, 255 F.3d at 867. In this case, the court held that EPA "has wide latitude" in selecting data for MACT floor analysis and that courts should "generally defer to an agency's decision to proceed on the basis of imperfect … information," unless it can shown that the use of that information "'bears no rational relationship to the reality it purports to represent.'" *Cement Kiln*, 255 F3d at 867 (quoting *Columbia Falls Aluminum Co. v. EPA*, 139 F3d 914, 923 (D.C. Cir. 1998)).
[53] Reducing Hazardous Air Pollutants from Industrial Boilers: Model Permit Guidance, National Association of Clean Air Agencies, June 2008.
[54] 69 Fed. Reg. at 4,674.

One such alternative expressly recognized by EPA was a method that the Department of Energy (DOE) developed to address variability in the MACT floors for the 2004 Utility MACT proposal.[55] Although similar to EPA's variability analysis in many regards, the DOE method also sought to account for the variability that could occur from the best performing similar source switching to a coal of the same rank not previously burned at the unit. EPA noted the reasonableness of the DOE method given that "the alternative coals were of the same rank and not precluded from use by regulation or permit" and, as a result, "ICR coal data from other units constituted relevant emission estimates under worst conditions at the best performing units."[56] As explained by EPA in the 2004 MACT proposal, "[t]he essence of the DOE analysis was to average at a plant level the Hg and Cl contents of all coals, by rank, in the ICR data base. Then DOE adjusted performance test results at the lowest emitting units in the ICR data base by assuming that they burn a coal similar to the 95th percent worst plant annual average coal."[57]

Santee Cooper has attempted to integrate this body of case law and analytical precedents into a MACT floor approach that addresses multiple sources of variability. This approach begins with the framework that EPA used in accounting for variability in the 2004 Utility MACT proposal. Building upon this framework, Santee Cooper has endeavored to develop a reasonable approach that seeks to account for the following two types of variability (both of which were discussed by EPA in the 2004 Utility MACT proposal) –

- Raw material variability with changes in coal composition (including mercury and chlorine content), using available relationships between mercury emissions and coal characteristics, in accordance with the EPA and DOE methodologies described above, and

- Process control variability at a given unit in accordance with the EPA methodology when EPA had developed a chlorine algorithm, or the NACAA

[55] Calculation of Possible Mercury MACT Floor Values for Coal-Fired Utilities: Influence of Variability and Approach, U.S. DOE National Energy Technology Laboratory, December 2003. *See also* 69 Fed. Reg. at 4,674 (discussing the DOE alternative).
[56] 69 Fed. Reg. at 4,674.
[57] 69 Fed. Reg. at 4,674. Note that in Santee Cooper's analysis, we employed DOE's basic approach, but used a 97.5% "worst" coal, consistent with EPA's statistical analyses of variability.

> methodologies described above for instances where EPA did not apply process control variability due to the lack of a clear relationship with fuel chlorine.[58]

By using both of these variability concepts, Santee Cooper is able to capture accurately the worst reasonably foreseeable circumstances of unit operation. One approach – referred to as the "EPA / NACAA Variability Method" – combines the 2004 EPA approach to raw material availability (based on site coal data) and either the 2004 EPA (where available) or NACAA approach to process control variability. The second approach – referred to as the "EPA / DOE Variability Method" – combines the 2004 EPA approach to process control variability (*i.e.*, no variability for some sources) and DOE approach to raw material availability.

Both methods clearly provide reasonable estimates of performance at a candidate best performing similar source under the worst reasonably foreseeable circumstances, as required by regulation and applicable case law. A reasonable exercise of DHEC's permitting discretion therefore could entail accounting for both methods of potential variability in setting the MACT floor for the Pee Dee facility. Such a combined approach is particularly appropriate due to the inherent limitations and uncertainties that exist under each variability method.[59]

Under this two-part analysis, DHEC can calculate variability by estimating the worst case-conditions, as defined by these two approaches in estimating variability at a candidate best performing similar source. The unit with the lowest rate of emissions after application of the worst reasonably foreseeable circumstances (identified by the variability approach that resulted in the worst-case emissions) is defined as the best controlled similar unit to the Pee Dee units, and its emission rate, adjusted for variability, is the MACT floor. Additional information on the calculation of emission variability at candidate "best performing similar sources" is presented in Section 6.1.3.

---

[58] Section 6.1.3 of the MACT Permit Application provides a more detailed description of these two methods that Santee Cooper used to account for variability of the units identified as candidates for the best performing similar source. In addition, Appendix D of the MACT Permit Application provides a sample calculation for both variability methods

[59] These limitations, as briefly noted above, were extensively discussed by EPA in the 2004 Utility MACT proposal. *See* 69 Fed. Reg. at 4,670-75 (discussing how EPA accounted for variability).

5.0 Requirements for the "Beyond-the-Floor" Analysis

Once DHEC has set the MACT floor, the next step of technology-based analysis is to evaluate whether it is appropriate to adopt MACT standards that are more stringent than the floor level of control. Both the statute and implementing regulations provide clear guidance on how DHEC shall perform this BTF analysis. First, the BTF analysis shall be based on an evaluation of "the maximum degree of reduction … that … is achievable" through the use of an available control technology or technique by the Pee Dee facility. Second, DHEC shall consider the following three factors in evaluating whether to adopt a MACT standard stricter than the floor:

- "cost" of achieving that reduction;
- "non-air quality health and environmental impacts;" and
- "energy requirements" in achieving that reduction.[60]

And third, the implementing regulations enumerate specific "information sources" that DHEC shall consider "for purposes of identifying control options for the affected source." This section provides a brief discussion on how each of these elements should guide DHEC in performing the BTF analysis for the Pee Dee facility.

5.1 Determination of Maximum Emission Reduction Achievable

The statute and implementing regulations authorize DHEC to adopt a MACT emission limit more stringent than the floor level only if DHEC identifies a "control technology" that is potentially capable of achieving that BTF level of control. In making this determination, DHEC must evaluate the level of emission reduction that is "achievable" by the Pee Dee facility when using that identified control technology. Notably, the courts repeatedly have stated that "where a statute requires a standard to be 'achievable,' it must

[60] Section 112(d)(2) of the CAA (emphasis added). This statutory requirement is codified in the federal and South Carolina regulations. *See* 40 C.F.R. § 63.43(d)(2); SC Regulation 61-62.63, Section 63.42(d)(2). It should be noted that these requirements are nearly identical to the requirements for a Best Available Control Technology (BACT) analysis under PSD permitting.

be achievable 'under the most adverse circumstances which can reasonably be expected to recur.'"[61]

This evaluation of what is "achievable" differs from the MACT floor analysis, which focuses on the level of control that the best performing similar source has actually "achieved in practice" over time. First, the BTF focus is not on what other similar sources might achieve through the use of the identified control technology. Rather, DHEC must assess the emission reductions that the Pee Dee facility can achieve through the identified control technology. Second, the BTF analysis should focus on the control level that the Pee Dee facility can continuously achieve under all foreseeable circumstances – every day and under all operating conditions. This assessment must be based on the use of the design coal and reflect the full range of operating conditions that are reasonably foreseeable at the Pee Dee facility.

5.2 Application of Three-Factor Test

Both EPA and courts have provided clear guidance on how DHEC should apply the three-factor test for evaluating whether to adopt a MACT standard stricter than the floor. A brief discussion of each factor is provided below.

5.2.1 Cost

The first factor is the cost of achieving the HAP emission reduction. Cost effectiveness is typically determined by calculating the annualized incremental cost for removing each ton of HAP emissions that is beyond the MACT floor emission level.[62] One important benchmark for assessing cost effectiveness is what EPA has rejected as excessive cost in setting generic MACT standards for other source categories by rulemaking. With respect

[61] *Sierra Club I*, 167 F.3d at 665 (quoting *National Lime Association v. EPA*, 627 F.2d 416, 431 n. 46 (D.C. Cir. 1980)).
[62] This cost-effectiveness metric measures the incremental control costs that go beyond the floor and includes both capital costs and operating costs. Capital costs are amortized over the expected life of the equipment using a capital recovery factor, resulting in an annual charge to cover the capital costs. That annual charge from the capital costs can be added to the other operating costs to determine the total annual costs of control. To determine cost effectiveness, the total annual costs of control are then divided by the mass of pollutant removed that are in addition to the MACT floor levels.

to mercury, EPA has determined in the Hazardous Waste Combustor MACT that BTF control costs of over $4,500/lb were cost prohibitive and consequently declined to adopt a more stringent limit based on the BTF control option.[63] In the case of other HAPs, EPA has found cost prohibitive BTF control costs of $29,000/ton in the Ferroalloys MACT, $610/Mg in the Oil and Gas MACT, and $50,744/ton in the Phosphoric Acid MACT. Another relevant benchmark is the "safety valve" price for purchasing mercury allowances under CAMR. The practical effect of the safety valve mechanism was to set control cost level that – as a matter of federal policy – was deemed to be excessive for reducing mercury emissions from any coal-fired power plant. Notably, EPA proposed to set a safety valve prices for mercury of $2,187.50 per ounce, which is equivalent to $35,000 per pound.[64]

5.2.2 Non-Air Health and Environmental Impacts

The "non-air quality health and environmental impacts" is another important factor that DHEC must consider in making its BTF assessment of potential control options for the Pee Dee facility. Both EPA and the courts have interpreted this factor to pertain to only those non-air quality impacts that result from the required control measures to limit HAP emissions – that is the "by-products of the control technology."[65]

One important reason in support of this interpretation is based on the fact Congress adopted a two-phased framework for regulating HAP emissions under section 112 of the Act. The first phase – the focus of this application for the Pee Dee units – entails the

---

[63] Specifically, EPA concluded that a removal cost of $10,000,000 per mega-gram for BTF mercury control is not cost effective. 64 Fed. Reg. at 52863. This control cost level converts to $4,536/lb in 1999 dollars.
[64] Other air regulatory programs also establish cost limitations on the maximum emission control levels for air pollutants. The PSD program, for example, authorizes the consideration of cost in setting BACT levels of controls and allows the permitting authority to reject BACT control options that have excessive cost. One recent example is the PSD permit for the Deseret Power Electric Cooperative's Bonanza Power Plant, where EPA determined that a cost-effectiveness value of $20,241/ton (for combined pollutants) "would be cost-prohibitive as a BACT option." *Prevention of Significant Deterioration Permit to Construct, Final Statement of Basis for Permit* No. PSD-OU-0002-04.00, August 30, 2007, p.28, EPA Region 8 (*Bonanza Final Permit Statement)*. Although there is no specified cut-off level for assessing cost-effectiveness, EPA cited in its *Bonanza Final Statement* many recently issued PSD permits for which the permitting authority determined incremental costs in the range of $6,000 to $10,000 per ton removed was "cost-prohibitive." *Id.*
[65] *Sierra Club II*, 353 F.3d at 990.

adoption of technology-based standards that are not to be based on an assessment of the risks posed by HAPs, but rather on the best performing similar source, as provided under section 112(d)(3) of the Act.[66] In contrast, the second phase occurs eight years later and involves the adoption of health-based standards that shall "provide an ample margin of safety to protect public health."[67] These health-based standards are intended to address any residual risk that exists after implementation of the MACT control levels and expressly authorize the consideration of "public health" and "adverse environmental effects."[68] Viewed in this context, the statutory two-part framework clearly confirms that DHEC is precluded from considering the health and environmental impacts of mercury and other HAPs in determining the stringency of the MACT standards in the BTF analysis.[69] These potential health and environmental impacts are precisely the considerations that must be considered in developing health-based standards during the second phase of the HAP regulatory process.

5.2.3 Energy Requirements

The third and final factor is the energy requirements for achieving the HAP emission reductions. The focus of this factor is limited to the "energy needs" that are likely to result, directly or indirectly, from control measures that will achieve the incremental BTF emission reductions.[70]

5.3 Consideration of Available Information

The implementing regulations require DHEC to consider "available information" in evaluating potential control technologies pursuant to the BTF analysis. The term "available information" is defined to include information contained in the 2004 Utility

---

[66] *Sierra Club II*, 353 F.3d at 980 (noting that the Senate Report confirmed that "MACT standards are based on the performance of technology, and not on the health and environmental effects of hazardous air pollutants").
[67] Section 112(f) of the CAA.
[68] Section 112(f) of the CAA.
[69] Notable examples excluded from consideration during the BTF analysis therefore include alleged impacts from potential deposition, persistence, toxicity and bioaccumulation of mercury and other metal HAP emissions on people, wildlife and the environment.
[70] *Sierra Club II*, 353 F.3d at 990.

MACT proposal, including "all supporting documentation" and any "background information documents" that might be available for this proposed regulation. As discussed in Appendix C of the MACT Permit Application (attached hereto), Santee Cooper has reviewed in detail all relevant information in the 2004 Utility MACT, as well as relevant information in the CAMR rulemaking docket and other information sources specifically enumerated in South Carolina regulations.[71]

6.0 MACT Determination for Mercury

Santee Cooper has performed a case-by-case MACT analysis for mercury in accordance with a two-part methodology prescribed by South Carolina regulations.[72] Santee Cooper's approach for performing this MACT analysis for the Pee Dee facility has been extensively described in the preceding sections of this case-by-case MACT application.[73]

As noted above, the starting point for the mercury MACT analysis for the Pee Dee facility is the 2004 Utility MACT proposal that EPA developed for electric utility coal-fired boilers. EPA's 2004 Utility MACT proposal contains an extensive database on coal-fired utility units,[74] as well as a useful framework for identifying similar sources and accounting for variability at the best performing of the similar sources. As explained in Section 3.5 of the MACT Permit Application, the South Carolina regulations only require the consideration of the 2004 Utility MACT proposal. DHEC is neither required to adopt the proposed 2004 Utility MACT standards, nor adhere to the specific methodology that EPA used for developing those proposed standards. Rather, DHEC is authorized to

---

[71] SC Regulation 61-62.63, Section 63.41 (definition of "available information"). *See* 40 C.F.R. § 63.41 (federal regulatory definition of available information). Among other things, Appendix C provides a review of state mercury rules and permit requirements that confirms that no new innovative control technologies are currently available for consideration in the BTF analysis. Additionally, the emission limitations in these programs are fundamentally different than required under MACT, making them unsuitable to the "achieved in practice" determination required for the MACT floor analysis.
[72] *See* SC Regulations 61-62.63.
[73] *See* Sections 3-5 of the MACT Permit Application.
[74] As noted in Appendix C of the MACT Permit Application, the rulemaking docket to the 2004 Utility MACT proposal includes an extensive database on the design, fuel, operating, and emissions control characteristics of 1,143 coal-fired units, as well as mercury emissions data gathered by stack emissions test at 79 of the coal-fired units. Other data sources that Santee Cooper considered in identifying similar sources, evaluating the performance of best performing similar sources, and assessing available control technologies are described in Appendix C.

exercise its permitting discretion in developing MACT standards for the Pee Dee units based on the consideration of all relevant information, including – but not limited to – the 2004 Utility MACT proposal. To this end, Santee Cooper has prepared a detailed MACT analysis that carefully reviews and evaluates the 2004 Utility MACT proposal and other available information relevant for setting MACT standards for mercury and other HAPs emitted from the Pee Dee units.

6.1 MACT Floor Analysis

The first step in establishing a MACT limit is to determine the MACT floor level based on the maximum degree of mercury emission reduction that is achieved in practice by the best performing similar source. As described above in Section 4 of the MACT Permit Application, DHEC has considerable discretion in performing each component of the MACT floor analysis for the Pee Dee facility. These components include the following:

- Determine which sources are "similar to" the Pee Dee facility based on the design, operating and other characteristics of each source;
- Identify those similar sources with low mercury emission rates that are good candidates for selection as the "best controlled similar source;"
- Develop reasonable estimates of performance that account for variability in emissions at each candidate source under the worst reasonably foreseeable circumstances; and
- Select the best controlled similar source, considering such variability in performance, and determine the mercury MACT floor based on the mercury emission rate achieved by that source under worse case conditions.

The discussion below presents how Santee Cooper performed each of the preceding MACT floor components and ends with a brief assessment of the mercury emissions data for the Cross units.

6.1.1 Determining Which Sources Are Similar to the Pee Dee Facility

For the reasons stated in Section 4.1 of the MACT Permit Application, Santee Cooper has classified the proposed Pee Dee facility in terms of the following two design

characteristics: (1) type of coal combusted; and (2) process type, including combustion configuration. Specifically, Santee Cooper has determined that the two most important characteristics of units similar to the proposed Pee Dee units were use of bituminous coal, and its PC boiler design (specifically a SCPC boiler design). Classifying the Pee Dee units in terms of these characteristics results in the exclusion from the MACT floor analysis those coal-fired electric generating units that –

- burn a fuel other than bituminous coal, or
- have a combustion configuration that deviates significantly from the SCPC boiler design proposed for the Pee Dee facility, in particular those units with a FBC boiler design.

Although stoker and cyclone boilers use different firing designs than PC boilers, Santee Cooper followed EPA's approach in the 2004 Utility MACT proposal and grouped these two other boiler designs together with PC units in identifying similar sources for the MACT floor analysis.[75]

Santee Cooper excluded from the MACT floor analysis the Stockton Cogeneration Unit as dissimilar for several reasons. The primary reason for the exclusion is that Stockton is a FBC unit. Another important factor for the exclusion is fuel that the Stockton Unit burned during its mercury stack test. Specifically, approximately 45% of the fuel burned on a heat input basis during the stack test was petroleum coke and the remaining fuel was a western bituminous coal. These high heat input levels of petroleum coke have the potential to alter fundamentally the boiler and flue gas chemistry, which can influence the form of mercury emissions entering the downstream control devices and thereby influencing their control effectiveness. Notably, the stack test results indicate that 95% of the total mercury entering the fabric filter was particulate mercury – which is much greater than the 35% typical for flue gas entering particulate control devices associated with pulverized coal boilers burning only bituminous coal. This high fraction of particulate mercury most likely resulted from the combined effect of the unit's FBC

[75] 69 Fed. Reg. at 4,666.

boiler design (with high specific surface area ash particles, which are also high in unburned carbon), and the chemistry of the petroleum coke.[76]

Finally, units burning western bituminous coals also were deemed to be dissimilar to the Pee Dee units due to the unique "geographic conditions" of these coals – another criterion that EPA recognized for classifying sources as dissimilar, as discussed above in Section 4.1 of the MACT Permit Application. However, Santee Cooper took a conservative approach and elected not to exclude these units from the MACT floor analysis. As reflected in the discussion below, the inclusion of these units did not affect our final determination in establishing the mercury emission floor for the Pee Dee facility.

Santee Cooper conducted an extensive review of all available information in performing the MACT floor analysis. This review included a detailed evaluation of databases that EPA used in the 2004 Utility MACT proposal,[77] as well as recent permits issued for the construction of new coal-fired generating units, data from the EPA Toxic Release Inventory (TRI) [78] and relevant information on performance of similar coal-fired units that is currently available from State environmental agencies. Notably, new source permitting data did not meet the statutory criterion that the MACT floor must be based on emission reductions "achieved in practice" given that these units had not yet begun commercial operation. One such example is the case-by-case mercury MACT standard that was reportedly just established for Dominion Energy's Virginia City Hybrid Energy Center. In this case, such a newly-adopted MACT standard simply for a newly built unit cannot reflect mercury emission levels that have been achieved in practice by an existing

[76] These performance differences at the Stockton Unit (as compared to PC boilers burning eastern bituminous coal) most likely were further augmented by the blending of the high amounts of petroleum coke with a western bituminous coal with lower mercury content and higher volatile content than eastern bituminous coals.
[77] EPA used two databases, generally cited as "ICR-2" (analysis of over 40,000 coal deliveries to power plants in 1999) and "ICR-3" (stack tests of 81 coal-fired power plants, also in 1999).
[78] Santee Cooper notes the TRI emission data also had little relevance for the MACT floor analysis due to the fact that the data were not subjected to rigorous quality control measures and often are based on non-unit specific emission factor data. For these reasons, TRI data does not reflect mercury levels that were achieved in practice and therefore need not be considered in the MACT floor analysis.

unit. In addition, the standard is not relevant to this instant proceeding because it applies to a fundamentally different type of unit – namely, a unit having a FBC boiler design and burning waste coal and waste wood, as well as bituminous coals. These major dissimilarities in design and fuel type, as compared to the Pee Dee facility, are independent grounds for excluding Dominion Energy's FBC plant from the MACT floor analysis for the Pee Dee facility.

Table 2 is a listing of all electric generating units that are similar to the Pee Dee facility and for which stack test mercury emission data are available from the EPA database used for the 2004 Utility MACT proposal. This list includes all PC, cyclone, and stoker units that burn bituminous coal (both eastern and western bituminous). The list does not include those electric generating units that burn other coal ranks (*i.e.*, subbituminous coal, lignite) or waste coals, and does not include FBC units.[79]

Table 2
Bituminous Coal-Fired Units Reviewed*

Plant	Unit No.	Boiler Combustion Technology	Fuel Mix Tested
AES Cayuga (NY) (formerly NYSEG Milliken)	2	PC	Bituminous
Bailly	7	Cyclone	Bituminous
Bay Front Plant Generating	5	Cyclone	Bituminous
Big Bend	BB03	Turbo	Bituminous
Brayton Point	1	PC	Bituminous
Brayton Point	3	PC	Bituminous
Bruce Mansfield	1	PC	Bituminous
Charles R. Lowman	2	PC	Bituminous
Cliffside	1	PC	Bituminous
Clover Power Station	2	PC	Bituminous
Dunkirk	2	PC	Bituminous
Dwayne Collier Battle Cogeneration Facility	2B	Stoker	Bituminous

[79] Santee Cooper also followed the approach in the 2004 Utility MACT proposal by classifying IGCC as an entirely separate subcategory of sources that are dissimilar to bituminous PC units.

Plant	Unit No.	Boiler Combustion Technology	Fuel Mix Tested
Gaston	1	PC	Bituminous
Gibson Generating Station (0300)	3	PC	Bituminous
Gibson Generating Station (1099)	3	PC	Bituminous
Intermountain	2SGA	PC	Bituminous
Jack Watson	4	PC	Bituminous
Logan Generating Plant	GEN 1	PC	Bituminous
Mecklenburg Cogeneration Facility	GEN 1	PC	Bituminous
Navajo	3	PC	Bituminous
Port Washington	4	PC	Bituminous
Presque Isle	5	PC	Bituminous/Pet Coke
Presque Isle	6	PC	Bituminous/Pet Coke
R.D. Murrow Sr. Generating Plant	2	PC	Bituminous
Salem Harbor	3	PC	Bituminous
SEI – Birchwood Power Facility	1	PC	Bituminous
Shawnee Fossil Plant	3	PC	Bituminous/Subbituminous
Valley	2	PC	Bituminous/Pet Coke
Valmont	5	PC	Bituminous
W.H. Sammis	1	PC	Bituminous
Widows Creek Fossil Plant	6	PC	Bituminous

* Based on the data from the 2004 Utility MACT Proposal

6.1.2 Identifying Candidates for Best Controlled Similar Source

The next step of the MACT floor analysis was to identify those similar sources with low mercury emission rates that are good candidates for selection as the "best controlled similar source." Santee Cooper completed this analysis for all of the bituminous coal-fired units listed in Table 2.

Table 3 presents the stack test results for all units identified in Table 2 and ranks these units by performance (based on stack test emission rates), starting at the top with the best performing similar unit that has the lowest mercury emission rate. It should be noted that those units ranked below the Clover unit in Table 3 had significantly higher emissions

than other units in the table. For this reason, Santee Cooper concluded that these units were not good candidates for selection as best performing similar source and therefore eliminated them from further consideration in performing the MACT floor analysis.

Table 3
Mercury Emission Rates from Bituminous Coal-Fired Units Reviewed

Plant	Unit No.	Mercury Emissions (lb/TBtu)
Mecklenburg Cogeneration Facility	GEN 1	0.1062
Dwayne Collier Battle Cogeneration Facility	2B	0.1074
Valmont	5	0.1268
SEI – Birchwood Power Facility	1	0.2379
Intermountain	2SGA	0.2466
Logan Generating Plant	GEN 1	0.2801
Salem Harbor	3	0.3348
Clover Power Station	2	0.3529
W.H. Sammis	1	0.8291
Charles R. Lowman	2	0.9706
Shawnee Fossil Plant	3	1.0507
Presque Isle	6	1.2217
Presque Isle	5	1.2622
Widows Breek Fossil Plant	6	1.3986
Big Bend	BB03	1.5652
Valley	2	1.663
AES Cayuga (NY) (formerly NYSEG Milliken)	2	2.0652
R.D. Morrow Sr. Generating plant	2	2.1269
Bailly	7	2.2306
Navajo	3	2.7359
Jack Watson	4	2.9333
Brayton Point	1	3.2
Bay Front Plant Generating	5	3.5792
Brayton Point	3	3.6979
Cliffside	1	4.3223
Gaston	1	6.0738
Port Washington	4	6.6916

Plant	Unit No.	Mercury Emissions (lb/TBtu)
Dunkirk	2	6.803
Bruce Mansfield	1	7.0985
Gibson Generating Station (1099)	3	9.7452
Gibson Generating Station (0300)	3	29.0614

Table 4 provides a list of the eight top-performing units that Santee Cooper identified as candidates for possible selection as best controlled similar source and for which further evaluation is necessary and appropriate in order to complete the MACT floor analysis. Each of the candidate units is ranked by performance, starting at the top with the best performing unit. In addition, Table 4 presents relevant information for each candidate unit on control technology configuration and the tested mercury emission rate based on information that EPA developed for the 2004 Utility MACT proposal (*i.e.*, ICR-3 stack tests.)

Table 4
Candidate Units for MACT Floor Analysis

Source	Control Configuration	Mercury Emissions (lb/TBtu)
Mecklenburg – Gen 1	FF/SDA	0.1062
Dwayne – 2B	FF/SDA	0.1074
Valmont – 5	FF	0.1268
SEI – Birchwood – 1	FF/SDA	0.2379
Intermountain – 2SGA	FF/WS	0.2466
Logan – Gen 1	FF/SDA	0.2801
Salem Harbor – 3	ESP(CS)	0.3348
Clover – 2	FF/WS	0.3529

FF/SDA = Fabric Filter and Spray Dryer Absorber. FF = Fabric Filter. FF/WS = Fabric Filter and Wet Scrubber. ESP(CS) = Cold-side Electrostatic Precipitator.

6.1.3 Developing Reasonable Estimates of Performance

For the reasons stated in Section 4.2 of the MACT Permit Application, Santee Cooper believes that it is necessary and appropriate to account for variability at each of the candidate units identified in Table 4. Such an analysis is essential for developing a reasonable estimate of the mercury emission levels that the candidate unit has achieved in practice under the worst foreseeable future conditions. Section 4.2 of the MACT Permit Application has presented a two-part framework to account for such variability, which is based upon reasonable approaches that –

- EPA has used or identified as an appropriate method in the 2004 Utility MACT proposal and other prior MACT rulemakings, and
- courts have upheld as being a reasonable estimate of performance by the best controlled similar source under worst reasonably foreseeable circumstances.

Based on this detailed review of acceptable variability methods, Santee Cooper has developed this two-part approach for estimating performance achieved by the identified candidate units based on the type and nature of emission data that are available for these units.

As discussed in Section 4.2 of the MACT Permit Application, Santee Cooper believes that it is appropriate to examine alternative sources of emission variability and to select the source of variability at a given unit that results in the "worst" foreseeable emissions, so long as that estimate of variability is reasonable. The following is a brief description of the two-part framework that Santee Cooper used to evaluate candidates for the best controlled similar source. Both prongs of this framework build upon the overall methodology that EPA used in the 2004 Utility MACT proposed rule.

The first prong of the framework is based on the methodology that the U.S. Department of Energy (DOE) developed to account for mercury emissions variability at coal-fired

electric generating units.[80] (Santee Cooper will refer to this approach as the "EPA-DOE" approach.) DOE specifically developed this variability analysis for setting the MACT floors in the 2004 Utility MACT rulemaking. Under this variability method, DOE used EPA's ICR-2 database on 1999 coal deliveries to calculate the annual average mercury content of coals used at each U.S. power plant reporting data to EPA in 1999, and by rank of coal. DOE assumed foreseeable circumstances for a well-controlled unit would include future use of an alternative coal, and that the worst reasonable scenario would be coal with a mercury content that is equal to the 95th percentile of the annual average coal mercury content (in pounds of mercury per trillion Btu's of heat content) by plant. Santee Cooper modified the DOE approach by adopting EPA's statistical convention in the 2004 MACT proposal, and used a 97.5th percentile "worst" coal. Under this approach, Santee Cooper calculated for each candidate the mercury emission rate that this unit would have achieved if it had burned this 97.5th percentile "worst" annual average coal (as described above), instead of limiting the coal variability to only a single shipment of coal that the unit actually received in 1999. Algorithms used by EPA in its 2004 MACT proposal were employed to reflect the process control variability of certain control configurations, using the combined effect of different mercury (and where available, chlorine) contents in the coals. An example of this calculation for the Mecklenburg Cogeneration Facility is presented in Appendix D of the MACT Permit Application (attached hereto).

The second prong of this framework was based on the variability method that EPA developed for the 2004 Utility MACT proposal. EPA estimated process control variability at a candidate "best performing source" by developing equations that predicted how units would perform using coals other than the coal used during the unit's performance test, and reported in the ICR-3 process. For some emission control configurations, these equations included coal chlorine content and mercury content, for others it included only mercury content. In contrast to the DOE methodology, which

[80] Calculation of Possible Mercury MACT Floor Values for Coal-Fired Utilities: Influence of Variability and Approach, U.S. Department of Energy National Energy Technology Laboratory, December 2003.

examined the "worst" coal in terms of annual average coal quality at every unit using the relevant rank of coal, EPA's approach considered the "worst" coal to be a coal burned for a portion at the unit of the year for which variability was being assessed. This EPA approach, however, has been modified to reflect certain refinements that the NACAA developed in model permit guidance. Santee Cooper will refer to this second approach to variability analysis as the "EPA-NACAA" approach. Specifically, the NACAA guidance provides recommendations on how State permitting authorities could develop MACT standards for industrial boilers.[81] NACAA defined process control variability by statistical evaluation of the differences in the three runs of a unit's performance test. Based on the values of each of the three test runs that led to an average emission rate estimate for a given unit, a "z-statistic" was used to calculate the upper value of an interval that represented the actual mean emission rate, rather than the tested result, with a confidence of 97.5%. For units that lacked a chlorine algorithm in EPA's methodology that estimates process control variability based on the coal chlorine content, this test variability was combined with coal mercury variability at that unit using the same statistical approach used by EPA in their utility MACT proposed rule. An example of this approach, using the Clover unit, is also presented in Appendix D of the MACT Permit Application (attached hereto).

Both approaches for variability analysis were applied to each of the candidate best performing units identified in Table 4. Table 5 presents the results of the variability analysis for the candidate units.

Table 5
Results of Variability Analysis

Unit	Maximum variability due to EPA-DOE approach	Maximum variability due to EPA-NACAA approach	Projected Hg emissions (lbs/TBtu)
Mecklenburg	x		2.06
Dwayne	x		2.06
Valmont	x		3.32

[81] *Reducing Hazardous Air Pollutants from Industrial Boilers: Model Permit Guidance*, National Association of Clean Air Agencies (June 2008), available at the following website address: http://www.4cleanair.org/Documents/RHAP.pdf .

Unit	Maximum variability due to EPA-DOE approach	Maximum variability due to EPA-NACAA approach	Projected Hg emissions (lbs/TBtu)
SEI Birchwood		x	3.95
Intermountain	x		3.98
Logan	x		2.06
Salem Harbor	x		2.49
Clover		x	1.07

6.1.4 Selecting the Best Controlled Similar Source and Setting the MACT Floor Emission Rate

Santee Cooper has identified Clover Power Station Unit 2 as the best controlled similar source for purposes of the Pee Dee MACT floor analysis. This determination is based on the results of the analysis presented in Section 6.1 and included a comparison of the mercury emission rates achieved in practice by all eight candidate units, as calculated by applying the variability analysis described above in Section 6.1.3. Furthermore, Santee Cooper has determined that the MACT floor emission rate for mercury is 1.07 lbs/TBtu, which is equivalent on an output basis to 10 $x10^{-6}$ lb/MWh, gross, based on the design heat rate used by EPA in the 2004 Utility MACT proposal. This level of performance represents the lowest mercury emission rate that is achieved in practice for bituminous coal-fired electric generating units that are similar to the Pee Dee facility and therefore constitutes the MACT floor for mercury.

6.1.5 Assessment of Mercury Emissions Data for the Cross Units

Santee Cooper also has assessed mercury emission data that is currently available for the coal-fired units at the Cross Generating Station. Our assessment indicates that the Cross units have no affect on MACT floor analysis presented for mercury in this MACT Permit Application. This conclusion is based on the fact that none of the Cross units have achieved in practice more stringent mercury emission levels than those achieved by Clover Power Station Unit 2. Furthermore, this conclusion means that the Clover unit still remains the best performing similar source and thereby sets the MACT floor level for mercury even if the Cross emission data were formally included in the MACT floor analysis presented in the MACT Permit Application. Santee Cooper will be submitting

shortly to DHEC a detailed analysis of the emissions control levels that the Cross units are achieving in practice and update the current MACT analysis to include the Cross units.

6.2 "Beyond-the-Floor" Analysis

The final step of the MACT standard-setting process is to perform a BTF analysis for the Pee Dee facility. This analysis focuses on whether the Pee Dee facility can reduce its mercury emissions to levels that are more stringent than the MACT floor level of 10×10^{-6} lb/MWh, gross. Santee Cooper has performed a BTF analysis for the Pee Dee facility in accordance with South Carolina regulations,[82] as described in Section 5 of the MACT Permit Application. In particular, the BTF analysis entailed Santee Cooper performing each of the following technical assessments –

- The estimation of mercury reductions that are achievable by the suite of emission control technologies that initially were proposed for the Pee Dee facility and subsequently enhanced pursuant to the MACT Permit Application;
- The identification of additional potential control options for achieving such further mercury reductions at the Pee Dee facility based on a review of all "available information," as defined by regulation; and
- The evaluation of whether any identified mercury control options justify the adoption of a MACT standard stricter than the floor based on a consideration of the following three factors, cost, non-air quality health and environmental impacts, and energy requirements that are related to achieving the BTF mercury reductions.

The results of each of these technical assessments are briefly presented below.

6.2.1 Estimation of Mercury Reductions by Proposed Control Technologies

As an initial step, Santee Cooper examined the mercury emission reductions that will be achieved by the suite of state-of-the-art control technologies that Santee Cooper initially proposed to use for reducing criteria air pollutants at the Pee Dee facility. These emission control technologies included a wet limestone FGD system, ESP, and a SCR

[82] SC Regulation 61-62.63, Section 63.43. *See* 40 C.F.R. § 63.43 (federal regulations).

system for controlling SO_2, PM, and NO_x respectively.[83] Bituminous coal-fired units equipped with this configuration of emission controls also should be able to achieve very stringent mercury reductions for the following reasons:

- The wet FGD system is highly effective at removing divalent (also known as oxidized) mercury. In those utility units that combust relatively high chlorine eastern bituminous coals, a substantial portion of the mercury is converted to divalent mercury, which is water soluble and easily removed through the wet FGD system.

- The ESP is highly effective at removing particulate-bound mercury during the normal collection of PM from the flue gas.

- SCR systems have demonstrated the ability to convert some of the elemental mercury to the divalent or oxidized form of mercury, which is more easily captured in the downstream control equipment (including wet FGD and wet ESP systems) than elemental mercury.

DOE has estimated in a recent mercury testing program that bituminous coal-fired utility units operating with this suite of control technologies have achieved an average reduction of 85% in mercury emissions.[84]

Although such mercury control levels are clearly very substantial, Santee Cooper has determined that the reductions in mercury and other HAP emissions can be maximized through the use of a fabric filter, instead of an ESP. The fabric filter is highly effective at removing particulate-bound mercury and the passage of gas through the filter cake can also provide additional removal of elemental mercury. Accordingly, Santee Cooper is proposing to equip each of the Pee Dee boilers with a fabric filter, in lieu of an ESP, and believes that this change in PM control technology will significantly increase the mercury

[83] Santee Cooper notes that the PSD application for the Pee Dee facility indicated that both boilers would be equipped with either an ESP or fabric filter given that both are highly effective PM control technologies and would achieve about the same very low PM_{10} emission levels. Prior to DHEC's issuance of the draft PSD permit for the Pee Dee facility, Santee Cooper elected to equip each of Pee Dee units with an ESP, instead of a fabric filter, given the established capability of ESP to operate on the relatively higher sulfur bituminous coals that the Pee Dee facility plans to burn.

[84] This extensive test program involved 10 separate power plants, burning bituminous coals that, with one exception, exceeded 3%S (dry basis). Evaluation of Mercury Emissions From Coal-Fired Facilities with SCR and FGD Systems, Project Final Report, Consol Energy, for USDOE National Energy Technology Laboratory, April 2006.

reduction levels achieved at the Pee Dee boilers. Furthermore, Santee Cooper believes that the combination of a fabric filter with wet FGD and SCR systems will enable the Pee Dee units to achieve an extremely low mercury emission rate while burning the full range of coals upon which the Pee Dee units' business plan is based.

The level of mercury reductions that will actually be achieved in practice, however, is difficult to predict with precision. One overarching reason for this difficulty is that controlling mercury emissions at coal-fired electric utility boilers remains an inexact science. Current efforts are still underway to resolve the many uncertainties on boiler and flue gas chemistry related to mercury emission control, and to gain a better understanding on effective and efficient ways to maximize mercury emission reductions from coal-fired combustion sources. Another important consideration relates to the types of coals that the Pee Dee units are designed to burn. Specifically, the Pee Dee units will be burning an eastern bituminous coal with sulfur content at levels that could diminish the effectiveness of the Pee Dee control technologies. This concern is based, in part, on recent reports indicating that relatively high sulfur bituminous coals have been demonstrated in certain cases to have lower mercury removal levels by particulate collection systems, all other things being equal, as compared to low sulfur units (with and without activated carbon injection).[85] Additional research is necessary to better understand the nature and extent of this problem, as well as techniques for minimizing the diminishing mercury removal efficiencies that may result from the use of higher sulfur coals in some cases.

Notwithstanding all of these uncertainties, Santee Cooper has sought to estimate the mercury emission levels that the Pee Dee units are likely to achieve under the full range of foreseeable operating conditions. Based on the careful evaluation of the preceding considerations, Santee Cooper makes the following conclusions:

[85] Activated Carbon Injection for Mercury Control: Overview, J.Bustard, ADA-ES, Inc., Electric Utilities Environmental Conference, January 29, 2008.

- The control configuration selected for minimizing NO_x, SO_2, and PM at the Pee Dee units is also the best possible configuration of commercially demonstrated controls for reducing mercury emissions.

- There currently is insufficient information to predict exactly the mercury emission rate that the suite of selected pollution control technologies (wet FGD, fabric filter, and SCR) will achieve at the Pee Dee Units.

- For the range of coals expected to be burned at the Pee Dee units, Santee Cooper believes that there is a high probability that mercury reduction generally will range between 90% and 95%.

- For the coal with the highest mercury content likely to be used by the Pee Dee units (Pennsylvania bituminous), performance at about a 92.5% reduction would closely approximate the MACT floor emission rate of 10×10^{-6} lb/MWh, gross.

In conclusion, the Pee Dee units will achieve very substantial mercury emission reductions through the use a wet FGD system, fabric filter, and SCR system. Although the exact reduction levels may be difficult to predict, the Pee Dee units are expected to achieve considerably better than a 90% removal and be able to achieve the MACT floor emission rate under the full range of foreseeable circumstances. However, no additional reduction in allowable emissions from this technology suite is justified through the "beyond the floor" analysis due to the uncertainties in mercury control levels discussed above.

6.2.2 Identification of Potential Control Technologies

Santee Cooper has conducted a detailed review of potential control technologies that might be able to achieve the mercury reductions that go beyond the proposed MACT floor. This review entailed an examination of all "available information" that are required to be considered by the implementing regulations.[86] Specifically, Santee Cooper reviewed and considered, to the extent feasible, all relevant information that is contained

[86] SC Regulation 61-62.63, Section 63.41 (definition of "available information"). *See* 40 C.F.R. § 63.41 (federal regulatory definition of available information).

in the 2004 Utility MACT proposal and each of the other information sources enumerated by regulation.[87]

Two potential mercury control technologies were identified based on Santee Cooper's review of all available information sources. The two technologies identified were sorbent injection and non-thermal plasma. The discussion below provides an evaluation of each identified control technology based on a consideration of the following three factors, cost, non-air quality health and environmental impacts, and energy requirements that are related to achieving the BTF mercury reductions. For the reasons explained below, Santee Cooper has determined that neither technology is an acceptable BTF control option that could justify the adoption of a MACT standard stricter than the proposed floor.

6.2.3 Evaluation of Sorbent Injection

Sorbent injection with activated carbon is increasingly being permitted for new power plant permits that combust subbituminous coals and low sulfur bituminous coals. However, there are significant technical concerns about the effectiveness of activated carbon when used with typical eastern bituminous coals of medium and high sulfur levels.[88] These technical concerns raise significant questions on whether sorbent injection is capable of removing any additional mercury at very well-controlled PC utility units combusting a medium-to-high sulfur bituminous coals, like the Pee Dee facility. Notwithstanding these technical concerns, Santee Cooper has evaluated the effectiveness of sorbent injection as a potential control technology based upon the three-factor test described above in Section 5.2 of the MACT Permit Application.

Cost. The first of three factors is the cost of achieving the HAP emissions reduction by use of sorbent injection. As explained in Section 5.2.1 of the MACT Permit Application, cost effectiveness is typically determined by calculating the annualized incremental cost

[87] A summary of information sources reviewed by Santee Cooper is provided in Appendix C to the MACT Permit Application (attached hereto).
[88] *Impact of Sulfur Oxides on Mercury Capture by Activated Carbons*, Albert A. Presto (Carnegie Mellon) and Evan J. Granite (National Energy Technology Laboratory) (presentation delivered at DOE/NETL 2007 Mercury Control Conference, December 12, 2007).

for removing each ton of HAP emissions that is beyond the MACT floor emission level. In evaluating the cost effectiveness of sorbent injection, Santee Cooper obtained quotes from vendors on the costs of installing and operating an activated carbon sorbent injection system. Cost data for the injection rate and capital equipment cost were provided by Siemens / Wheelabrator. The cost for activated carbon was provided by Norit.

Santee Cooper currently sells nearly all of its fly ash to various users for beneficial use. If activated carbon was injected into the system, the resulting fly ash / activated carbon mixture would no longer be a marketable byproduct and therefore have to be disposed in a landfill. The costs for landfilling the fly ash are based on actual Santee Cooper data and are lower than the average costs listed by DOE.[89] Additional costs would result from the loss of revenue from fly ash sales; revenue data for these sales were provided by Santee Cooper and are also lower than DOE average values.

Based on this information, Santee Cooper estimates the total costs for the use of an activated carbon sorbent injection system on one of the Pee Dee units to be as follows:

- Capital cost $5,200,000
- Annual operating cost $10,889,580

The other key parameter for completing this cost-effectiveness analysis is the incremental amount of mercury that the sorbent injection system would likely achieve at the Pee Dee units. As earlier discussed, it is uncertain at best whether activated carbon injection would remove any additional mercury from a well-controlled unit burning higher sulfur coals, like the Pee Dee units. Notwithstanding this uncertainty, however, Santee Cooper has prepared the following cost-effectiveness analysis that most optimistically assumes that 100% of the remaining mercury emissions would be captured at the Pee Dee units. Santee Cooper is making this unrealistic assumption in order to demonstrate that the

[89] DOE/NETL's Phase II Mercury Control Technology Field Testing Program - Updated Economic Analysis of Activated Carbon Injection, May 2007, footnote d on p. 7.

sorbent injection technology is not a viable control option under any circumstances due to the high costs of the control technology and low amounts of incremental mercury reductions that are possible.

Based on the MACT floor value of 10 x 10^{-6} lb/MWh, gross, mercury emissions from one Pee Dee unit would be approximately 57.8 lb/yr. Assuming that all 57.8 pounds could be removed annually by the activated carbon, the cost effectiveness is $188,349 per pound. This cost is far higher than other determinations of cost effectiveness for mercury, even with an unrealistically optimistic assumption that all mercury could be removed. If, in contrast, a more realistic incremental mercury removal rate were used in the cost-effectiveness calculation, the cost-per-pound removed would be significantly higher. The details of the cost effectiveness calculations for this analysis are provided in Appendix E of the MACT Permit Application (attached hereto).

Section 5.2.1 of the MACT Permit Application provides useful benchmarks for evaluating the cost-effectiveness of the sorbent injection option. All of these benchmarks clearly demonstrate that the use of sorbent injection at the Pee Dee facility is cost prohibitive and therefore should be rejected as a BTF control option. Santee Cooper based this conclusion on the fact that in setting generic MACT standards, EPA has rejected as excessive control costs that are well below the sorbent injection control costs on numerous occasions. One notable example is the Hazardous Waste Combustor MACT where EPA determined that BTF control cost of approximately $4,500/lb for mercury was cost prohibitive and consequently declined to adopt a more stringent limit based on the corresponding BTF control option. Another relevant benchmark noted above is the "safety valve" price for purchasing mercury allowances under CAMR. EPA proposed to set a safety valve prices for mercury at $2,187.50 per ounce, which is equivalent to $35,000 per pound. These and other cost benchmarks noted in Section 5.2.1 provide a strong factual basis for finding that sorbent injection is cost prohibitive and therefore should be eliminated from consideration in setting a MACT standard for mercury emissions from the Pee Dee facility.

Health and Environmental Impacts. There are no significant health impacts associated with the usage of a sorbent in the system. Handling of the sorbent is not significantly different than for other bulk material handling, and dust from sorbent unloading can be minimized through a fabric filter on the storage silo.

However, there are significant adverse environmental impacts associated with the usage of sorbent injection. These can be separated into impacts from usage of activated carbon specifically and from use of mercury sorbent overall. To understand the environmental impacts due to addition of sorbent to the fly ash, an understanding of the current uses for fly ash is necessary. Most fly ash is sold to the cement industry where it can be used in one of two ways.

- Fly ash can be fed to a cement kiln as a raw material replacement, primarily for alumina but also partly for silica, iron and calcium. In this case, the fly ash becomes part of the clinker that is then ground to become cement.
- Fly ash is a pozzolan, whereby it fills the gaps between cement particles and creates stronger concrete than cement alone. When used in this manner, fly ash is blended with finished cement and serves as a cement replacement.

To be used as a cement replacement, the fly ash must meet certain specifications regarding carbon content. When activated carbon is injected as a sorbent, the fly ash carbon content increases and can prevent usage as a cement replacement.

When used as a raw material replacement for cement kiln feed, any mercury sorbent can prevent the usage of fly ash. The Cement MACT, for example, prohibits the usage of fly ash with any mercury sorbent from being used as a raw material replacement in any cement kiln.[90]

Thus, usage of mercury sorbent would likely require Santee Cooper to dispose into nearby landfills over 200,000 tons per year (tpy) of fly ash product that would be generated annually by the Pee Dee facility. That, in turn, would require cement

[90] See generally 71 FR 76518, December 20, 2006.

manufacturers to replace this lost product with an additional 200,000 tpy of raw materials in order to produce an equivalent amount of cement. To illustrate the magnitude of this impact, 200,000 tons of fly ash is equal to approximately 80,000 trucks of replacement product, assuming that each truck carries a payload of 25 tons. This results in a double negative for the environment, with increased virgin material usage and increased landfilling. These adverse environmental impacts of sorbent injection weigh in favor of eliminating sorbent action.

Energy Impacts. There are no direct energy impacts at the Pee Dee units from usage of sorbent injection. However, there are related energy impacts at cement kilns that would otherwise use the ash had the Pee Dee units not included sorbent.

When used as a cement replacement, each ton of fly ash replaces approximately one ton of cement. However, there are no additional energy requirements when a cement kiln uses fly ash, whereas producing one ton of cement through the kiln requires substantial energy. The American Coal Ash Association has estimated that every ton of fly ash used as cement replacement saves the energy equivalent of one ton of coal.[91] Thus, if all 200,000+ tpy of fly ash were used as cement replacement, an equivalent tonnage of coal combustion could be avoided. These energy savings are significant.

In conclusion, the cost of using sorbent injection for mercury control clearly exceeds any reasonable benchmark for cost effectiveness. In addition, there are significant environmental and energy impacts that result from the elimination of fly ash usage in the cement industry. Based on the consideration of these factors, Santee Cooper concludes that sorbent injection should be eliminated as a BTF technology option in setting a mercury MACT standard for the Pee Dee units.

[91] See http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=5 where ACAA discusses the energy savings of cement replacement with fly ash on a carbon dioxide basis, where one ton of carbon dioxide is approximately equivalent to one ton of coal.

6.2.4 Evaluation of Non-Thermal Plasma

Non-thermal plasma has been commercialized by the Powerspan Corporation and is sold as the ECO process (*i.e.*, "electro catalytic oxidation"). Unlike activated carbon that specifically targets mercury control, the ECO process is designed to replace multiple control devices by controlling SO_2 and NO_x instead of using a wet scrubber and SCR.

A small ECO unit was tested on a 50 MW slipstream at the R.E. Burger plant in Shadyside, Ohio. Based on those tests, a mercury removal rate of 85% was achieved by the ECO system, which is consistent with the advertised mercury removal rate by Powerspan of mercury removal efficiencies of 80 to 90%.

Since no full scale test data are yet available for ECO, and no full scale installations are in operation, there are significant questions regarding the commercial availability and potential applicability of this system to Pee Dee. However, as demonstrated below, emission performance of ECO is below the performance of the suite of emission control technology that Santee Cooper is proposing for Pee Dee and thus further analysis of ECO is not necessary based on the consideration of the three factors.

Powerspan marketing information indicates that two full-scale installations are planned. One planned ECO installation is on additional units at the R.E. Burger plant with a projected date for startup in 2011. The other planned installation is for the recently permitted greenfield AMP Ohio facility. For the AMP Ohio facility, the Ohio air pollution control agency required the establishment of mercury emission rate limit based on a Best Available Technology analysis. The final permit for AMP Ohio includes a 1.9 lb/TBtu mercury limit on a 12-month rolling average.

Based on the available data, the ECO process results in less stringent mercury control levels than the mercury control levels than Santee Cooper is proposing for the Pee Dee facility, both in terms of percent removal and mercury emission rate.

Percent Removal. Powerspan claims a removal efficiency of 80 to 90% for ECO and has test data demonstrating 85% removal. By comparison, Santee Cooper is proposing, as discussed above in Section 6.2.1 of the MACT Permit Application, to install a suite of control technologies that should achieve mercury removal efficiencies in the range of 90 to 95%.

Emission Rate. The AMP Ohio final permit limits mercury emissions to 1.9 lb/TBtu. In contrast, Santee Cooper is proposing to achieve a MACT floor emission rate for mercury of 1.07 lbs/TBtu, (converted on an output basis to 10 $x10^{-6}$ lb/MWh, gross), which is well below the AMP Ohio limit.

Since available data indicate that the performance of the ECO system on mercury provides less control than the suite of emission control technologies planned for the Pee Dee facility, non-thermal plasma is eliminated from further consideration in the BTF analysis.

6.2.5 Summary of BTF Determinations

Two potential technologies were identified based on review of all "available information," as defined by regulation and described in Appendix C of the MACT Permit Application. One technology, non-thermal plasma, would provide less mercury control than the currently planned MACT Floor technology for Pee Dee. The other technology, ACI, could potentially provide additional mercury removal. However, even given the most generous assumptions on mercury removal rate, ACI is not cost effective on the well-controlled Pee Dee unit, with the minimum cost for mercury removal at nearly $190,000/lb.

7.0 MACT Determination for Non-Mercury Metal HAPs

For the reasons provided in Section 3.4 of the MACT Permit Application, Santee Cooper is proposing to use PM_{10} filterable as a surrogate for non-mercury metal HAPs that are potentially emitted from the Pee Dee facility. PM_{10} filterable is the relevant pollutant for

metal HAP. The additional larger particulate included in the PM limit (10 μm to approximately 30 μm) does not correlate with metal HAP. Further, the additional condensable particulate included in the PM_{10} (total) limit does not represent metal HAP, but rather predominately acid gases (mainly H_2SO_4).

As can be seen in Table 6 of the Preliminary Determination for Pee Dee, the proposed PM_{10} filterable limit of 0.012 lb/MMBtu is as stringent as any limit for a similar source. Review of Table 6 in fact shows very few limits as low as value proposed for Pee Dee.

Based on the BACT analysis submitted as part of the PSD permit application as well as Table 6 in the Preliminary Determination, the MACT floor level based on achieved in practice is 0.015 lb/MMBtu. There are no permit limits that have been achieved in practice for similar sources that are lower than 0.015 lb/MMBtu.

As part of the BACT review process, which is analogous to the BTF determination, a lower PM_{10} filterable limit of 0.012 lb/MMBtu has been agreed upon.

The MACT determination for metal HAP emissions for Pee Dee is the BACT limit proposed for PM_{10} filterable, which is a BTF level.

8.0 MACT Determination for Acid Gas HAPs

For the reasons provided in Section 3.4 of the MACT Permit Application, Santee Cooper is proposing to use SO_2 as a surrogate for acid gas HAPs (collectively hydrogen chloride and hydrogen fluoride) that are potentially emitted from the Pee Dee facility. As a surrogate for acid gases, either SO_2 or H_2SO_4 could potentially be used, since each is an acid gas. However, SO_2 includes continuous data via the CEMS, while H_2SO_4 is only monitored via sporadic stack tests. The availability of SO_2 CEMS data for compliance monitoring encourages SO_2 as the preferred surrogate for acid gases.

Review of Table 7 and Table 11 from the Preliminary Determination shows that the limits for both SO_2 and H_2SO_4 are the lowest values for a similar unit (*i.e.*, burning predominantly eastern bituminous coal).

Based on the BACT analysis submitted as part of the PSD permit application as well as Table 7 in the Preliminary Determination, the MACT floor level based on achieved in practice is 0.15 lb/MMBtu on a 30-day average. There are no permit limits that have been achieved in practice for similar sources that are lower than 0.15 lb/MMBtu. While Santee Cooper Cross 3 has demonstrated in practice the lower limit of 0.13 lb/MMBtu, the Cross 3 SO_2 limit is on an annual average and cannot be compared directly to a 30-day rolling average. Using a reasonable conversion, the Cross 3 annual average of 0.13 lb/MMBtu would translate into a 30-day average value of at least 0.14 to 0.15 lb/MMBtu.

As part of the BACT review process, which is analogous to the BTF determination, a lower SO_2 limit of 0.12 lb/MMBtu has been agreed upon.

A wet ESP was considered by DHEC as a potential control technology for H_2SO_4 as part of the BACT analysis. However, the Pee Dee project is able to reach very low acid gas emission levels without the addition of a wet ESP, with estimated acid gas emissions of approximately 77 tpy. Given these relatively low emissions and the relatively high capital cost, a wet ESP is clearly not cost effective. Even when only considering the amortized capital costs and zero operating costs, the estimated cost effectiveness value is $165,000 per ton, which is clearly not cost effective.[92]

The MACT determination for acid gas HAP for Pee Dee is the BACT limit for SO_2, which is a BTF level.

[92] Installed capital cost median estimate of $67.5 million from Worley Parsons and Siemens Environmental Systems and Services. Capital recovery factor based on 20 years at 7.0% and equals 9.44% per year, which translates into amortized costs of $6,371,522. Assuming 50% removal of the 77 tpy of acid gas HAPs, the cost effectiveness value is $165,494. Note that this cost only includes the capital cost and no operating costs. Were operating costs included the resulting cost effectiveness value would be somewhat higher.

9.0 MACT Determination for Organic HAPs

For the reasons provided in Section 3.4 of the MACT Permit Application, Santee Cooper is proposing to use CO as a surrogate for organic HAPs that are potentially emitted from the Pee Dee facility. Either CO or VOC could be used as a surrogate for organic HAPs, but the availability of a CEMS for CO results in CO being the preferred surrogate. Further, EPA used CO as the surrogate for organic HAPs in the Boiler MACT.

Unlike the other two HAP categories (acid gases and metals), organic HAPs are not primarily a function of the fuel. Rather, organic HAPs are primarily a function of the combustion process. Similarly, both CO and VOC are controlled by the combustion process, as is a pollutant unrelated to HAP, NO_x. In general, CO/VOC emissions and NO_x emissions trend in differing directions. Thus, attempts to reduce CO/VOC typically result in increases in NO_x emissions, and vice versa.

The current levels of CO and VOC predicted for Pee Dee are based on utilizing state of the art combustion controls. There are no technically feasible control technologies for either CO or VOC in a coal boiler. Oxidation catalysts are used successfully in some combustion sources, such as gas turbines, but they are not technically feasible in a coal boiler due to (1) catalyst contamination by SO_2 and H_2SO_4, (2) erosion by fly ash, (3) high oxidation rates of SO_2 to H_2SO_4, and (4) they are not commercially available based on questionnaires sent to Cormetech Inc, Hitachi Power Systems America and Haldor Topsoe.

As can be seen in Table 9 of the Preliminary Determination for Pee Dee, the proposed CO limit of 0.15 lb/MMBtu is a median value. However, based on the BACT analysis submitted as part of the PSD permit application as well as Table 9 in the Preliminary Determination, the MACT floor level based on achieved in practice is 0.16 lb/MMBtu. There are no permit limits that have been achieved in practice for similar sources that are lower than 0.16 lb/MMBtu.

As part of the BACT review process, which is analogous to the BTF determination, a lower CO limit of 0.15 lb/MMBtu has been agreed upon.

The MACT determination for organic HAP for Pee Dee is the BACT limit for CO, which is a BTF level.

HAP Emission Estimates for Pee Dee

Pollutant	Emission Factor	Units	Source[1]	Emissions per Unit (lb/hr)	(g/s)	(tpy)	Total Emissions (lb/hr)	(tpy)
1,1,1-Tricholorethane	2.00E-05	lb/ton Coal	AP-42, Table 1.1-14	5.18E-03	6.53E-04	2.27E-02	1.04E-02	4.54E-02
2,4-Dinitrotoluene	2.80E-07	lb/ton Coal	AP-42, Table 1.1-14	7.25E-05	9.14E-06	3.18E-04	1.45E-04	6.35E-04
2-Chloroacetophenone	7.00E-06	lb/ton Coal	AP-42, Table 1.1-14	1.81E-03	2.29E-04	7.94E-03	3.63E-03	1.59E-02
5-Methyl Chrysene	2.20E-08	lb/ton Coal	AP-42, Table 1.1-13	5.70E-06	7.18E-07	2.50E-05	1.14E-05	4.99E-05
Acenapthene	5.10E-07	lb/ton Coal	AP-42, Table 1.1-13	1.32E-04	1.66E-05	5.79E-04	2.64E-04	1.16E-03
Acenapthylene	2.50E-07	lb/ton Coal	AP-42, Table 1.1-13	6.48E-05	8.16E-06	2.84E-04	1.30E-04	5.67E-04
Acetaldehyde	5.70E-04	lb/ton Coal	AP-42, Table 1.1-14	1.48E-01	1.86E-02	6.47E-01	2.95E-01	1.29E+00
Acetophenone	1.50E-05	lb/ton Coal	AP-42, Table 1.1-14	3.89E-03	4.90E-04	1.70E-02	7.77E-03	3.40E-02
Acrolein	2.90E-04	lb/ton Coal	AP-42, Table 1.1-14	7.51E-02	9.47E-03	3.29E-01	1.50E-01	6.58E-01
Anthracene	2.10E-07	lb/ton Coal	AP-42, Table 1.1-13	5.44E-05	6.86E-06	2.38E-04	1.09E-04	4.77E-04
Benzene	1.30E-03	lb/ton Coal	AP-42, Table 1.1-14	3.37E-01	4.24E-02	1.48E+00	6.74E-01	2.95E+00
Benzo(a) anthracene	8.00E-08	lb/ton Coal	AP-42, Table 1.1-13	2.07E-05	2.61E-06	9.08E-05	4.15E-05	1.82E-04
Benzo(a) pyrene	3.80E-08	lb/ton Coal	AP-42, Table 1.1-13	9.85E-06	1.24E-06	4.31E-05	1.97E-05	8.62E-05
Benzo(b,j,k) flouranthene	1.10E-07	lb/ton Coal	AP-42, Table 1.1-13	2.85E-05	3.59E-06	1.25E-04	5.70E-05	2.50E-04
Benzo(g,h,i)perylene	2.70E-08	lb/ton Coal	AP-42, Table 1.1-13	7.00E-06	8.81E-07	3.06E-05	1.40E-05	6.13E-05
Benzyl chloride	7.00E-04	lb/ton Coal	AP-42, Table 1.1-14	1.81E-01	2.29E-02	7.94E-01	3.63E-01	1.59E+00
Biphenyl	1.70E-06	lb/ton Coal	AP-42, Table 1.1-13	4.40E-04	5.55E-05	1.93E-03	8.81E-04	3.86E-03
Bis(2-ethylhexyl) phthalate	7.30E-05	lb/ton Coal	AP-42, Table 1.1-14	1.89E-02	2.38E-03	8.28E-02	3.78E-02	1.66E-01
Bromoform	3.90E-05	lb/ton Coal	AP-42, Table 1.1-14	1.01E-02	1.27E-03	4.43E-02	2.02E-02	8.85E-02
Carbon disulfide	1.30E-04	lb/ton Coal	AP-42, Table 1.1-14	3.37E-02	4.24E-03	1.48E-01	6.74E-02	2.95E-01
Chlorobenzene	2.20E-05	lb/ton Coal	AP-42, Table 1.1-14	5.70E-03	7.18E-04	2.50E-02	1.14E-02	4.99E-02
Chloroform	5.90E-05	lb/ton Coal	AP-42, Table 1.1-14	1.53E-02	1.93E-03	6.70E-02	3.06E-02	1.34E-01
Chrysene	1.00E-07	lb/ton Coal	AP-42, Table 1.1-13	2.59E-05	3.26E-06	1.13E-04	5.18E-05	2.27E-04
Cumene	5.30E-06	lb/ton Coal	AP-42, Table 1.1-14	1.37E-03	1.73E-04	6.01E-03	2.75E-03	1.20E-02
Cyanide	2.50E-03	lb/ton Coal	AP-42, Table 1.1-14	6.48E-01	8.16E-02	2.84E+00	1.30E+00	5.67E+00
Dimethyl sulfate	4.80E-05	lb/ton Coal	AP-42, Table 1.1-14	1.24E-02	1.57E-03	5.45E-02	2.49E-02	1.09E-01
Ethyl benzene	9.40E-05	lb/ton Coal	AP-42, Table 1.1-14	2.44E-02	3.07E-03	1.07E-01	4.87E-02	2.13E-01
Ethyl chloride	4.20E-05	lb/ton Coal	AP-42, Table 1.1-14	1.09E-02	1.37E-03	4.77E-02	2.18E-02	9.53E-02
Ethylene dibromide	1.20E-06	lb/ton Coal	AP-42, Table 1.1-14	3.11E-04	3.92E-05	1.36E-03	6.22E-04	2.72E-03
Ethylene dichloride	4.00E-05	lb/ton Coal	AP-42, Table 1.1-14	1.04E-02	1.31E-03	4.54E-02	2.07E-02	9.08E-02
Fluoranthene	7.10E-07	lb/ton Coal	AP-42, Table 1.1-13	1.84E-04	2.32E-05	8.06E-04	3.68E-04	1.61E-03
Fluorene	9.10E-07	lb/ton Coal	AP-42, Table 1.1-13	2.36E-04	2.97E-05	1.03E-03	4.72E-04	2.07E-03
Formaldehyde	2.40E-04	lb/ton Coal	AP-42, Table 1.1-14	6.22E-02	7.83E-03	2.72E-01	1.24E-01	5.45E-01
Hexane	6.70E-05	lb/ton Coal	AP-42, Table 1.1-14	1.74E-02	2.19E-03	7.60E-02	3.47E-02	1.52E-01
Hydrocholoric acid[2]	6.00E-02	lb/ton Coal	AP-42, Table 1.1-15	1.55E+01	1.96E+00	6.81E+01	3.11E+01	1.36E+02
Hydrogen fluoride[2]	7.50E-03	lb/ton Coal	AP-42, Table 1.1-15	1.94E+00	2.45E-01	8.51E+00	3.89E+00	1.70E+01
Indeno(1,2,3-cd) pyrene	6.10E-08	lb/ton Coal	AP-42, Table 1.1-13	1.58E-05	1.99E-06	6.92E-05	3.16E-05	1.38E-04
Isophorone	5.80E-04	lb/ton Coal	AP-42, Table 1.1-14	1.50E-01	1.89E-02	6.58E-01	3.01E-01	1.32E+00
Methyl bromide	1.60E-04	lb/ton Coal	AP-42, Table 1.1-14	4.15E-02	5.22E-03	1.82E-01	8.29E-02	3.63E-01
Methyl chloride	5.30E-04	lb/ton Coal	AP-42, Table 1.1-14	1.37E-01	1.73E-02	6.01E-01	2.75E-01	1.20E+00
Methyl ethyl ketone	3.90E-04	lb/ton Coal	AP-42, Table 1.1-14	1.01E-01	1.27E-02	4.43E-01	2.02E-01	8.85E-01
Methyl hydrazine	1.70E-04	lb/ton Coal	AP-42, Table 1.1-14	4.40E-02	5.55E-03	1.93E-01	8.81E-02	3.86E-01
Methyl methacrylate	2.00E-05	lb/ton Coal	AP-42, Table 1.1-14	5.18E-03	6.53E-04	2.27E-02	1.04E-02	4.54E-02
Methyl ter butyl ehter	3.50E-05	lb/ton Coal	AP-42, Table 1.1-14	9.07E-03	1.14E-03	3.97E-02	1.81E-02	7.94E-02
Methylene chloride	2.90E-04	lb/ton Coal	AP-42, Table 1.1-14	7.51E-02	9.47E-03	3.29E-01	1.50E-01	6.58E-01
Napththalene	1.30E-05	lb/ton Coal	AP-42, Table 1.1-13	3.37E-03	4.24E-04	1.48E-02	6.74E-03	2.95E-02

Pollutant	Emission Factor	Units	Source[1]	Emissions per Unit (lb/hr)	(g/s)	(tpy)	Total Emissions (lb/hr)	(tpy)
PCDD/PCDF (total)	1.76E-09	lb/ton Coal	AP-42, Table 1.1-12	4.56E-07	5.75E-08	2.00E-06	9.12E-07	3.99E-06
Phenanthrene	2.70E-06	lb/ton Coal	AP-42, Table 1.1-13	7.00E-04	8.81E-05	3.06E-03	1.40E-03	6.13E-03
Phenol	1.60E-05	lb/ton Coal	AP-42, Table 1.1-14	4.15E-03	5.22E-04	1.82E-02	8.29E-03	3.63E-02
Propionaldehyde	3.80E-04	lb/ton Coal	AP-42, Table 1.1-14	9.85E-02	1.24E-02	4.31E-01	1.97E-01	8.62E-01
Pyrene	3.30E-07	lb/ton Coal	AP-42, Table 1.1-13	8.55E-05	1.08E-05	3.74E-04	1.71E-04	7.49E-04
Styrene	2.50E-05	lb/ton Coal	AP-42, Table 1.1-14	6.48E-03	8.16E-04	2.84E-02	1.30E-02	5.67E-02
Tetrachloroethylene	4.30E-05	lb/ton Coal	AP-42, Table 1.1-14	1.11E-02	1.40E-03	4.88E-02	2.23E-02	9.76E-02
Tolune	2.40E-04	lb/ton Coal	AP-42, Table 1.1-14	6.22E-02	7.83E-03	2.72E-01	1.24E-01	5.45E-01
Vinyl acetate	7.60E-06	lb/ton Coal	AP-42, Table 1.1-14	1.97E-03	2.48E-04	8.62E-03	3.94E-03	1.72E-02
Xylenes	3.70E-05	lb/ton Coal	AP-42, Table 1.1-14	9.59E-03	1.21E-03	4.20E-02	1.92E-02	8.40E-02
Antimony	1.80E-05	lb/ton Coal	AP-42, Table 1.1-18	4.66E-03	5.88E-04	2.04E-02	9.33E-03	4.09E-02
Arsenic	4.10E-04	lb/ton Coal	AP-42, Table 1.1-18	1.06E-01	1.34E-02	4.65E-01	2.12E-01	9.31E-01
Beryllium	2.10E-05	lb/ton Coal	AP-42, Table 1.1-18	5.44E-03	6.86E-04	2.38E-02	1.09E-02	4.77E-02
Cadmium	5.10E-05	lb/ton Coal	AP-42, Table 1.1-18	1.32E-02	1.66E-03	5.79E-02	2.64E-02	1.16E-01
Chromium (all)	3.39E-04	lb/ton Coal	AP-42, Table 1.1-18	8.78E-02	1.11E-02	3.85E-01	1.76E-01	7.69E-01
Cobalt	1.00E-04	lb/ton Coal	AP-42, Table 1.1-18	2.59E-02	3.26E-03	1.13E-01	5.18E-02	2.27E-01
Manganese	4.90E-04	lb/ton Coal	AP-42, Table 1.1-18	1.27E-01	1.60E-02	5.56E-01	2.54E-01	1.11E+00
Mercury	10.4	lb/TW-hr gross	Case-by-Case MACT	6.60E-03	8.32E-04	2.89E-02	1.32E-02	5.78E-02
Nickel	2.80E-04	lb/ton Coal	AP-42, Table 1.1-18	7.25E-02	9.14E-03	3.18E-01	1.45E-01	6.35E-01
Selenium	1.30E-03	lb/ton Coal	AP-42, Table 1.1-18	3.37E-01	4.24E-02	1.48E+00	6.74E-01	2.95E+00
Total HAP[3]				**20.77**		**90.97**	41.54	181.94

1. Emission factors taken from AP-42, Section 1.1, Bituminous and Subbituminous Coal Combustion, September 1998.

2. Emission factors for all HAP are controlled except for HCl and HF. A 95% control efficiency is assumed for the HCl and HF emission factors, as these compounds are readily controlled by scrubbing systems.

3. Total HAP is conservatively assumed to include all lead emissions.

Differences Between FBC and PC Power Plants That Are Relevant To Mercury Emissions and Emission Controls

Introduction

This paper reviews structural parameters, operating characteristics, and mercury emissions associated with of two methods of producing power from coal: fluidized bed combustion (FBC) and supercritical pulverized coal combustion (SCPC). This information is then viewed within the statutory and regulatory framework established for identifying "similar sources" for purposes of determining Maximum Achievable Control Technology (MACT) for the proposed Pee Dee SCPC units.

Structural differences

There are several fundamental differences between the design and structure of FBC power plants and SCPC power plants. These include:

- The basic approach to combustion. In a FBC boiler, crushed coal is fed into the bottom of a bed of dense particulate material (mostly inert material and limestone) which is suspended, or fluidized, by the upward flow of combustion air, also provided from below. The fluid bed is maintained at approximately 1500° – 1600° F, which is hot enough to ignite the coal, and the heat released by combustion maintains the bed temperature. In a SCPC boiler, coal is fed into the boiler with preheated air through arrays of burners in the furnace walls or corners, usually at multiple elevations within the boiler. As EPA stated in the Preamble to its 2004 Notice of Proposed Rulemaking on mercury emissions from Electric Utility Steam Generating Units, "FBC units employ a fundamentally different process for combusting coal from that employed by conventional-, stoker-, or cyclone-fired boilers."

- Additional hardware. The FBC design includes a cyclonic device to separate large particles, which contain unburned carbon, from flue gases leaving the boiler, so that they can be returned to the boiler for additional energy extraction. SCPC systems do not recycle particles leaving the boiler.

- Coal processing. Because coal crushed to about one-quarter inch diameter is used in an FBC boiler, much less energy is needed to process the coal than in a SCPC boiler. SCPC, as the name implies, must pulverize coal, typically down to the fineness of talcum powder. On the other hand, maintenance of the suspended bed requires additional parasitic power for the FBC design, as more powerful forced draft fans are needed than those used with SCPC units.

- Overall size and efficiency. Most FBC systems are smaller than 300 MW in capacity, with only 4 units in the U.S. exceeding that capacity. No FBC of the size of the proposed Pee Dee units has been built anywhere in the world. All existing FBC systems are subcritical steam designs, the best of which have about 36% efficiency. SCPC boilers have been built up to 1300 MW in generating capacity, and operate above the critical point of steam. The Pee Dee unit is designed for 39.1% efficiency, and will use about 10% less fuel than FBC units of equivalent capacity.

Operational differences

The fundamental design differences in FBC boilers, versus a SCPC boiler such as the proposed Pee Dee unit, lead to different operating characteristics. These include:

- Operating temperature. FBC units operate at a uniform temperature between 1500° and 1600° F, much lower than SCPC units for which the temperature varies within the boiler and is normally above 2500° F at the burners. Temperature has been demonstrated to be an important factor in mercury speciation (whether the mercury exists in particulate, oxidized, or elemental form), which in turn impacts the effectiveness of mercury capture hardware.

- Ash characteristics. The larger coal particle sizes for FBCs tend to result in larger ash particles. Additionally, the lower FBC temperatures tend to result in higher unburned carbon content in the ash, typically about 2% for FBC versus about 0.5% for SCPC. These lower temperatures are below the ash fusion temperature, so the ash in a FBC boiler does not melt or vaporize, resulting in an ash that has a much greater specific surface area. All of these factors cause FBC ash to take on some of the characteristics of activated carbon and should make it much more amenable to mercury adsorption than ash from a SCPC boiler.

- Residence times. FBC gases stay within the boiler area about twice as long as combustion gases remain within a comparable capacity SCPC boiler. In addition, coal particles (which are retained within the fluid bed until their weight diminishes via combustion), remain much longer. The result is that in a FBC unit there is much more opportunity for interaction between mercury in the flue gases and carbon-laden particles, which might adsorb the mercury or otherwise influence flue gas chemistry.

- Boiler chemistry. All power plant FBC units in the U.S. have limestone mixed within the fluid bed material in order to capture SO_2, and SO_2 capture rates of 90% or more are possible. This results in a much more alkaline environment within the FBC boiler than within a SCPC boiler. Additionally, the lower temperature in the FBC results in less NO formation, but generally greater N_2O formation (N_2O is a greenhouse gas). The impact on mercury speciation and capture of this different chemical environment within the FBC boiler versus a SCPC boiler is not fully understood.

Emission differences

There is a modest amount of empirical data available that permits some general observations regarding mercury emissions from FBC units versus from SCPC units.

- Two units in EPA's ICR-3 test program burned either anthracite waste coal or bituminous waste coal in an FBC boiler equipped with a fabric filter for particulate matter control. These units averaged 99.7% and 99.9% mercury reduction. On the other hand, two pulverized coal units burning bituminous coal, at a unit equipped with a fabric filter, achieved only 89.4% mercury reduction. One bituminous coal-fired pulverized coal unit in the ICR test series was equipped with a spray dryer fabric filter (which may more closely parallel the limestone-equipped FBC), and that unit averaged 98.8% mercury reduction. The fraction of emissions passing through the two FBC's equipped with fabric filters was substantially less than that measured for any other mercury control system, on any rank of coal in the ICR-3 test series.

- For lower rank coals burned in pulverized coal units, the ICR-3 generally showed very little mercury capture by particulate collection devices. For example, the Stanton Unit 1 test in the ICR-3 series actually showed more mercury leaving the pulverized coal power plant than entering it, a physical impossibility, but results that strongly support the conclusion that very little mercury capture was taking place in the unit's electrostatic precipitator. Three subbituminous pulverized coal-fired units equipped with electrostatic precipitator spray dryers (for particulate and SO_2 control) also averaged more mercury exiting the control system than entering it. Indeed, in modeling conducted by ICF for EPA in 2006, ICF assumed that pulverized coal units burning lignite achieved no mercury reduction from either electrostatic precipitators or fabric filters. On the other hand, ICF assumed that similarly equipped FBCs achieved 38% and 57% mercury reductions, respectively.

- The Energy and Environmental Research Center at the University of North Dakota conducted multiple mercury research projects for the USDOE/NETL over the past ten years. One of those projects: "Assessment of Mercury Control Options & Ash Behavior in FBC" was funded at $846,000 over two years. The project's Final Report, issued September 30, 2007, concluded with the statement, "The results of mercury control combustion tests using low-rank fuels such as North Dakota lignite indicate that mercury control in a FBC system firing these fuels is more easily achievable than in pulverized coal-fired systems using similar fuels."

Conclusions

The information presented above demonstrates conclusively that, for each of the key legal criteria that are used to identify "similar sources," there are significant differences

between FBC-based power plants and SCPC-based power plants. As a result Santee Cooper believes that FBC systems should not be considered "similar" to the Pee Dee SCPC unit, for purposes of determining MACT.

References

Proposed National Emission Standards for Hazardous Air Pollutants; and, in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units; Proposed Rule, U.S. EPA, January 30, 2004 Federal Register.

Steam: Its Generation and Use, 40th edition, Babcock and Wilcox, 1992.

Final Report, "Assessment of Mercury Control Options & Ash Behavior in FBC", Dr. S. Benson, University of North Dakota Energy and Environmental Research Center, September 30, 2007.

Bin Table.xls, (Results from the ICR-3 test program), U.S. EPA.

Integrated Planning Model, Documentation for EPA Base Case 2006, Section 5: Emission Control Technologies. USEPA website, http://www.epa.gov/airmarkets/progsregs/epa-ipm/index.html .

Information Sources Reviewed for Case-by-Case MACT Determination for the Proposed Pee Dee Facility

This Appendix provides a summary of the informational sources that Santee Cooper reviewed in support of the application for a case-by-case maximum achievable control technology (MACT) determination for the proposed Pee Dee facility (referred to as "MACT Permit Application) pursuant to SC Regulation 61-62.63 and section 112(g) of the Clean Air Act (CAA or Act). Section 1 of the Appendix briefly describes the data sources that Santee Cooper reviewed in performing the MACT floor analysis, while Section 2 of the Appendix summarizes the data sources that Santee Cooper reviewed in completing the "beyond the floor" (BTF) portion of the MACT analysis.

1.0 Data Sources Considered for MACT Floor Analysis

In developing the basis for the MACT floor, a wide range of potential informational sources were initially reviewed to ensure a strong data set for developing the floor. The data sources reviewed included the following.

- 2004 Utility MACT proposal and related rulemaking materials for the Clean Air Mercury Rule (CAMR);
- State mercury rules and permit requirements;
- Case-by-case MACT permits;
- RACT/BACT/LAER Clearinghouse; and
- Toxic Release Inventory

The discussion below summarizes Santee Cooper's review of each of the identified informational sources.

1.1 2004 Utility MACT Proposal and Related CAMR Rulemaking Materials

As part of the rulemaking that led to the 2004 Utility MACT proposal and the related CAMR rulemaking, EPA compiled substantial data on utility emissions. Initially, data

were compiled in the *Electric Utility Steam Generating Units Section 112 Rulemaking* section on the *Technology Transfer Network Air Toxics Web Site*. Later, EPA opened an official rulemaking docket titled *National Emission Standards for Hazardous Air Pollutants for Utility Air Toxics; Clean Air Mercury Rule (CAMR)* [OAR-2002-0056].

EPA gathered considerable data for the 2004 Utility MACT proposal and the related CAMR rulemaking. This data collection effort included EPA issuing multiple "Information Collection Requests" (ICR) to electric utilities nationwide pursuant to section 114 of the CAA. Based on the utility industry's response to the ICR requests, EPA created two comprehensive databases. One is generally referred to as "ICR-2" and includes analyses of over 40,000 coal deliveries to power plants in 1999. The other is generally referred to as "ICR-3" and includes the results of detailed mercury emission stack tests that were conducted in 1999 for 81 coal-fired power plants. Although both databases provide useful information for completing the MACT floor analysis, the ICR-3 provides the most relevant information to determining "the emission control is achieved in practice by the best controlled similar source" [93] – a key element of the MACT floor determination.

1.2 State Mercury Rules

A number of states have developed independent mercury control programs that were fundamentally different from the federal mercury control requirements imposed under CAMR. In some states (*e.g.*, Georgia, North Carolina), the state mercury requirement simply included a requirement that sources achieve mercury emission standards based on best available control technology (BACT). Where case-specific state mercury standards have been set and the facilities are actually constructed, the emissions limits can be useful representations of what sources and agencies believe can be achieved in practice. However, given the newness of these rules, there are no newly permitted sources with case-specific limits that have yet been achieved in practice. Santee Cooper also examined mercury rules that have been developed in other states, particularly those in the Northeast plus Illinois, Wisconsin and Minnesota. Although these states impose stringent

[93] Section 112(d)(3) of the CAA.

mercury control limits, these limits generally do not apply until 2010 or thereafter so that coal-fired utility units in these states are not yet achieving the applicable state mercury standards. Finally, the emission limitations in these programs typically are fundamentally different than required under MACT, making them unsuitable to making the "achieved in practice" determination required for the MACT Floor analysis – absent of actual mercury emissions data (which is unavailable at this time).

Notably, three states have rules that do require compliance in 2008 – Connecticut, Massachusetts, and New Jersey. However, these state standards do not translate effectively to a single unit emission rate standard as required under MACT. The reasons that these standards are not relevant for MACT are generally (1) the standards apply on a facility-basis rather than on a unit-basis; as demonstrated by Santee Cooper's Cross units, three similar units with the same coal feed have widely ranging emission; and (2) the standards offer a percent removal alternative or other "out" clause, while MACT requires a specific emission rate limit.[94] In addition, very little emission data is available for any of the affected units at this time and the information available is not sufficient to evaluate its performance as a part of the MACT floor analysis.

1.3 Case-By-Case MACT Permits

Santee Cooper has considered construction permits that contain case-by-case MACT standards that have been issued to coal-fired utility units pursuant to 112(g) of the Act. This review has included MACT standards that were issued after the December 2000 listing of coal-fired utility units as being subject to MACT, including the most recent case-by-case MACT proposals. Where facilities are actually being constructed, these prior case-by-case MACT permits are relevant to consider in determining the MACT floor.

[94] Connecticut requires meeting either a lb/TBtu standard or a percent removal standard by July 2008, with an out clause if the controls cannot achieve the limitation. Massachusetts similarly requires either a lb/GW-hr limit or a percent removal starting in 2008, with emissions averaging across multiple units at the same facility allowed. New York's standard is based on either lb/GW-hr or percent removal, though a multi-pollutant approach allows an effective out clause from either requirement until 2012.

1.4 RACT/BACT/LAER Clearinghouse

Santee Cooper has reviewed and considered the permitting information contained in EPA's RACT/BACT/LAER Clearinghouse (RBLC). This data base contains information on emission limit determinations made during permitting projects, categorized by source type and pollutant. The RBLC primarily contains information on BACT limits set in PSD permits, since the vast majority of control technology determinations are made for PSD permits; the RBLC was consulted in preparing the BACT analysis for this project. Additionally, there is a much more limited set of data on case-by-case MACT determinations.

For mercury in particular, the RBLC contains a mix of limitations. Since mercury was previously regulated under the PSD program, the RBLC includes multiple BACT determinations for mercury. Additionally, there are a small number of determinations for case-by-case MACT for mercury.

While the RBLC contains a diverse group of data from across the country, data are entered into the system by state agencies as determinations are made. Due to intermittent participation in the RBLC, the database does not contain a robust dataset. Additionally, data entered in the RBLC should generally be checked against the actual permit to verify that the details of each pollutant limit are accurately captured, including averaging time, exceptions, and compliance methods.

While the RBLC does not necessarily represent "achieved in practice" values, for facilities that are actually constructed the limits in the RBLC can be useful representations of what sources and agencies believe can be achieved in practice.[95] Thus, the RBLC data are potentially useful in determining the MACT floor.

[95] Many permits are issued for speculative facilities that are never constructed for various reasons. For these speculative facilities, there are often competing priorities that are critical to transforming the project from speculative into actual project, with timing often being the most significant priority. To try to save these projects from cancellation, developers may agree to emissions limits that are unrealistic solely to speed the permitting timeframe. The rationale appears to be that if the project is saved (built), hopefully the emission limits could be met, but if not, that would be a future problem to solve. Thus, it is important to differentiate permit limits for real, viable, happening projects from speculative projects that never occur.

1.5 Toxic Release Inventory

Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) requires EPA and states to collect annual data on releases of toxic chemicals and to make those data available through the Toxic Release Inventory (TRI). TRI applicability is determined by industry sector and emissions quantity.

Since reporting year (RY) 1998, electric utilities have been included on the list of source categories regulated by TRI, and essentially any coal-fired electric utility has sufficient emissions to exceed TRI reporting thresholds. Thus, a substantial body of emissions data is available through TRI reports.

TRI does include a data field for releases to the air, which is potentially useful. However, while much data are available, the relative data quality of TRI emissions estimates is poor. TRI data can be useful in broad emissions studies, where it is important to obtain a wide range of sources and the accuracy of the data provided for any individual source is less important. However, TRI data are not appropriate to use in determining that the emissions levels that coal-fired utility units have "achieved in practice" for purpose of the rigorous MACT standard-setting process. For these reasons, Santee Cooper only generally reviewed available TRI data, but did not rely on the data in making the MACT floor determination.

2.0 2004 Utility MACT Proposal and Related CAMR Rulemaking Materials

The implementing regulations require DHEC to consider "available information" in evaluating potential control technologies pursuant to the BTF analysis. The term "available information" is defined to include information contained in the 2004 Utility MACT proposal, including "all supporting documentation" and any "background information documents" that might be available for this proposed regulation.[96] As discussed in Section 1 of this Appendix, Santee Cooper has reviewed in detail all relevant

[96] SC Regulation 61-62.63, Section 63.41 (definition of "available information"). *See* 40 C.F.R. § 63.41 (federal regulatory definition of available information).

information in the 2004 Utility MACT, as well as relevant information in the CAMR rulemaking docket in the development of the BTF analysis for the proposed Pee Dee facility. In addition, Santee Cooper has sought to review the other sources of "available information" that are specifically enumerated in South Carolina regulations. Those information sources include the following:[97]

- Data and information available from the Control Technology Center developed pursuant to Section 113 of the Act; and
- Data and information contained in the Aerometric Retrieval System, including information in the MACT database.

Although specifically listed in the implementing regulations, neither of two information sources are currently available under the exact name referenced in the regulations. Santee Cooper therefore reviewed two EPA data sources that are believed to be the current manifestation of the two referenced information sources.

2.1 Control Technology Center

The "Control Technology Center" (CTC) is one of the referenced data sources that is no longer in existences under this specific name.[98] The Control Technology Center merged in 1997 with the RBLC and became known as the Clean Air Technology Center (CATC), which still operates under the same name. Beyond the RBLC, the CATC also provides other products, including technical bulletins on air pollution control technology and the Cost Control Manual.

As noted above in Section 1, Santee Cooper reviewed the RBLC for all coal-fired utility listings regarding mercury. No mercury control technologies (beyond those already listed) were identified from the RBLC review. Review of the technical bulletins on air pollution control in the CATC identified non-thermal plasma as a potential removal technique for mercury. The bulletin provides a brief discussion of a slipstream test by one provider of non-thermal plasma that resulted in additional mercury removal by

[97] SC Regulation 61-62.63, Section 63.41 (definition of "available information"). *See* 40 C.F.R. § 63.41 (federal regulatory definition of available information).
[98] See, for example, the July 1997 *Control Technology Center News*, EPA 456/N-97-002.

converting elemental mercury to the more easily controlled divalent mercury. Based on the EPA databases, non-thermal plasma is potentially effective at removing elemental mercury and is considered further in the BTF analysis of the MACT Permit Application.

2.2 Aerometric Informational Retrieval System

The other specific EPA data source referenced that no longer exists in the same form is the Aerometric Informational Retrieval System. In 2001, the AIRS database was split into Air Facility System (AIRS/AFS) and Air Quality System (AQS). AQS solely addresses ambient concentrations of pollutants; those data are clearly not relevant to a case-by-case MACT analysis. AIRS/AFS tracks the compliance of air pollution sources with EPA regulations and is administered by EPA's Office of Enforcement and Compliance Assistance. It is unclear what usefulness these data could have in developing a case-by-case MACT.

The MACT database referenced here is presumed to be the same one discussed in the final rule for implementing case-by-case MACT, which is included in the regulation at 40 C.F.R. § 63.43(m).[99] Under this regulatory provision, states are required to submit case-by-case MACT determinations to EPA for inclusion in a MACT database. EPA has entitled the database as follows: *The 112(g) MACT Determination State Permit Engineers Clearinghouse.* The database can be viewed at the following web address: http://www.epa.gov/ttn/atw/112g/112gmact/112gmact.html

At the time of preparation of this case-by-case analysis, the web page reported the last update as July 26, 2007. Review of the database shows no electric utility steam generating units listed. The closest related listings are for two sites where combustion turbines were installed in 1999 in North Carolina.

[99] "The EPA has also designed a data management system that will support case-by-case MACT determinations. This data base is called the MACT data base. The EPA is developing guidance documents on how to use the MACT data base." 61 FR 68394, December 27, 1996.

SAMPLE CALCULATIONS FOR VARIABILITY ANALYSES FOR THE MERCURY MACT FLOOR

This Appendix presents sample calculations for the two-part framework that Santee Cooper used to evaluate candidates for the best controlled similar source. Both prongs of this framework build upon the overall methodology that EPA used in the 2004 Utility MACT proposed rule to examine alternative sources of emission variability and to select the source of variability at a given unit that results in the "worst" foreseeable emissions, as a reasonable estimation of variability.

The first prong of this framework was based on the variability method that EPA developed for the 2004 Utility MACT proposal. EPA estimated process control variability at a candidate "best performing source" by developing equations that predicted how units would perform using coals other than the coal used during the unit's performance test, and reported in the ICR-3 process. This EPA approach, however, has been modified to reflect certain refinements that the NACAA developed in model permit guidance. Santee Cooper will refer to this first approach to variability analysis as the "EPA-NACAA" approach.

The second prong of the framework is based on the methodology that the U.S. Department of Energy (DOE) developed to account for mercury emissions variability at coal-fired electric generating units. Santee Cooper will refer to this approach as the "EPA-DOE" approach.

PRONG 1 – EPA / NACAA VARIABILITY EXAMPLE

The Clover unit is used in the following example of determining emission variability based on performance test data and the range of coals used at Clover Power Station in 1999. The basic steps involve:

- When EPA had not previously established an algorithm basing process control variability on the chlorine content of the coal (the fabric filter-wet scrubber

configuration at Clover did not have a chlorine algorithm in EPA's proposed Utility MACT), the first step is calculating a mean and standard deviation for the 3 test runs in the ICR-3 database.

- Determining the upper confidence limit of the average emission rate from the unit, based on these data, at a 97.5% confidence level. Converting this emission rate to an adjusted emission reduction percentage, based on the average uncontrolled mercury emissions from the ICR-3 database.

- Arraying the delivered coal quality data for the unit (by delivery), from EPA's 1999 ICR-2 database, in order of ascending mercury content, and identification of the 97.5% highest mercury coal delivered to the unit in 1999.

- Applying the adjusted emission reduction percentage to the 97.5% worst coal used at the unit in 1999 to obtain an adjusted emission rate, reflecting variability.

For the Clover – Unit 2, these stack test data utilized are as follows:

TABLE D-1
CLOVER – UNIT 2 ICR STACK TEST RESULTS BY RUN

Run	Coal-to-Stack Hg Removal (%)	Hg Emission Rate (lb/TBtu)
1	93.85%	0.5606
2	97.22%	0.3566
3	99.05%	0.1417
Average	*96.71%*	*0.3529*

With the average mercury removal rate and the average mercury emission rate, the average pre-controlled mercury emission rate can be back-calculated using the following formula.

$$ER_{PreControl} = ER_{Control} \div \left(1 - \frac{\%\,Removal}{100}\right)$$

For the Clover – Unit 2 this results in the following estimated average pre-controlled mercury emissions during the 1999 ICR stack testing.

$$10.73\left(lb/TBtu\right) = 0.3530\left(lb/TBtu\right) \div \left(1 - \frac{96.71\%}{100}\right)$$

The standard deviation of the controlled mercury emission rate between each run is calculated as 0.2095. Using the one-tailed z test at a 97.5 percent confidence interval (z-statistic = 1.96), the mercury emission rate after applying process control variability is:

$$0.7635\left(lb/TBtu\right) = 0.3530\left(lb/TBtu\right) + (1.96 \times 0.2095)$$

Considering this 97.5 percent confidence interval with the back-calculated average pre-controlled emission rate, the expected mercury removal rate of the control device configuration on the Clover – Unit 2 is determined by the following equation.

$$\%\,\mathrm{Re}\,moval = \left(1 - \frac{ER_{Control}}{ER_{\mathrm{Pr}\,eControl}}\right) \times 100$$

Or, for the Clover – Unit 2 mercury removal during the ICR test,

$$92.88\% = \left(1 - \frac{0.7635\,lb/TBtu}{10.73\,lb/TBtu}\right) \times 100$$

A mercury removal rate of 92.88% represents the expected coal-to-stack mercury removal rate for the Clover Unit after applying process control variability as described in the MACT Permit Application. With this calculated removal rate, mercury variability in the fuel can then be applied consistent with how EPA applied the worst-case fuel for each source when developing the proposed Utility MACT. For Clover – Unit 2, the equations developed and used by EPA in their proposed Utility MACT for all sources (those with and without a chlorine algorithm), relating the variability in mercury emissions to the varying coal mercury and chlorine content, were applied to Clover coal samples collected under Phase II of the 1999 ICR.

The equation developed for process control variability defined by EPA is as follows:

$$F_r = 1 - \beta \times \exp(-\alpha \times C_{Cl}).$$

Because EPA did not establish a chlorine algorithm for the Clover unit's control configuration, the value of alpha in the above equation is zero. An alpha value of zero in this permissible approach does not tie process control variability to the fluctuation of chlorine concentration in the coal. Also consistent with EPA's proposed Utility MACT where a chlorine algorithm was not established, the value for beta is equal to one minus the expected mercury removal rate. The expected mercury removal rate for the Clover – Unit 2 used in this application of process control variability is the 97.5 percent confidence interval mercury removal of 92.88%:

Using this expected mercury removal rate and the following equation, an estimated controlled mercury emission rate could be estimated for each coal sample collected under Phase II of the ICR.

$$ER_{Controlled}\left(lb/TBtu\right) = \frac{10^6 \times Hg_{Conc.}(ppm) \times (1 - F_r)}{H\left(Btu/lb\right)}$$

Because there were 283 coal samples collected for the Clover – Unit 2 in the ICR-2 database, each of the calculated controlled mercury emissions have not been delineated in this example. Also, as with EPA's approach, the 97.5th percentile worst-case emission rate based on the coal samples was identified. This percentile was determined by sorting the calculated controlled emission rates in ascending order and interpolating between the estimated emission rates that represented the 275th and 276th worst-case emissions, as these represent the 0.9717 and 0.9753 cumulative frequencies, respectively.

The interpolated 97.5th percentile of the calculated mercury emissions for each coal sample was determined to be 1.0654 lb/TBtu for the Clover – Unit 2 using this approach to process control variability and fuel variability, consistent with EPA's proposed Utility MACT.

PRONG 2 – EPA / DOE VARIABILITY EXAMPLE

A second approach to emissions variability as a candidate for best controlled similar source is to follow the methodology used by DOE and cited in EPA's proposed Utility MACT. An example of this approach to variability is provided below, using data for the Mecklenburg Cogeneration Facility – Unit Gen1.

As summarized under the example for the application of Prong 1 – EPA / NACAA variability methodology, the first step in this analysis is to summarize the measured mercury emissions out of the last control device and the measured control device removal rate for each of three valid stack test runs from the 1999 ICR-3 database. For the Mecklenburg – Unit Gen1, the stack test data utilized in this permissible application of variability are as follows:

TABLE D-2
MECKLENBURG – UNIT GEN1 ICR STACK TEST RESULTS BY RUN

Run	Control Device Hg Removal (%)	Hg Emission Rate (lb/TBtu)
1	99.23%	0.1182
2	98.42%	0.1128
3	98.78%	0.0877
Average	*98.81%*	*0.1062*

It should be noted that the Mecklenburg – Unit Gen1 has a control configuration of a spray dryer absorber with fabric filters. To support their 1999 proposed rule for mercury emissions from coal-fired steam electric generating units, EPA defined an algorithm for this control configuration that was utilized to relate emissions to the mercury and chlorine concentration in the coal.[100]

[100] WEST Associates, *Multivariable Method to Estimate the Mercury Emissions of the Best-Performing Coal-Fired Utility Units Under the Most Adverse Circumstances Which Can Reasonably Be Expected to Recur*; prepared by ENSR Corporation, March 4, 2003; Statistical Analysis.

The referenced algorithm is based on the following formula, where alpha and beta define this curve of best fit to the data set of mercury emissions for units with spray dryer absorbers and fabric filters:

$$F_r = 1 - \beta \times \exp(-\alpha \times C_{Cl}).$$

The equation developed in a report by WEST Associates and used by EPA in the proposed Utility MACT identified alpha as 0.0022 and beta as 0.8188 for this control configuration:

$$F_r = 1 - 0.82 \times \exp(-0.002 \times C_{Cl})$$

Using this algorithm, the expected mercury removal rate of the control device including process control variability could be determined for any coal sample based on the chlorine concentration in the coal.

This information was then combined with a possible alternative coal, selected using a technique developed by DOE and cited in EPA's proposed Utility MACT. DOE used the EPA ICR-2 database to estimate, by coal rank, the average coal characteristics at each unit in the U.S. reporting data to EPA in 1999. For this application of variability the 97.5% "worst" coal, in terms of mercury content (measured at a unit over the entire year) was deemed a reasonable alternative coal for use as a candidate best-controlled unit. This turned out to be the annual average coal from the Niles facility. Applying the EPA / West Associates algorithm to this worst coal, provided an expected mercury removal rate for this 97.5th percentile worst-case bituminous coal as:

$$91.63\% = 1 - 0.82 \times \exp(-0.002 \times 1{,}054\, ppm_{Cl})$$

Using this expected mercury removal rate and the following equation, an estimated controlled mercury emission rate could then be estimated for the 97.5th percentile worst-case annual average coal sample from the Niles facility, as collected for the ICR-2 database.

$$ER_{Controlled}\left(lb/TBtu\right) = \frac{10^6 \times Hg_{Conc}(ppm) \times (1 - F_r)}{H\left(Btu/lb\right)}$$

With an annual average mercury concentration of 0.31 ppm, , and process control variability consistent with the chlorine algorithm applied by EPA in the proposed Utility MACT, the controlled mercury emission rate using this approach to fuel variability was calculated to be 2.0641 lb mercury/trillion Btu, or:[101]

$$2.0641\left(lb/TBtu\right)=\frac{10^{6}\times 0.31\left(ppm_{Hg}\right)\times\left(1-\frac{91.63\%}{100}\right)}{12{,}500\left(Btu/lb\right)}$$

[101] It was assumed for this analysis that the annual average heat content of the worst-case bituminous coal would have a heating value of 12,500 Btu/lb. Because the annual average values were calculated for both the mercury and chlorine concentrations in units of lb/Btu, the assumed heating value is only for purposes of this example and does not effect the estimated mercury emissions.

Beyond the Floor Cost Analysis for Controlling Mercury By Sorbent Injection Technology

Cost Analysis Supporting Information for Activated Carbon Injection (ACI)

Parameter	Pee Dee 1	Units	Note(s)
Emissions w/out ACI	10	lb/MW-hr^{-6}	1
Removal Efficiency	100	%	2
Projected Boiler Utilization	100	%	
Pollutant Removed	57.8	lb/yr	3
PAC Injection Rate	7.5	lb/MMacf	4
Baghouse Inlet Airflow	2,200,000	acfm	5
Boiler Max Heat Input	5,700	MMBtu/hr	
Boiler Generation Capacity, Gross	600	MW	
Flyash to Landfill	138,753	tpy	6
Lime Consumption	4,163	tpy	7
PAC Cost	$0.85	$/lb	8
Operating Labor Cost	24.49	$/hr	9
Maintenance Labor Cost	26.95	$/hr	9
Landfilling Haul Cost	$10.00	$/ton	10
Clean Flyash Sale	$5.00	$/ton	11
Lime Cost	$150.00	$/ton	12
Equipment Life	20	years	13
Interest Rate	7.0	%	14
September 1991 $	137.2	n/a	15
April 2008 $	214.8	n/a	15

1. Emissions based on the MACT Floor, as identified for a pulverized coal boiler firing bituminous coal
2. Best-case removal efficiency for conservative cost estimation purposes only.
3. Pollutant Removed (lb/yr) = (Removal Efficiency, %) × (Emissions, lb/MWh) × (Generation, 660 MW) × (Operation, 8760 hrs/yr).
4. Used average of 5 to 10 range from Wheelabrator/Siemens quote for guaranteed 95% coal-to-stack control.
5. Back-calculated from projected PAC injection rate from Wheelabrator/Siemens quote (7.5 lb/MMacf or 990 lb/hr).
6. Assumes the average heat content of coal fired is 13,000 Btu/lb, the average ash content is 8.5%, of which 85% is flyash. Assumes all flyash will have to be landfilled with use of PAC.
7. Assumed 3% by weight of flyash for ash stabilization.
8. PAC cost, as quoted from Norit on May 15, 2008.
9. Cost based on example problem in OAQPS Manual, Section 5.2, Chapter 1, page 1-40, converted from September 1991 $ to 2008 $.
10. Based on actual costs from Santee Cooper used in Worley Parsons design. Lower than estimate of $17/ton in footnote d, page 7 of DOE/NETL's Phase II Mercury Control Technology Field Testing Program - Updated Economic Analysis of Activated Carbon Injection, May 2007.
11. Based on actual costs from Santee Cooper used in Worley Parsons design. Lower than estimate of $18/ton in footnote d, page 7 of DOE/NETL's Phase II Mercury Control Technology Field Testing Program - Updated Economic Analysis of Activated Carbon Injection, May 2007.
12. Cost of Lime at Santee Cooper's Cross Generating Station, June 5, 2008.
13. Consistent with 20 year levelized costs used in: DOE/NETL's Phase II Mercury Control Technology Field Testing Program] - Updated Economic Analysis of Activated Carbon Injection
14. Assumed similar to scrubbers, as referenced per OAQPS Manual, Section 5.2, Chapter 1, page 1-30.
15. Values based on U.S. Historical Consumer Price Index: ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt.

Cost Analysis for Activated Carbon Injection (ACI)

Capital Cost	Pee Dee 1	OAQPS Notation[1]
Purchased Equipment Costs		
Total Equipment Cost[2]	*2,290,000*	*A*
Total Purchased Equipment Costs	*2,290,000*	*B*
Direct Installation Costs		
Total Direct Installation Costs[3]	*620,000*	*C*
Indirect Installation costs		
Total Indirect Installation Costs[4]	*2,290,000*	*D*
Total Capital Investment	**5,200,000**	**TCI = (B+C+D)**

Operating Cost	Pee Dee 1	OAQPS Notation
Direct Annual Costs		
Operating Labor (1/2 hr, per 8-hr shift)	13,407	E
Supervisory Labor	2,011	F = 0.15 x E
Maintenance Labor (1/2 hr, per 8-hr shift)	14,753	G
Maintenance Materials	14,753	H = G
PAC Use	7,371,540	I
Landfilling	1,429,159	J
Lime Use	624,390	K
Lost Revenue from Sale of Ash	693,767	L
Total Direct Annual Costs	*10,163,782*	*DAC = E + F + G + H + I + J + K + L*
Indirect Annual Costs		
Overhead	26,955	L = 0.60 x (E + F + G + H)
Administrative Charges	104,000	M = 0.02 x TCI
Property Tax	52,000	N = 0.01 x TCI
Insurance	52,000	O = 0.01 x TCI
Capital Recovery[5]	490,843	P
Total Indirect Annual Costs	*725,798*	*IDAC = L + M + N + O + P*
Total Annual Cost	**10,889,580**	*TAC = DAC + IDAC*
Pollutant Removed (lb/yr)	57.8	
Cost per pound of Hg Removed	**188,349**	*$/lb = TAC/Pollutant Removed*
Haz Waste Combustor MACT Cost Effectiveness Threshold[6]	4,536	*$/lb Hg = TAC/Pollutant Removed*
Proposed Safety Valve Threshold in CAMR[7]	35,000	*$/lb (converted from $/ounce)*

[1] U.S. EPA OAQPS, EPA Air Pollution Control Cost Manual (6th Edition), January 2002, Section 5.2, Chapter 1. Values based on average requirement specified in OAQPS manual Section 5.2, Chapter 1, pages 1-27 and 1-28 unless otherwise noted.
[2] Estimated cost of Material for Activated Carbon Injection System from Wheelabrator/Siemens budget quote. Assumes this quote includes the cost of instrumentation, sales tax, and freight.
[3] Estimated cost of Balance of Plant (BOP) for Activated Carbon Injection system from Wheelabrator/Siemens budget quote. Assumes this quote includes the cost of foundations and supports, handling and erection, electrical, piping, insulation, and painting.
[4] Estimated cost of labor for Activated Carbon Injection System from Wheelabrator/Siemens budget quote (1.0 times material). Assumes this quote includes the cost of engineering, construction and field expenses, contractor fees, start-up, performance test, and contingencies.
[5] Capital Recovery calculated based on Equations 1.33 and 1.34 of OAQPS Manual, Section 4.2, chapter 1, pages 1-37 and 1.38.
[6] 40 CFR 63 Subpart EEE, 64 FR 52863. Costs of $10,000,000 per mega-gram which converts to $4,536/lb. Note these are 1999 dollars and are not converted here.
[7] See 70 FR 28630. A safety valve was proposed in CAMR though not adopted in the final rule.

Application Requirements for a Case-By-Case MACT Analysis

40 CFR § 63.43(e), *Application requirements for a case-by-case MACT determination,* lists the components of a case-by-case MACT analysis. This section presents the information in the order listed in the Code of Federal Regulations (CFR). For each requirement listed in 40 CFR § 63.43(e), first the verbatim text of the requirement is listed, followed by a response with the applicable information for this project.

Most contents of 40 CFR § 63.43(e) have already been discussed throughout the case-by-case MACT submittal and are repeated here (often briefly) solely for convenience of comparison to the 40 CFR § 63.43(e).

Section 63.43(e)(1)

An application for a MACT determination (whether a permit application under title V of the Act, an application for a Notice of MACT Approval, or other document specified by the permitting authority under paragraph (c)(2)(ii) of this section) shall specify a control technology selected by the owner or operator that, if properly operated and maintained, will meet the MACT emission limitation or standard as determined according to the principles set forth in paragraph (d) of this section.

The control technologies selected to meet the proposed case-by-case MACT limits are listed below.

Mercury:
- Wet limestone scrubbing
- Fabric filter
- Selective catalytic reduction

Metal HAP:
- Fabric filter

Acid Gas HAP:
- Wet limestone scrubbing

Organic HAP:
Proper combustion control

Section 63.43(e)(2)(i)

In each instance where a constructed or reconstructed major source would require additional control technology or a change in control technology, the application for a MACT determination shall contain the following information:
(i) The name and address (physical location) of the major source to be constructed or reconstructed;

Units to be constructed:	Pee Dee 1 Pee Dee 2 (both units share a common exhaust stack)
Address:	2651 South Old River Road Pamplico, South Carolina [Florence County]
Stack Location:	639,253 m East 3,754,781 m North UTM Zone 17

Section 63.43(e)(2)(ii)

A brief description of the major source to be constructed or reconstructed and identification of any listed source category or categories in which it is included;

Pee Dee 1 and Pee Dee 2 will be identical pulverized coal-fired boilers each with a maximum heat input capacity of 5,700 MMBtu/hr. Steam produced by each boiler will generate 660 MW gross. Power produced by the steam generators will be sold to the commercial electricity grid.

Both units are classified as fossil fuel-fired electric utility steam generating units as defined in CAA Section 112(a)(8). The specific subcategory determined in this analysis is based on pulverized coal combustion technology and bituminous coal as the primary fuel.

Section 63.43(e)(2)(iii)

The expected commencement date for the construction or reconstruction of the major source;

Construction on Pee Dee 1 will commence upon issuance of all necessary permits for the project. Construction on Pee Dee 2 will likely commence during construction on Pee Dee 1, similar to the current construction schedule for Cross 3 and Cross 4. However, as allowed under the PSD regulations, Pee Dee 2 could commence construction as late as 18 months after completion of construction on Pee Dee 1.

The estimated date of issuance of the PSD permit and 112(g) determination is fall 2008.[1]

Section 63.43(e)(2)(iv)

The expected completion date for construction or reconstruction of the major source;

Construction is estimated to require approximately four years from the time of commencing construction on each unit.

Section 63.43(e)(2)(v)

The anticipated date of start-up for the constructed or reconstructed major source;

Startup will commence upon completion of construction. Based on the assumption that a PSD permit and Section 112(g) MACT determination both are issued in Fall 2008, the startup of Pee Dee 1 is planned for Summer 2013 and the startup for Pee Dee 2 is planned for Summer 2016.

Section 63.43(e)(2)(vi)

The HAP emitted by the constructed or reconstructed major source, and the estimated emission rate for each such HAP, to the extent this information is needed by the permitting authority to determine MACT;

Table 1 of this report .lists the expected emission rates of the groupings of Metal HAP, Acid Gas HAP, and Organic HAP. Note that these emission estimates are based largely on AP-42 data and may vary (details on the method of calculating emissions are provided in the appendix to the PSD permit application).

A detailed listing of expected emission rates is provided in Appendix A to this report.

The actual future utilization of the units is not known. However, actual controlled HAP emissions may be estimated by multiplying the maximum rates listed by the likely utilization range of 60-99%.[2]

---

[1] Note that the CAA prohibits Santee Cooper from commencing construction until the PSD permit is issued and the 112(g) determination is made.
[2] See 40 C.F.R. § 63.43(e)(2)(viii).

Finally, estimates of emissions magnitude are only required to the extent that DHEC staff need to determine MACT. Since the proposed MACT determination for non-mercury HAP is based on control technologies and surrogate monitoring, non-mercury HAP emission estimates are actually not needed to support this determination.

Section 63.43(e)(2)(vii)

Any federally enforceable emission limitations applicable to the constructed or reconstructed major source;

Section II(A) of the draft PSD permit application lists the federally enforceable emission limitations for Pee Dee 1 and Pee Dee 2 as well as the regulatory basis.

This case-by-case MACT submittal proposes no changes to the relevant emission limitations proposed in the draft PSD permit for SO_2, CO, or filterable PM_{10}.

The case-by-case MACT submittal does propose two changes to the draft PSD permit. First, this case-by-case MACT submittal proposes replacing the planned ESP for particulate control with a fabric filter to better capture Metal HAP, including particulate mercury. Second, the case-by-case MACT submittal proposes a lower mercury emission rate than in the draft PSD permit.

KEY FEDERALLY ENFORCEABLE EMISSION LIMITS IN CASE-BY-CASE MACT [FROM DRAFT PSD PERMIT]

Pollutant	Emission Limit (lb/MMBtu)
PM_{10} (filterable) – Metal HAP Surrogate	0.012
SO_2 – Acid Gas HAP Surrogate	0.12
CO – Organic HAP Surrogate	0.15

The proposed mercury limit in this case-by-case MACT analysis is 10×10^{-6} lb/MW-hr, gross.

Section 63.43(e)(2)(viii)

The maximum and expected utilization of capacity of the constructed or reconstructed major source, and the associated uncontrolled emission rates for that source, to the extent this information is needed by the permitting authority to determine MACT;

The maximum utilization of the two coal boilers is 5,700 MMBtu/hr each. The boilers are being constructed as base load units and will have expected utilizations in the 60-99% range.

Controlled HAP emissions (except for organic HAP, which are not controlled) are addressed in 40 CFR § 63.43(e)(2)(vi). Uncontrolled emissions can be calculated from other tables in the same AP-42 section used to calculate the controlled emissions. This information can be provided to DHEC if needed; however, Santee Cooper does not believe that the uncontrolled information is needed to determine MACT.

Section 63.43(e)(2)(ix)

The controlled emissions for the constructed or reconstructed major source in tons/yr at expected and maximum utilization of capacity, to the extent this information is needed by the permitting authority to determine MACT;

Controlled emissions from the source are presented under 40 CFR § 63.43(e)(2)(vi) for maximum, potential-to-emit conditions. Controlled emissions for expected utilization of 60-99% may be obtained by scaling from the potential-to-emit values.

Section 63.43(e)(2)(x)

A recommended emission limitation for the constructed or reconstructed major source consistent with the principles set forth in paragraph (d) of this section;

Sections 6 through 9 of the case-by-case MACT permit application contain the recommended emission limitations for the Pee Dee units. These limitations are also summarized in 40 CFR § 63.43(e)(2)(vii), and have all been made following the principles set forth in 40 CFR § 63.43(d).

Section 63.43(e)(2)(xi)

The selected control technology to meet the recommended MACT emission limitation, including technical information on the design, operation, size, estimated control efficiency of the control technology (and the manufacturer's name, address, telephone number, and relevant specifications and drawings, if requested by the permitting authority);

40 CFR § 63.43(e)(1) lists the control technologies planned to meet the recommended MACT emission limitations.

Details on the wet scrubber and SCR system have already been provided to DHEC as part of the PSD permit application. Santee Cooper also is proposing to equip the two Pee Dee boilers with fabric filter and has provided information on enhanced removal of mercury and other HAPs. Additional information on the proposed fabric filter will be provided upon request from DHEC. However, Santee Cooper does not believe that additional information on the fabric filter is needed for this MACT determination.

Section 63.43(e)(2)(xii)

Supporting documentation including identification of alternative control technologies considered by the applicant to meet the emission limitation, and analysis of cost and non-air quality health environmental impacts or energy requirements for the selected control technology;

This section refers to the "beyond the floor" (BTF) determination. For mercury, the BTF determination is addressed in Section 6.2 of this report. For non-mercury HAPs, the BTF determination is addressed in Sections 7 through 9 of the case-by-case MACT permit application.

Section 63.43(e)(2)(xiii)

Any other relevant information required pursuant to subpart A.

Santee Cooper is not aware of any additional information required to make a case-by-case MACT determination under this citation.