MONTANA-DAKOTA UTILITIES CO.

LEWIS & CLARK GENERATING STATION

ENVIRONMENTAL CONTROL TECHNOLOGY STRATEGY FOR COMPLIANCE WITH MATS AND REGIONAL HAZE RULES

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Prepared by

Sargent & Lundy LLC

55 East Monroe Street • Chicago, IL 60603 USA • 312-269-2000
www.sargentlundy.com

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SL-011198 REPORT CONTRIBUTORS

Prepared by:

Holly Hills
Environmental Associate

Reviewed by:

Kenneth J. Snell
Sr. Environmental Consultant

Approved by:

Rajendra Gaikwad
Vice President, Environmental Technologies

6/14/13
Date

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EXECUTIVE SUMMARY

Recently promulgated and proposed environmental regulations may have a significant impact on operations at existing fossil fuel-fired power plants. These regulations will require existing coal-fired steam electric generating units to control hazardous air pollutant (HAP) emissions, and will likely require additional reductions of criteria air pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NO_X), and particulate matter (PM, including PM_{10} and $PM_{2.5}$).

Montana-Dakota Utilities Co., a Division of MDU Resources Group, Inc. (Montana-Dakota) contracted with Sargent & Lundy, L.L.C. (S&L) to evaluate emission control technology strategies at its Lewis & Clark Generating Station. The Lewis & Clark Generating Station is a lignite-based steam electric generating station located near Sidney, Montana. The station consists of one lignite-fired boiler (referred to as "Lewis & Clark").

Environmental regulations that will have the most immediate impact on operations at the Lewis & Clark are the federal Regional Haze Rule and the Mercury and Air Toxics Standard (MATS Rule). The Regional Haze Rule requires that each state develop and adopt an implementation plan to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment to visibility in federal Class I Areas which result from man-made pollutants. The MATS Rule regulates HAP emission from coal- and oil-fired electric generating units (EGUs).

On September 18, 2012, the U.S. Environmental Protection Agency (EPA) published in the *Federal Register* its final Federal Implementation Plan (FIP) addressing the regional haze requirements in Montana. Based on EPA's evaluation of the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of Lewis & Clark, and also taking into consideration the relatively small reduction in visibility impacts that may be achieved with the installation of advanced air pollution control systems on Lewis & Clark, EPA concluded that no additional PM, SO_2, or NO_X controls would be required for Lewis & Clark for this regional haze implementation period (i.e., through about 2018). Therefore, this control technology evaluation is based on the assumption that no additional emission reductions or control technologies will be required on Lewis & Clark for regional haze compliance through 2018.

Lewis & Clark will be subject to emission limits and work practice standards in the MATS Rule. The MATS Rule was published as a final rule in the *Federal Register* on February 16, 2012, and includes emission limits for mercury (Hg), acid gases (regulated as hydrochloric acid (HCl) or SO_2), and non-Hg trace metal HAP emissions (regulated as filterable particulate matter (FPM), total non-Hg metals, or individual non-Hg metals). The rule became effective on April 16, 2012, and compliance with the MATS standards will be required by April 16, 2015, with the opportunity for a state approved additional year to install control technologies.

This report identifies the regulatory requirements as they apply to Montana-Dakota's Lewis & Clark Generating Station, and identifies compliance strategies available to the station to meet the applicable regulatory standards. Because the final Montana Regional Haze FIP does not require Lewis & Clark to achieve additional emission reductions, this study focuses on control technologies and strategies that will provide compliance with the final MATS emission limits. Secondary objectives of this study include an evaluation of available SO_2 and NO_X control technologies for their ability to provide additional emission reductions in the event future Regional Haze Reasonable Progress Goal reviews require additional control.

Table ES-1 provides a comparison of existing baseline HAP, and HAP surrogate, emission rates from Lewis & Clark to the applicable MATS emission limits.

Table ES-1. MATS Rule Emissions Limits and Baseline Emissions

Hazardous Air Pollutant		Emissions		Emissions Reduction Requirements
		Baseline Emissions	MATS Limit	
Mercury (Hg)		1.35 lb/TBtu	4.0 lb/TBtu	Unit 1 should meet the MATS Hg emission limit with no additional controls.
Non-Hg HAP Metals	FPM	0.050 lb/MMBtu	0.030 lb/MMBtu	To demonstrate compliance with Non-Hg HAPS using FPM emissions, FPM must be reduced by approximately 40% to an emission rate of 0.030 lb/MMBtu or below.
	Total Non-Hg Metal HAPs	71.7 lb/TBtu	50 lb/TBtu	To demonstrate compliance with the total non-Hg HAP metal emission limit, emissions must be reduced by approximately 30% to an emission rate of 50 lb/TBtu or below. Additional FPM controls would be required to demonstrate compliance using total non-Hg HAP metals.
	Individual Non-Hg Metal HAPs	See Table 3-5	See MATS Rule	Individual non-Hg emission limits were exceeded for arsenic, beryllium, cadmium, chromium, manganese, nickel and lead. Additional FPM controls would be required to demonstrate compliance using individual non-Hg metals.
Acid Gases	Hydrogen Chloride (HCl)	0.00008 lb/MMBtu	0.002 lb/MMBtu	HCl emissions currently meet the MATS emission limit of 0.002 lb/MMBtu.
	SO_2	0.50 lb/MMBtu	0.20 lb/MMBtu	Alternatively for acid gas emissions compliance, SO_2 emissions would need to be reduced by approximately 60% to an emission rate of 0.20 lb/MMBtu or below.

The following regulatory findings are based on a comparison of existing HAP emissions data available from Lewis & Clark to the applicable MATS emission limits, taking into consideration fuel characteristics and existing air pollution control systems:

- Existing mercury emissions from Lewis & Clark are below the MATS Hg emission limit of 4.0 lb/TBtu. Lewis & Clark is expected to meet the MATS Hg emission limit with no additional controls.
- Existing FPM and total non-Hg HAP metal emissions are above the MATS emission limits of 0.030 lb/MMBtu and 50 lb/TBtu, respectively. Upgrades or modifications to the existing flooded wet disk scrubber, or installation of advanced particulate matter control systems (including wet and dry electrostatic precipitation or fabric filter baghouse) are needed to reduce FPM and/or total non-Hg HAP metal emissions below the applicable MATS limits.
- Based on stack test results from Lewis & Clark, existing HCl emissions are well below MATS limit of 0.002 lb/MMBtu. Lewis & Clark should meet the MATS HCl emissions limit with no additional controls. This conclusion assumes that the existing flooded wet disk scrubber, or an equivalent control system, remains in place and operational.
- Existing SO_2 emissions from Lewis & Clark are above the MATS SO_2 emission limit of 0.20 lb/MMBtu (30-day average). Upgrades or modifications to the existing flooded wet disk scrubber, on installation of advanced flue gas desulfurization (FGD) controls, would be needed to reduce SO_2 emissions below the MATS limit. However, Lewis & Clark is not required to meet the SO_2 emissions limit if it can demonstrate compliance with the HCl emissions limit.

Control technologies and compliance strategies were evaluated for their ability to meet all applicable MATS emission limits. Because baseline Hg and HCl emissions are below their respective MATS limits, the evaluation focused on control technologies capable of reducing FPM and/or total non-Hg HAP metal emissions, without adversely affecting Hg and HCl emissions. Table ES-2 provides a summary of the compliance strategies evaluated for Lewis & Clark. Compliance alternatives listed in Table ES-2 are listed by pollutant and divided into primary and secondary alternatives.

Primary alternatives focus on MATS compliance while relying on the existing suite of control technologies for Hg and HCl compliance. Options 1 and 2 include modifications to the existing flooded wet disk scrubber (i.e., installation of a quench spray system) to achieve additional particulate matter removal and demonstrating compliance using a PM Continuous Emissions Monitoring (CEM) System (Option 1) or quarterly stack testing (Option 2). However, stack tests conducted subsequent to the installation of a quench spray system did not show emission reductions sufficient for MATS compliance. Therefore, both options were excluded from further analysis.

The secondary alternatives focus on control technologies capable of reducing SO_2 emissions below the MATS surrogate limit of 0.20 lb/MMBtu. These alternatives are presented for Montana-Dakota's information, as additional SO_2 control is not currently required if Lewis & Clark can demonstrate compliance with the MATS HCl emissions limit. These alternatives may become needed if future Regional Haze Reasonable Progress Goal reviews require additional SO_2 control.

Table ES-2. Compliance Options Summary

Compliance Option	Non-Hg Metal HAPS		Acid Gases		Comments
	FPM	Total Non-Hg Metals	HCl	SO_2	
Primary Compliance Alternatives					
Option 1	Flooded Wet Disk Scrubber Modifications and PM CEMS	Not used	No Control System Modifications (HCl CEMS)	Not used	Least capital. However, testing has shown the quench spray system does not provide the FPM control needed for MATS compliance.
Option 2	Not used	Flooded Wet Disk Scrubber modifications and Stack Modifications for Quarterly Compliance Testing	Stack Modifications for Quarterly Compliance Testing	Not used	Low capital. However, testing has shown the quench spray system does not provide the non-Hg HAP metal emissions control needed for MATS compliance.
Option 3	Baghouse and Mist Eliminator Vessel Modifications and PM CEMS	Not used	Stack Modifications for Quarterly Compliance Testing	Not used	Low risk, high capital.
Secondary Compliance Alternatives – Not Currently Required					
Option 4	Baghouse and PM CEMS	Not used	Not used	Dry Sorbent Injection (DSI) - Trona (SO_2 CEMS)	High capital. Achieves MATS compliance with low compliance risk. SO_2 control is not required at this time as Lewis & Clark can demonstrate compliance with the MATS HCl limit.
Option 5	Baghouse and PM CEMS	Not used	Not used	Lime Spray Dryer (SO_2 CEMS)	High capital. Achieves MATS compliance with low compliance risk. SO_2 control is not required at this time as Lewis & Clark can demonstrate compliance with the MATS HCl limit.

S&L developed conceptual cost estimates for each of the control strategy options capable of achieving MATS compliance. Costs for Option 3 include the baghouse, mist eliminator modifications, demolition of an abandoned chimney, and stack modifications to allow year round quarterly HCl compliance testing. Annual O&M costs associated with Option 3 include auxiliary power costs associated with the baghouse, as well as the costs for bag replacement and maintenance.

Costs for Option 4 include a DSI control system upstream of the new baghouse and demolition of the abandoned chimney. No stack modifications are required for Option 4 (to allow for quarterly stack testing) as compliance would be demonstrated using the existing SO_2 CEMS. Annual O&M costs for Option 4 include auxiliary power costs associated with the DSI and baghouse, bag replacement and maintenance costs, and dry sorbent consumption costs. Sorbent costs were calculated based on the quantity of sorbent (i.e., sodium-based trona) needed to achieve a controlled SO_2 emission rate of 0.20 lb/MMBtu. Costs shown for Option 4 do not include any additional capital or O&M costs that may be incurred to handle and dispose of the sodium contaminated fly ash.

Costs for Option 5 are calculated using EPA's Integrated Planning Model (IPM) Algorithm cost calculations for an SDA FGD control system. The IPM cost algorithms were prepared by S&L for use by EPA. No stack modifications are required for Option 5 (to allow for quarterly stack testing) as compliance would be demonstrated using the existing SO_2 CEMS. Annual O&M costs for Option 5 include auxiliary power costs associated with the SDA and baghouse, bag replacement and maintenance costs, and reagent consumption costs (i.e., hydrated lime). Reagent costs were calculated based on achieving a controlled SO_2 emission rate of 0.20 lb/MMBtu.

Table ES-3 shows the results of S&L's economic evaluation comparing the options.

Table ES-3. Option Economic Comparison Summary [Note 1]

Compliance Strategies		Primary MATS Compliance Alternatives [Note 1]	Secondary MATS Compliance Alternatives	
Option:		**Option 3**	**Option 4**	**Option 5**
Modification:		**Baghouse + Mist Eliminator Vessel Modifications**	**Baghouse + Dry Sorbent Injection (DSI)**	**Baghouse + Dry Flue Gas Desulphurization (FGD)** [Note 2]
Capital Cost	$	$26,142,000	$33,851,000	$43,869,000
Total O&M (First Year)	$/yr	$531,000	$1,929,000	$1,452,000
Net Present Value	$	$39,385,000	$65,266,000	$72,539,000
Levelized Revenue Requirement	$/yr	$5,329,000	$8,830,000	$9,815,000

Note 1 – Costs were not developed for Compliance Options 1 and 2 as stack test data indicate that the quench spray system modifications do not provide sufficient particulate control for MATS compliance. See comments in Table ES-2.

Note 2 – Costs for Option 5 are calculated using EPA's Integrated Planning Model (IPM) Algorithm cost calculations for an SDA FGD control system. The IPM cost algorithms were prepared by S&L for use by EPA. Costs shown do not include AFUDC or owner's costs.

Although Options 1 and 2 represented the lowest cost compliance options, stack test data indicate that the quench spray system modifications proposed for Options 1 & 2 do not provide sufficient particulate control (either FPM or non-Hg HAP metals) for MATS compliance. The most effective control system for particulate matter control includes installation of a new baghouse control system and modifying the mist eliminator vessel (Option 3). Option 3 should achieve all applicable MATS emission limits, including Hg, HCl, and FPM, with low compliance risk. Installation of a baghouse control system, including demolition of the abandoned chimney, will have a project duration, from project authorization to completion, of approximately 23 months. Based on a 23-month project schedule, the project must commence on or before October 2013 to ensure completion prior to the April 2016 compliance deadline.

1. INTRODUCTION

Recently promulgated and proposed environmental regulations may have a significant impact on operations at existing fossil fuel-fired power plants. These regulations will require existing coal-fired steam electric generating units to control hazardous air pollutant (HAP) emissions, and will likely require additional reductions of criteria air pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NO_X), and particulate matter (PM, including PM_{10} and $PM_{2.5}$).

Environmental regulations that will have the most immediate impact on operations at Montana-Dakota Utilities Co.'s Lewis & Clark Generating Station are the federal Regional Haze Rule and the Mercury and Air Toxics Standard (MATS Rule). The Regional Haze Rule requires that each state develop and adopt an implementation plan to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment to visibility in federal Class I Areas which result from man-made pollutants. The MATS Rule regulates HAP emission from coal- and oil-fired electric generating units (EGUs). The rule includes emission standards for mercury (Hg), non-Hg trace metals, and acid gas emissions from existing coal-fired boilers.

This report reviews the status of recently published and proposed environmental regulations, identifies the regulatory requirements as they apply to Montana-Dakota Utilities Co.'s Lewis & Clark Generating Station, and identifies compliance strategies available to the station to meet the applicable regulatory standards.

1.1 *Scope of Study*

Montana-Dakota Utilities Co. (Montana-Dakota) contracted with Sargent & Lundy, L.L.C. (S&L) to evaluate emission control technology strategies for its Lewis & Clark Generating Station. The Lewis & Clark Generating Station is a lignite-based steam electric generating station located near Sidney, Montana. The station consists of one lignite-fired boiler (hereinafter referred to as "Lewis & Clark"). The primary objective of this study is to identify and evaluate air pollution control technologies for their ability to reduce HAP emissions to ensure compliance with the applicable MATS Rule Hg, non-Hg trace metals, and acid gas emission standards. Secondary objectives of the study include an evaluation of available SO_2 control technologies for their ability to provide additional emission reductions in anticipation of future regulatory requirements.

To conduct this study, S&L completed the following tasks:

- Baseline emission rates were developed for each regulated HAP, or HAP surrogate, based on a review of available emissions data from Lewis & Clark, as provided by Montana-Dakota.
- Baseline emissions from Lewis & Clark were compared to the applicable MATS emission limits to identify emission reductions required for MATS compliance.
- For the HAPs, or HAP surrogates, with baseline emissions above the applicable MATS standards, control technologies capable of reducing emissions were identified. Control technology selection was based on expected control efficiencies, and controlled HAP emission rates achieved in practice at other existing coal-fired facilities, taking into consideration boiler size, firing configuration, coal characteristics, existing air pollution control systems, and taking into consideration potential balance-of-plant (BOP) impacts.
- MATS compliance strategies were divided into two categories: Primary MATS Compliance Alternatives, and Secondary MATS Compliance Alternatives. The Primary MATS Compliance Alternatives focus on those control technologies and strategies capable of achieving compliance with the applicable MATS emissions standards. Secondary Compliance Alternatives are provided for Montana-Dakota's information to assess the impacts of installing control technologies capable of reducing SO_2 to comply with the MATS alternate HCl emission rate limit of 0.20 lb SO_2/MMBtu. The Secondary Compliance Alternatives would be applicable only if future Regional Haze reasonable progress reviews or another future environmental regulation would require additional SO_2 control.
- The following information was prepared for the recommended MATS compliance strategies:
  - — Estimated capital costs for each option;
  - — Estimated operations and maintenance (O&M) costs for each option; and
  - — Preliminary implementation schedules.

Relevant information from previous S&L studies was used for input into our evaluation and report, and referenced as applicable.

1.2 *Unit Information*

The Lewis & Clark Station is located near Sidney, Montana. The station consists of one 50-MW dry-bottom tangentially-fired boiler designed to fire lignite coal, but is capable of co-firing lignite with subbituminous Power River Basin (PRB) and natural gas on a limited basis. The unit commenced commercial operation in 1958 and is owned and operated by Montana-Dakota. The unit is equipped with mechanical particulate collectors, as well as a wet particulate scrubber. The flooded wet disk scrubber is primarily designed for PM control, but also provides moderate amounts of SO_2 and HCl control. Fuel additives and activated carbon injection (ACI) are installed for Hg control. Basic design and operating parameters for Lewis & Clark are listed in Table 1-1.

Table 1-1. Lewis & Clark Operating Parameters Summary

Parameter	**Lewis & Clark Unit 1**
Gross unit output	50 MW
General description	Dry bottom, tangentially fired
Nominal full-load heat input	600 MMBtu/hr
Primary fuel	Lignite
NO_X control	Low-NO_X burner (LNB) / close-coupled overfire air (CCOFA)
PM control	Multi-cyclone dust collector and flooded wet disk scrubber
SO_2 control	Flooded wet disk scrubber
Mercury control	Fuel additive and ACI

2. ENVIRONMENTAL REGULATORY SUMMARY REVIEW

A detailed environmental regulatory review, including an evaluation of the MATS Rule and the Montana Regional Haze Rule as they apply to Lewis & Clark, is provided in Appendix A to this report. A brief summary of the Regional Haze Rule and MATS Rule is provided below.

2.1 *Montana Regional Haze Rule*

On July 1, 1999, EPA promulgated a rule under the authority and requirements of sections 169(A) and 169(B) of the Clean Air Act (CAA) establishing a comprehensive plan to address regional haze and visibility impairment in 156 federally-protected parks and wilderness areas (the "Regional Haze Rule"). Among other things, the Regional Haze Rule required each state to develop and adopt an implementation plan to prevent any future and remedy any existing impairment of visibility in the federally-protected parks and wilderness areas ("Class I areas"), which impairment results from man-made air pollutants. Regional Haze State Implementation Plans (SIPs) must give specific attention to existing stationary emission sources that cause or contribute to visibility impairment in a Class I area, and directs states to conduct a Best Available Retrofit Technology (BART) determination for such "BART-eligible" emission sources. In addition, the Regional Haze SIPs must include milestones for establishing reasonable progress (RP) towards the visibility improvement goals, and plans for the first five-year progress period.

On June 19, 2006, the Montana Department of Environmental Quality (MDEQ) informed EPA that the state of Montana was withdrawing its efforts to adopt the provisions of the federal Regional Haze Rule. Because the State of Montana did not address the federal regional haze requirements, EPA Region 8 moved forward with the technical and rulemaking work needed to implement the requirements in Montana under a Federal Implementation Plan (FIP). On September 18, 2012, EPA published in the Federal Register a final rule addressing the regional haze requirements in Montana (the "RH FIP"). As required by the Regional Haze Rule, the final RH FIP includes a determination of the baseline, natural, and current visibility conditions in Class I areas affected by emission sources located in Montana; identifies the existing stationary emission sources in Montana subject to the BART requirements; and establishes BART control technologies and emission limits for the subject-to-BART sources.

Because Lewis & Clark commenced commercial operation prior to August 7, 1962, the unit does not meet the definition of a BART-eligible source under the Regional Haze Rule, and was not identified as a subject-to-BART source in the final RH FIP. However, Lewis & Clark was identified as a Reasonable Progress (RP) source, and EPA prepared a RP determination for the station. The RP determination included an evaluation of technologies available to provide additional NO_X and SO_2 emission reductions from the station. Based on its analysis, EPA concluded that no additional emission controls were required for this regional haze planning period (See Appendix A, Section 3.2).

2.2 *Mercury and Air Toxics Standards Rule*

The MATS Rule, published as a final rule in the Federal Register on February 16, 2012, requires existing coal-fired EGUs to meet HAP emission standards reflecting the application of maximum achievable control technology (MACT). The rule applies to all new and existing coal- and oil-fired EGUs. An EGU is defined in the rule as a fossil fuel-fired combustion unit of more than 25 MW that serves a generator that produces electricity for sale. Based on the definition of EGU in the rule, Lewis & Clark is subject to the applicable MATS standards.

The rule includes HAP emission limits for mercury (Hg), non-Hg trace metals, and acid gases. For the non-Hg trace metals, the MATS Rule includes alternative emission limits for filterable particulate (FPM), total non-Hg HAP metals, and individual HAP metals. For the acid gases, the rule includes alternative emission standards for either hydrochloric acid (HCl) or SO_2 as a surrogate for all acid gases.

2.3 *Regulatory Summary*

Based on the detailed regulatory review provided in Appendix A, the MATS Rule will have the most immediate impact on operations at the Lewis & Clark Generating Station. The MATS Rule applies to all existing coal-fired EGUs, including Lewis & Clark, and includes emission standards for Hg, non-Hg trace metals, and acid gases. Compliance with the MATS emission standards is required by April 16, 2015, with the opportunity for a one-year extension to install air pollution control technologies.

Lewis & Clark is not a BART eligible source, and is not subject to the BART control technology requirements included in the September 2012 Montana RH FIP. Lewis & Clark was identified as a RP source in the RH FIP; however, based on a RP control technology evaluation EPA concluded that no additional emission controls are required for this planning period. Although no additional controls are required for this RH planning period, the possibility exists that additional NO_X, SO_2, and/or PM emission reductions may be required in the next planning period, which is scheduled to begin 2018.

Because the Montana RH FIP does not require Lewis & Clark to achieve any additional emission reductions through at least 2018, the primary objective of the study is to identify control technologies and strategies that will provide compliance with the final MATS emission limits.

3. MATS EMISSION STANDARDS

3.1 *MATS Emission Limits*

The MATS Rule includes emission standards for Hg, non-Hg trace metals, and acid gases. Work practice standards are included to control organic HAP emissions. The rule includes emission standards for two coal-fired EGU subcategories: (1) units designed for coal >8,300 Btu/lb; and (2) units designed for low rank virgin coal (or the "<8,300 Btu/lb" subcategory). EPA concluded that two subcategories were warranted because EGUs firing lower rank coals had significantly different Hg emissions than other coal-fired units. Lewis & Clark currently fires lignite from the nearby Savage Mine; thus, the unit falls into the <8,300 Btu/lb subcategory. MATS emission limits for the <8,300 Btu/lb subcategory are summarized in Table 3-1.

Table 3-1. MATS Emission Limits for Existing Coal- Fired EGUs(1)

Existing Coal-Fired EGUs	Non-HG Metals	Acid Gases	Hg
Existing coal-fired unit designed for low rank virgin coal (i.e., <8,300 Btu/lb)	**Filterable PM(2)** 0.030 lb/MMBtu or **Total non-Hg HAP Metals(3)** 0.000050 lb/MMBtu (0.5 lb/GWh) or **Individual HAP Metals(3)**	**HCl** 0.0020 lb/MMBtu [~2 ppmvd @ 3% O_2] or **SO_2(4)** 0.20 lb/MMBtu	**Hg** 4.0 lb/TBtu (0.04 lb/GWh)

(1) MATS emission limits are based on 30-boiler operating day averages.
(2) The PM emission limit in the final rule includes filterable PM emissions only.
(3) The Total non-Hg HAP Metals emission limits equals the sum of: Antimony (Sb), Arsenic (As), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Lead (Pb), Manganese (Mn), Nickel (Ni), and Selenium (Se). As an alternative to the total non-Hg metals limit, owners/operators can choose to demonstrate compliance with the individual non-Hg metal limits included in Table 2 to Subpart UUUUU of Part 63
(4) The alternate SO_2 limit is available only for coal-fired EGUs using an FGD control system.

The MATS Rule does not require affected units to install specific emission control technologies. Existing coal-fired units are simply required to meet the applicable HAP emission limits using whatever control technology, or combination of technologies, they deem appropriate for their specific situation.

3.2 *Baseline HAP Emissions*

Baseline existing HAP emissions from Lewis & Clark are summarized in Table 3-2. HAP emissions summarized in Table 3-2 are based on an evaluation of available emissions data from stack tests, continuous emissions monitoring system (CEMS) data, and HAP emissions data available from EPA's Information Collection Request (ICR) database.[1]

Table 3-2. MATS Rule Emission Reductions and Baseline Emissions

Hazardous Air Pollutant		Baseline Emissions	Source
Mercury		1.35 lb/TBtu	CEMS
Non-Hg HAP Metals	FPM	0.050 lb/MMBtu	Stack Testing
	Total Non-Hg HAP Metals	71.7 lb/TBtu	Stack Testing. Total Non-Hg HAP Metals emissions have been measured from Lewis & Clark. One test was below the MATS requirement limit of 50 lb/TBtu; however, a subsequent test showed emissions above the MATS limit.
	Individual Non-Hg HAP Metals	See Table 3-5	Stack Testing. Individual Non-Hg HAP metals emission limits were exceeded for arsenic, beryllium, cadmium, chromium, manganese, nickel and lead.
Acid Gases	HCl	0.00008 lb/MMBtu	Stack Testing
	SO_2	0.50 lb/MMBtu	CEMS

3.2.1 *Baseline Hg Emissions*

Lewis & Clark currently uses calcium bromide ($CaBr_2$) solution as an additive to the fuel, in conjunction with activated carbon injection into the flue gas to reduce mercury emissions. Based on data shown in Table 3-3, the unit consistently achieves controlled Hg emissions well below the 4.0 lb/TBtu MATS limit.

Table 3-3. Mercury Emission Rates (All Units lb/TBtu)

	MATS Limit	Baseline Emissions Note 1	Annual Average EmissionRate (2012)	Annual Average Emission Rate (2011)	Annual Average Emission Rate (2010)
Mercury (CEMS)	4.0	**1.35**	1.33	1.35	1.34

Note 1 - Baseline Hg emissions for this evaluation were based on the highest annual average Hg emission rate measured during the period 2010 – 2012.

[1] Additional information regarding HAP emissions data including in EPA's ICR Database is available at: http://utilitymacticr.rti.org/.

3.2.2 *Baseline Non-Hg HAP Metal Emissions*

Three alternatives are available to demonstrate compliance with the non-Hg HAP metal MATS requirements, including: (1) FPM emissions; (2) total non-Hg HAP metal emissions; and (3) individual non-Hg metal emissions.

3.2.2.1 *Baseline FPM Emissions*

The first method of non-Hg HAP metal compliance involves using FPM emissions as a surrogate and maintaining FPM emission below 0.030 lb/MMBtu. Diagnostic FPM stack tests conducted after the quench spray system was installed indicate that the existing multiclones and upgraded flooded wet disk scrubber do not provide the FPM emission reductions needed to meet the MATS FPM limit. Existing FPM emission from Lewis & Clark based on available stack test data are summarized in Table 3-4.

Table 3-4. FPM Emission Rates (All Units lb/MMBtu)

	MATS Limit	Average Baseline Emissions	Baseline Emissions Mid Load (6/2012)	Baseline Emissions Full Load (6/2012)	Baseline Emissions Full Load (9/2012)
FPM	0.030	0.050	0.055	0.054	0.048

3.2.2.2 *Baseline Non-Hg HAP Metal Emissions*

Other non-Hg HAP metal compliance alternatives include a total non-Hg HAP metal emission rate and individual non-Hg metal emission rates listed in the MATS Rule. It can be seen from the stack test results summarized in Table 3-5 that the measured emission rates for certain individual, and total non-Hg HAP metal emissions, exceed their respective MATS emission limit.

Table 3-5. Individual and Total Non-Mercury Metal Emission Rates (All Units lb/TBtu)

Non-mercury HAP	MATS Limit	Average Baseline Emissions	Baseline Emissions Mid Load (6/2012)	Baseline Emissions Full Load (6/2012)	Baseline Emissions Full Load (9/2012)
Antimony	0.8	**0.57**	0.52	0.56	0.62
Arsenic	1.1	6.44	5.79	6.58	6.96
Beryllium	0.2	0.26	0.27	0.26	0.25
Cadmium	0.3	0.45	0.34	0.37	0.65
Chromium	2.8	3.86	4.15	3.97	3.46
Cobalt	0.8	**0.51**	0.50	0.43	0.59
Lead	1.2	4.80	4.30	4.73	5.36
Manganese	4.0	46.38	43.70	47.23	48.20
Nickel	3.5	3.59	2.32	2.16	6.28
Selenium	5.0	**4.78**	4.12	5.02	5.20
Total Non-Hg Metal HAP	<50.0	71.7			

Diagnostic stack testing conducted in June 2011 indicated that certain individual non-Hg HAP metal emissions exceeded their respective MATS limits; however, total non-Hg HAP metal emissions from Lewis & Clark were below the MATS standard of 50 lb/TBtu. Diagnostic stack tests conducted in June 2012, summarized in Table 3-5, also showed certain individual non-Hg HAP metal emissions above their MATS limit (shown in red), but also showed that total non-Hg metal emissions were above the MATS requirement with the current suite of pollution controls.

Diagnostic testing conducted in 2012 found that manganese constitutes a significant majority, approximately 70%, of the total non-Hg metals measured at the stack. Further, manganese emissions measured in 2012 (46.38 lb/TBtu) were more than an order of magnitude higher than the 2011 test result of 2.05 lb/TBtu.

Based on a review of the June 2011 and June 2012 stack test reports, and a review of the Lewis & Clark fuel characteristics, it can be concluded that the 2012 test results are more representative of actual non-Hg HAP metal emissions than the 2011 results for the following reasons. First, based on manganese concentrations in fuel samples taken during the 2011 and 2012 tests, controlled PM emissions, and trace metal emission factors published by EPA, the 2012 stack test results are more consistent with the manganese emission rate calculated using EPA emission factors.[2] Second, based on the concentration of manganese in fuel samples, manganese emissions measured in 2011 and 2012 would be expected to be similar. Third, the 2011 stack test durations (i.e., 60 minutes compared to 120 minutes in 2012) and the volume of gas sampled (i.e., approximately 36 dscf in 2011 compared to approximately 82 dscf in 2012), may not have been sufficient to accurately measure the low non-Hg metal concentrations in the flue gas. Finally, in 2011 the sampling probe and filter box were maintained at 248 °F ± 25 °F, compared to a probe and filter box temperature of 320 °F ± 25 °F used in 2012, which is consistent with the MATS requirements.

For the reasons summarized above, including the manganese concentration in the coal, stack test duration, volume of stack gas sampled, and published EPA emission factors, the June 2012 test results were determined to be more representative of actual non-Hg HAP metal emissions from Lewis & Clark, and were used to establish baseline total and individual non-Hg HAP metals emissions. Based on the 2012 stack test results, it appears that manganese will consistently prevent the unit from being compliant with either the individual or total non-Hg HAP metals emission limits with the existing suite of air pollution control technologies. Therefore, additional particulate matter control is needed for Lewis & Clark to meet the individual or total non-Hg HAP metals emission limits.

3.2.3 *Baseline Acid Gas Emissions*

Diagnostic stack testing in 2012 resulted in very low HCl emissions from Lewis & Clark, measured at 0.00008 lb/MMBtu compared to the MATS limit of 0.002 lb/MMBtu. Existing HCl emissions from Lewis & Clark are summarized in Table 3-6.

[2] See, U.S.EPA, *Compilation of Air Pollutant Emission Factors (AP-42)*, Chapter 1.7 (Lignite Combustion), Table 1.7-12. See also, Electric Power Research Institute, *Electric Utility Trace Substances Synthesis Report – Volume 2: Appendices A through N*, EPRI TR-104614-V2, Project 3081, November 1994, pages B-21 through B-25.

Table 3-6. HCl Emission Rates (All Units lb/MMBtu)

	MATS Limit	Average Baseline Emissions	Baseline Emissions Mid Load (6/2012)	Baseline Emissions Full Load (9/2012)
Hydrogen Chloride (HCl)	0.002	**0.00008**	0.000039	0.000096

3.3 *MATS Emission Reduction Requirements*

Based on a comparison of baseline HAP emissions in Table 3-2 to the applicable MATS emission standards provided in Table 3-1, Lewis & Clark should meet the MATS Hg and acid gas (i.e., HCl) emission standards with the exiting suite of control technologies. Baseline Hg emissions from Lewis & Clark currently average approximately 1.35 lb/TBtu, which is below the MATS standard for lignite-fired units of 4.0 lb/MMBtu. Similarly, baseline HCl emissions from the unit were measured at 0.00008 lb/MMBtu, well below the MATS standard of 0.002 lb/MMBtu.

For the non-Hg HAP metals, the MATS Rule includes alternative emission limits for FPM, total non-Hg HAP metals, and individual HAP metals. Based on stack tests conducted in 2012, emissions of all three alternatives are at, or above the respective MATS standards. FPM emissions from Lewis & Clark currently average approximately 0.050 lb/MMBtu, above the MATS limit of 0.030 lb/MMBtu. Total non-Hg HAP metals have been measured at approximately 72 lb/TBtu (above the limit of 50 lb/TBtu), and certain individual non-Hg trace metals have been measured above their respective limits (see Table 3-5). Therefore, Lewis & Clark will be required to reduce non-Hg trace metal emissions (or FPM emissions) to achieve compliance with the MATS standards.

4. AVAILABLE CONTROL TECHNOLOGIES FOR MATS COMPLIANCE

This section of the report identifies control technologies capable of reducing HAP emissions from Lewis & Clark and evaluates various strategies available to ensure compliance with each applicable MATS emission standard. Although baseline HCl emissions are currently below the MATS standard, alternative acid gas control technologies, focusing on technologies capable of achieving the surrogate SO_2 emission standard are also reviewed. Because baseline FPM (and total non-Hg metal) emissions are currently above the applicable MATS standard, compliance strategies focus on particulate control technologies capable of reducing both FPM and non-Hg metal emissions without resulting in increases of other pollutant emissions.

4.1 *Fuel Switching for Overall Compliance*

4.1.1 *Fuel Switching to Powder River Basin (PRB) Fuel*

Lignite, the primary fuel fired at Lewis & Clark, is supplied to the station from the nearby Savage Mine. The mine, which is owned and operated by Westmoreland Savage Corporation, is located approximately 20 miles south of Sidney, Montana. Lignite is characterized by relatively high moisture content, low heating values, and low sulfur content. Owing to the high moisture content and low heating value, it is generally not economical to transport lignite long distances. Typical fuel characteristics for the lignite currently fired at Lewis & Clark are summarized in Table 4-1.

Table 4-1. Typical Lignite Characteristics [Note 1]

Parameter	Lignite
Proximate Analysis (As Received)	
Moisture	35.9%
Ash	9.9%
Total Sulfur	0.53%
Ultimate Analysis (As Received)	
Carbon	41.9%
Hydrogen	6.54%
Nitrogen	0.54%
Total Sulfur	0.53%
Oxygen	40.6%
Heating Value	6,540 Btu/lb

Note 1 - Fuel characteristics summarized in this table are based on analytical data available from 2012, and may not be representative of all fuels fired at Lewis & Clark.

Fuel switching to fire Powder River Basin (PRB) subbituminous coal is often considered as a strategy to reduce SO_2 emissions from units firing higher sulfur coals. PRB subbituminous coals have a higher heating value than lignite (ranging from approximately 8,000 to 9,000 Btu/lb) and similar low sulfur content. Potential uncontrolled SO_2 emissions associated with firing PRB will be somewhat lower than the potential SO_2 emissions associated with firing lignite (approximately 0.53% sulfur in lignite compared to 0.25% sulfur in PRB); however, additional post-combustion SO_2 control would still be needed to achieve that MATS SO_2 surrogate limit of 0.20 lb/MMBtu.

Like North Dakota/Montana lignite, low-sulfur PRB coals also typically have low chloride content, and correspondingly low HCl emissions. Based on emissions data available in the ICR Database, HCl emissions from PRB-fired units are typically below the MATS acid gas emission standard of 0.002 lb/MMBtu, averaging approximately 0.0011 lb/MMBtu (average of PRB-fired units with no FGD control system). Therefore, fuel switching can be considered as part of a MATS acid gas compliance strategy; however, the feasibility of fuel switching and potential balance-of-plant impacts must be carefully evaluated on a case-by-case basis because of the many site-specific issues that can arise.

In general, there are two main cost components associated with converting to firing PRB coal. One is to address the safety issues (fire and explosion) that are associated with handling of PRB, and the second is to address boiler performance issues. Firing PRB also may result in increased emissions of other MATS regulated air pollutants; thus, PRB-related emission increases must also be taken into consideration when evaluating the feasibility of a fuel switch.

PRB coals have unique characteristics that make them more of a fire and explosion hazard than other coals. PRB coal is more friable (breakable); that is, it fractures more easily, producing a high percentage of fines. The greater friability increases the potential for dust formation. PRB coals also tend to spontaneously combust because of natural oxidation of fine dust causing an increase in localized temperature. Because of the potential for personnel injury and the potential costs associated with equipment or unit availability, additional fire protection and dust control provisions should be included when planning a conversion to PRB coal.

Fire and explosion issues associated with PRB conversions require significant capital costs to address the following principal areas:

- Dust control
- Ventilation
- Housekeeping
- Electrical requirements
- Fire protection
- O&M procedures

In addition to safety concerns, the characteristics of PRB coals impact a power plant's ability to perform in many areas. The key areas impacted are:

- Boiler performance
- Boiler auxiliaries
- Combustion air and flue gas equipment
- ESPs
- SCR systems
- Coal handling
- Ash handling
- Makeup water system
- Wastewater system
- Auxiliary power equipment

At Lewis & Clark, the rail unloading infrastructure is not currently in place to receive PRB fuel. Test burns of PRB have been conducted to assess the feasibility of firing PRB at the unit; however, the unit has experienced high flue gas temperatures and significant fouling to the boiler walls and heat exchange surfaces.

In addition, even though firing PRB may be a technically feasible acid gas compliance strategy, potential impacts on Hg emissions from the unit must be assessed. As described more thoroughly in Section 4.2, the low-chloride levels in PRB fuels results in higher concentrations of elemental mercury in the boiler flue gas. Elemental Hg is more difficult to remove using conventional air pollution control systems than oxidized mercury species (e.g., $HgCl_2$). This change in mercury speciation may result in increased mercury emissions compared to the unit's current baseline. Firing PRB fuel would also change Lewis & Clark's MATS subcategory to the "Unit Designed for Coal >8,300 Btu/lb" subcategory, which requires a mercury emission rate of less than 1.2 lb/TBtu. Also, if firing PRB fuel, Lewis & Clark would no longer be subject to the Montana mercury limit for units firing lignite coal of 1.5 lb/TBtu on a 12-month rolling average, but would be subject to the more stringent Montana mercury limit for units firing subbituminous coal of 0.9 lb/TBtu on a 12-month rolling average. Additional mercury control technologies, or modifications to the unit's existing Hg controls, would likely be required if the unit were to convert to PRB firing.

Because substantial physical modifications would be required to the systems listed above, because test burns indicated significant performance issues associated with PRB, and because potential increases of other MATS-regulated pollutants could result, fuel switching was not considered as part of a MATS compliance strategy for Lewis &Clark.

4.1.2 *Fuel Switching to Beulah, ND Lignite Fuel*

Montana-Dakota has also reviewed the potential option of switching the source of Lewis & Clark's current lignite fuel to Beulah, ND lignite fuel. Based on available analyses, Beulah, ND lignite has similar characteristics to the lignite that is currently fired, including similar individual metal concentrations. Therefore, Lewis & Clark would be expected to experience similar emissions while burning the Beulah, ND lignite fuel, including emissions of the non-Hg HAP metals. However, should Lewis & Clark switch the Beulah, ND lignite fuel, it is likely that the station would no longer be categorized under the MATS Rule as a unit designed to fire low rank virgin coal. The "designed for low rank virgin coal" subcategory is defined in the MATS Rule as "a coal-fired EGU designed to burn, and is burning, nonagglomerating virgin coal having a calorific value (moist, mineral matter-free basis) of less than 19,305kJ/kg (8,300 Btu/lb) that is constructed and operates at or near the mine that produces such coal." (40 CFR 63.10042). It is likely that firing Beulah, ND lignite would not meet the "near the mine" requirement; thus, Lewis & Clark would be subject to the more stringent Hg emission standard applicable to the >8,300 Btu/lb subcategory. In addition, Lewis & Clark does not have rail unloading infrastructure in place to receive Beulah, ND lignite. Because there are no regulatory advantages to firing Beulah, ND lignite and no rail unloading infrastructure, the option was not considered as part of a MATS compliance strategy for Lewis &Clark.

4.1.3 *Natural Gas Conversion*

Converting Lewis & Clark to fire natural gas would reduce SO_2, HCl, Hg, and PM emissions, and natural gas-fired EGUs are currently exempt from the MATS Rule. However, significant modifications to the infrastructure are needed to deliver a firm natural gas supply to the station. As part of the 2012 MT Regional Haze FIP rulemaking process, EPA evaluated the cost-effectiveness of converting Lewis & Clark to natural gas. EPA concluded that natural gas conversion for Regional Haze compliance was not an economical alternative (see, 77 FR 24071 and 77 FR 57905). Therefore, natural gas conversion is not considered an economically viable MATS compliance option.

4.2 *Available Control Technologies for Hg Compliance*

Mercury emissions from coal-fired boilers are a complex function of fuel characteristics (including the concentration of mercury and halogens in the coal), fly ash characteristics, combustion controls, and post-combustion air pollution control systems. During combustion, mercury readily volatilizes from the fuel and is found in the flue gas predominantly in the vapor phase as elemental mercury (Hg^0). As the flue gas cools, a series of complex reactions begin to convert Hg^0 to gaseous ionic (or oxidized) mercury (Hg^{2+}) compounds, and Hg compounds that are in a solid-phase at flue gas temperatures (Hg^p).[3] Mercury speciation testing indicates that the distribution of Hg^0, Hg^p, and Hg^{2+} varies with coal type, and is dependent upon the chloride concentration in the coal.

Mercury removal is a function of the mercury speciation in the flue gas and the unit's air pollution control systems. In general, particulate matter control systems will capture particulate forms of mercury, and FGD control systems will effectively capture oxidized Hg^{2+}. Elemental Hg^0, the primary species in lignite-generated flue gas, is more difficult to capture, and may not be effectively captured in the air pollution control systems designed to capture more conventional pollutants.

4.2.1 Fuel Additives with Activated Carbon Injection

The current mercury control scheme employed at Lewis & Clark consists of both a fuel additive for enhanced mercury oxidation and an activated carbon injection (ACI) control system. Commercial experience has shown that ACI control systems can effectively reduce total mercury emissions from coal-fired power plants. However, the effectiveness of the activated carbon is highly influenced by the mercury speciation in the flue gas, with oxidized mercury being easier to capture. The oxidation of elemental mercury depends on several factors, with one of the most influential being the presence of halogens in the flue gas.

To improve mercury capture with carbon, halogens can be added in the form of halogenated powder activated carbon (PAC) or fuel additives. Fuel additives typically are applied directly to the coal feed belt as a diluted solution of a halogenated compound, usually calcium bromide ($CaBr_2$). The presence of this compound in the fuel will aid in the conversion of elemental mercury to an oxidized compound. The oxidized mercury can then be

[3] See e.g., "Control of Mercury Emissions From Coal-Fired Electric Utility Boilers," U.S. Environmental Protection Agency, Office of Research and Development, Air Pollution Prevention and Control Division, Research Triangle Park, NC.

captured downstream of the economizer with the introduction of activated carbon to the gas stream. ACI would be applied to the flue gas through injection lances either downstream of the economizer or downstream of the air preheaters, at a location that would provide the highest dispersion and ample residence time for the sorbent to achieve adequate contact with the mercury molecules in the gas before reaching the unit's particulate control device.

Mercury reduction effectiveness with PAC has been shown to be temperature limited, as the absorption capacity of the carbon is reduced at temperatures above approximately 350 °F. Flue gas temperatures at the PAC injection location on Lewis & Clark range from 400 °F to approximately 450 °F, which may limit the effectiveness of PAC injection. However, brominated PAC has shown favorable results in low-chlorine, high temperature environments, similar to the existing conditions and mercury control scheme at Lewis & Clark.[4]

The presence of activated carbon may negatively impact the salability of fly ash. Depending on the plans for future air quality control devices, it is possible that the existing Lewis & Clark flooded wet disk scrubber may be taken out of service. Because some mercury removal is expected to be occurring across the scrubber, activated carbon injection rates would likely need to increase if the scrubber is taken out of service, negatively impacting fly ash salability.

Based on CEMS data of mercury emissions on a 12-month rolling average, which are reported to the Montana Department of Environmental Quality on a quarterly and semiannual basis, Lewis & Clark has been able to achieve effective mercury removal with its current mercury controls. Baseline mercury emissions with the existing fuel additive and ACI control systems averaged 1.34 lb/TBtu for the years 2010 - 2012, well below the MATS limit of 4.0 lb/TBtu and the Montana mercury limit of 1.50 lb/TBtu (12-month rolling average). Also, the current mercury control systems can be used in combination with FPM controls, such as a baghouse. Because the current control strategies are providing effective mercury removal, other potentially available mercury control strategies were not evaluated.

[4] Lockert, C., Zhang, Y., Zhou Q. (2006) "Update on Sorbent-Based Mercury Control in Hot-Side ESP Environments" in Electric Utility Environmental Conference, January 24, 2006, Tucson, AZ.

4.3 *Available Control Technologies for Acid Gas Compliance with HCl*

As discussed in Section 3.2, baseline HCl emissions from Lewis & Clark are currently below the applicable MATS emissions limit. The low baseline HCl emissions are a function of the low chlorine content in North Dakota/Montana lignite, and acid gas removal in the existing scrubber. Stack test data suggest that the existing flooded wet disk scrubber is not only an effective SO_2 removal device, but also effective at removal of HCl, because of the flue gas contact with the scrubber slurry. Calcium present in the fly ash, and any added calcium from hydrated lime in the slurry, will readily react with SO_2 and HCl in the flue gas. Stack test results showed HCl emission rates from Lewis & Clark of 0.00008 lb/MMBtu, well below the MATS limit of 0.002 lb/MMBtu. This result is consistent with units that fire fuels with low chlorine concentrations and high levels of alkalinity, such as the fuels at Lewis & Clark. Therefore, Lewis & Clark should achieve compliance with the MATS acid gas requirements with the existing suite of air pollution control equipment.

Depending on the results of this MATS compliance evaluation, the possibility exists that the existing flooded wet disk scrubber may be taken out of service. In the event the scrubber is removed from service, co-benefit HCl control currently achieved in the scrubber would no longer be available. Based on the lignite fuel characteristics, HCl emissions from Lewis & Clark would still be low, even without the wet disk scrubber. However, in the event additional HCl removal is required for MATS compliance, alternative retrofit HCl and SO_2 control systems are evaluated below.

4.3.1 Dry Sorbent Injection

Dry sorbent injection (DSI) can be an effective method for HCl control, while also lowering SO_2 emissions. A detailed description of DSI control is provided in subsection 4.4.5. However, highly reactive sodium sorbents react preferentially with SO_2 and SO_3, which results in increased sorbent feed rates when only HCl is targeted. As an alternative, hydrated lime (calcium hydroxide, $Ca(OH)_2$), effectively captures HCl, but is less reactive toward SO_2, and is the preferred sorbent when only targeting HCl because of its selectivity towards HCl. Therefore, hydrated lime is the likely sorbent that would be used to mitigate HCl emissions.

Hydrated lime reacts with HCl according to the following chemical reactions:

$$Ca(OH)_2 + Cl \rightarrow CaClOH + H_2O$$
$$CaClOH + HCl \rightarrow CaCl_2 + H_2O$$

For sodium sorbents, at elevated temperatures, both Trona ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$) and sodium bicarbonate ($NaHCO_3$) convert to sodium carbonate. Subsequently, the sodium carbonate reacts with HCl according to the following chemical reactions:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

Baseline measurements of HCl at Lewis & Clark are well below the MATS requirement. Calcium present in the fly ash and any added calcium from hydrated lime added in the wet scrubber slurry will readily react with HCl in the flue gas. However, due to the additional solids loading to the wet scrubber, all options that consider DSI in this report require the use of a baghouse, and the existing scrubber would be taken out of service. Without the wet scrubber in service, the added benefit of gas-liquid reaction is no longer available and testing must be conducted to determine how much HCl removal can be expected when the flooded disk scrubber is taken out of service.

The required sorbent injection rates to control HCl emissions would be much lower than what would be required to inject for SO_2 control. Since the station will be required to control SO_2 at least to their current emissions, S&L assumes that with such large injection rates for SO_2 control, there will be enough sorbent injected to ensure control of HCl emissions. Therefore, the HCl emission rate should remain below the MATS standard of 0.002 lb/MMBtu at the high injection rates and a DSI system specifically targeting HCl was not evaluated further.

4.4 *Available Control Technologies for Acid Gas Compliance with SO_2*

As discussed in Section 3.1, the MATS acid gas requirements can be met by using either HCl or SO_2 emissions. Although baseline HCl emissions are below the MATS standard, Lewis & Clark has the option of demonstrating compliance with the MATS acid gas limit by installing additional control technologies to reduce SO_2 emissions from a baseline rate of 0.50 lb/MMBtu to below the 0.20 lb/MMBtu SO_2 surrogate acid gas limit. Furthermore, as discussed in Section 2.1, additional SO_2 removal is not currently required under Regional Haze for Lewis & Clark. However, S&L has provided information regarding SO_2 control technologies to address the potential that future Regional Haze Reasonable Progress reviews may require additional SO_2 reductions. Since the primary focus of this report is MATS compliance, S&L has evaluated the technologies capable of achieving 0.20 lb SO_2/MMBtu, which is the limit that allows SO_2 to be used as the surrogate to demonstrate compliance with the MATS acid gas requirements. From review of historic SO_2 continuous emissions monitoring data included in Montana-Dakota's Control Analysis for Lewis & Clark Station Unit 1- June 2011, the average SO_2 emission rate at Lewis & Clark is approximately 0.50 lb/MMBtu.

4.4.1 Wet Disk Scrubber

Lewis & Clark is equipped with a "flooded" wet disk scrubber, which is intended to be a particulate removal device but also serves as the unit's primary SO_2 emissions control. In the wet disk scrubber, flue gas coming from the induced draft (ID) fan enters a Venturi where it comes in contact with fly ash/lime slurry. The slurry is tangentially fed into the Venturi throat, creating a quench zone above an adjustable flooded disk. The contact with the slurry quenches the flue gas down to its adiabatic saturation temperature and removes fly ash particles. The system also removes acid gases by using the natural alkalinity of the fly ash and the lime. At the moment of contact between the hot flue gas and the slurry, water is evaporated, at which point the SO_2 reacts with the calcium in the fly ash and lime. These reactions will form calcium sulfites and sulfates according to the flowing chemical reactions:

$$Ca^{2+}(g) + SO_3^{2-} \rightarrow CaSO_3$$
$$Ca^{2+}(g) + SO_4^{2-} \rightarrow CaSO_4$$

SO_2 removal in the particulate scrubber is moderate at approximately 60%, but may be capable of achieving up to 70% removal depending on the amount of fresh lime added and the alkalinity of the fly ash. However, even at a removal efficiency of 70%, SO_2 emissions from Lewis & Clark will be above the MATS limit of 0.20 lb/MMBtu, and, it is S&L's opinion that the existing flooded wet disk scrubber cannot consistently achieve controlled SO_2 emissions of 0.20 lb/MMBtu or less (*Control Analysis for Lewis & Clark Station Unit 1 - June 2011*,). Since HCl can be used to demonstrate compliance with the MATS acid gas standard, no further evaluation of modifications the existing wet scrubber for SO_2 control was conducted.

4.4.2 Wet Limestone FGD

In a wet limestone FGD system, flue gas from the particulate collection device is directed into an absorber tower, where it is brought into contact with a limestone-water slurry. The slurry is produced by mixing limestone with water and grinding it in a ball mill. Flue gas comes into contact with the limestone slurry in a countercurrent absorber tower, with the flue gas passing upward through the absorber tower, while the slurry is sprayed downward through a series of spray nozzles. As the flue gas and slurry come into contact, SO_2 is removed, and the flue gas becomes saturated with the water. After passing through a series of mist eliminators, the saturated flue gas will exit the top of the absorber and out a wet stack. The key parameters that determine overall SO_2 removal efficiencies with a wet limestone FGD include flue gas velocity in the absorber, liquid-to-gas ratio, pH, inlet SO_2 concentration, and reagent stoichiometry (the ratio of calcium fed via the limestone to SO_2 in the flue gas).

The SO_2 first absorbs into the water phase and reacts to form sulfurous acid, which rapidly dissociates to produce bisulfite (HSO_3^-) ion and hydrogen (H+) ion according to the following reactions:

$$SO_2(g) + H_2O \leftrightarrow H_2SO_3\ (aq)$$
$$H_2SO_3 \leftrightarrow H^+ + HSO_3^-$$

An acid-base neutralization reaction occurs to control the acidity by removing the hydrogen ions, which allows SO_2 absorption to continue according to the following chemical reaction:

$$CaCO_3 + H^+ + HSO_3^- \rightarrow Ca^{2+} + SO_3^{2-} + H_2O + CO_2\ (g)$$

In the reaction tank, at the bottom of the absorber tower, the products of the above reactions accumulate and further react to form a mixture of calcium sulfite hemi-hydrate and hydrated calcium sulfate (gypsum) according to the following chemical reactions:

$$Ca^{2+}(g) + SO_3^{2-} + \frac{1}{2}H_2O \rightarrow CaSO_3 \cdot \frac{1}{2}H_2O$$
$$Ca^{2+}(g) + SO_4^{2-} + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O\ (gypsum)$$

The extent to which each of these products forms is highly dependent on the degree of oxidation occurring within the reaction tank, with more gypsum forming at higher degrees of oxidation. A forced oxidation system typically is employed because the addition of air drives reaction to complete oxidation, which helps prevent the formation of scale in the absorber.

A dewatering island consisting of hydroclones followed by rotary drum or belt filters are used to remove water from the byproduct. Depending on the purity and moisture content, the final product can be sent to landfill or potentially sold for use in the wallboard, cement, or agricultural industries.

The wet limestone FGD process typically is applied to larger units burning medium- to high-sulfur fuels. Because of the high capital costs associated with this technology, it generally is not economically justified to apply wet FGD to small units, such as Lewis & Clark. Because a new wet FGD system would replace the existing scrubber, additional capital costs would also be needed for a new baghouse to control the particulate emissions. If additional SO_2 removal becomes a requirement for Lewis & Clark, consideration should be given to lower capital cost alternatives, such as further upgrading the existing scrubber system or installing a dry sorbent injection system.

4.4.3 Spray Dryer Absorber FGD

In a spray dryer absorber (SDA) FGD system, the flue gas flows from the air heater into the SDA vessel, where it is brought into contact with the lime slurry. The SDA vessel is a vertical open chamber, which provides space for contact between the flue gas and the lime slurry. Typically, SO_2 is absorbed by co-current contact with the slurry; both the flue gas and slurry are fed into the absorber from the top. The absorber is normally operated 30-40 °F above the gas saturation temperature preventing moisture condensation in the SDA vessel and the downstream particulate collection device.

Both dry powder hydrated lime ($Ca(OH)_2$) and quicklime (CaO) can be used as the reagent. If quicklime is used, preparation of the lime slurry involves slaking the quicklime, either in a conventional lime slaker with a high-efficiency grit removal and lime recovery system or in a ball mill slaker system. In the slaker, lime is mixed with water, forming a slurry of fine lime particles. The chemical reaction is as follows:

$$CaO + H_2O \leftrightarrow Ca(OH)_2$$

Then, the slurry is injected at the top of the tower using either a rotary atomizer or dual-fluid nozzles. SO_2 absorption takes place in the SDA vessel. Calcium reacts with the SO_2 to form the waste solids calcium sulfate ($CaSO_4$) and calcium sulfite ($CaSO_3$). Typically, approximately one-third of the waste is sulfate and two-thirds is sulfite. Waste-solid formation reactions occur in the SDA according to the following chemical reactions:

$$Ca(OH)_2 + SO_2 + H_2O \rightarrow CaSO_3 \cdot ½H_2O + 3/2H_2O$$
$$CaSO_3 \cdot ½H_2O + 3/2\ H_2O + ½O_2 \rightarrow CaSO_4 \cdot 2H_2O \text{ (gypsum)}$$

The dried solids are entrained in the flue gas and exit the SDA vessel with the fly ash. The solid byproduct and fly ash are collected in the downstream particulate removal equipment, which is generally a baghouse rather than an ESP. Although most of the SO_2 removal occurs in the SDA vessel itself, some additional SO_2 capture occurs across the filter cake that accumulates on the outer surfaces of a fabric filter. A portion of the fly ash, unreacted lime, and SDA reaction products collected in the baghouse are mixed with water and returned to the absorber as a high-solids recycle stream.

The byproduct is conveyed to a storage silo before disposal. Because the byproduct is mixed with fly ash, it generally cannot be sold and must be sent to landfill.

In general, SDA control systems have several advantages as compared with a wet FGD system, including:

- Less costly materials of construction and lower capital cost;
- Lower water consumption;
- Lower auxiliary power consumption;
- Better inherent capture of SO_3; and
- Dry solid waste production precluding the need for a dewatering island.

An SDA system would be a practical technology selection to enable Lewis & Clark to meet emissions of 0.20 lb SO_2/MMBtu. The low sulfur content (low SO_2 removal requirements) of the fuel currently used at the station is better suited for a semi-dry FGD process like an SDA as compared with a wet FGD. Lewis & Clark is a small unit and an SDA system has less process equipment and would require less site real estate than a wet FGD. This, combined with less expensive materials, would translate to lower capital cost as compared with a wet FGD system. Also, Lewis & Clark is already equipped to receive lime on-site, which would mean low capital requirements for a reagent preparation system for an SDA. An SDA system, coupled with a baghouse at the unit, in S&L's opinion, would provide compliance with MATS limits for SO_2 and FPM. Furthermore, as the unit is already equipped with ACI and fuel additive systems for Hg control, the additional residence time gained from an SDA system and the downstream baghouse may allow for reductions in feed rates for ACI and fuel additives.

4.4.4 Circulating Dry Scrubber or NID™

In a circulating dry scrubber (CDS) system, the flue gas is treated by injecting dry hydrated lime and recycled byproduct solids into a scrubber vessel. Within the scrubber vessel, the bed of fine solids is fluidized by the flue gas entering the bottom and flowing upward. To promote fluidization, flue gas is injected through a bank of Venturis, increasing the gas velocity at the entrance to the scrubber. Solids carryover is expected and captured in the downstream baghouse, which is equipped with an airslide ash handling system. To control the CDS outlet flue gas temperature, water is added independently of the fresh hydrated lime, which allows the CDS system to operate on slightly higher-sulfur fuels than the SDA technology. Water and lime are added to the scrubber just above the inlet Venturis.

In the fluidized bed, the flue gas, water, and solids mix to promote the reaction of the SO_2 with the calcium. Significant recycle of solids is required to achieve optimal mixing and to increase lime utilization.

First, hydrated lime is formed in the hydrator from the following chemical reaction:

$$CaO + H_2O \leftrightarrow Ca(OH)_2$$

Similar to the SDA, calcium reacts with the SO_2 to form the waste solids calcium sulfate ($CaSO_4$) and calcium sulfite ($CaSO_3$). Typically, approximately one-third of the waste is sulfate and two-thirds is sulfite. Waste-solid formation reactions occur in the absorber according to the following chemical reactions:

$$Ca(OH)_2 + SO_2 + H_2O \rightarrow CaSO_3 \cdot \tfrac{1}{2}H_2O + 3/2 H_2O$$
$$CaSO_3 \cdot \tfrac{1}{2}H_2O + 3/2\ H_2O + \tfrac{1}{2}O_2 \rightarrow CaSO_4 \cdot 2H_2O \text{ (gypsum)}$$

The byproducts are entrained in the flue gas and exit the absorber vessel with the fly ash. The byproducts and fly ash are collected in the downstream particulate collector. Most solids are recycled back to the absorber vessel to maximize lime usage. All other waste is disposed of, generally to a landfill.

The Alstom NID™ system is a similar technology to the CDS system. With the NID™ system, in contrast to a typical CDS system, dust, water, and lime first come into contact in a mixer prior to entering the reactor. However, as each reactor can handle only approximately 50 MW to 75 MW equivalent flue gas, each reactor is paired with an appropriately sized baghouse and mixer.

The greatest disadvantage with a CDS or NID™ FGD system is the inability to retrofit the absorber on an existing baghouse. The downstream baghouse must be sized to anticipate a high-solids loading, which would require an oversized baghouse. Typically, an existing baghouse intended for FPM control will be smaller than one required at the backend of a CDS system. In addition, a baghouse used with a CDS system must be elevated so that an airslide can be used to recycle the fly ash and byproduct back to the reactor.

The main benefit of CDS technology, as compared with SDA FGD, is its ability to achieve good SO_2 removal efficiencies with higher-sulfur coals. Since Lewis & Clark does not require high SO_2 capture rates, and because SDA could be used to achieve the 0.20 lb/MMBtu emission level at a lower cost, CDS technology was not evaluated further.

4.4.5 Dry Sorbent Injection

Dry sorbent injection (DSI) is a viable technology for moderate SO_2, SO_3, and HCl reduction on coal fired boilers. This technology uses blowers to feed a powdered alkaline sorbent to injection lances that are permanently installed in the unit's ductwork. The sorbent used in the process reacts with the acid gases in the flue gas for pollution control. DSI systems for coal-fired boilers have been used for SO_2, SO_3, and most recently HCl control. The sorbent is injected into the flue gas downstream of the boiler, though the exact injection location can vary depending on the type of sorbent, and upstream of a PM collection device to collect fly ash and the byproducts from the DSI process. Typical sorbents used for DSI systems include sodium-based Trona ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$) and sodium bicarbonate ($NaHCO_3$) (SBC), as well as calcium-based hydrated lime ($Ca(OH)_2$). Hydrated lime reacts with sulfur oxides according to the following chemical reactions:

$$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$$
$$Ca(OH)_2 + SO_3 \rightarrow CaSO_4 + H_2O$$

At elevated temperatures, both Trona and sodium bicarbonate convert to sodium carbonate. Subsequently, the sodium carbonate reacts with SO_X according to the following chemical reactions:

$$Na_2CO_3 + SO_2 \rightarrow Na_2SO_3 + CO_2$$
$$2Na_2SO_3 + O_2 \rightarrow 2Na_2SO_4$$
$$Na_2CO_3 + SO_3 \rightarrow Na_2SO_4 + CO_2$$

DSI testing has shown alkaline sorbent injection into the flue gas is able to achieve high levels of SO_2 reduction at very high sorbent injection rates. Sodium based sorbents are more effective at SO_2 capture than calcium sorbents, but may preclude fly ash from being a salable byproduct. The products formed from the reaction of the sorbents with the sulfur oxides will be captured in the particulate collector. SO_2 reduction with sorbents requires relatively high injection rates that can significantly increase the particulate content in the flue gas. With the additional solids loading to the wet disk scrubber, it is possible that FPM emissions may increase from the current levels. Therefore, all options that consider DSI in this report require use of a baghouse in place of the existing scrubber. A DSI system would also allow for Lewis & Clark's existing disk scrubber to be taken out of service, and would provide the flexibility for the unit to comply with either acid gas emissions limits mandated by the MATS Rule.

Baghouses generally achieve large SO_2 removal efficiencies by virtue of the filter cake on the bags, which allows for longer reaction time between the sorbent solids and the flue gas. SBC is a more reactive sorbent than Trona, so with SBC injection, most of the sulfur removal takes place upstream of the particulate collection device. Reaction within the filter cake is less significant for SBC than for Trona. Also, the expected SBC feed rates are lower than Trona feed rates for a given sulfur removal due to the higher reactivity of SBC.

High surface area per unit volume hydrated lime has recently been tested to target SO_2. Some hydrated lime suppliers claim that up to 60% SO_2 removal can be achieved; however, limited data are available at this time, and available data can not be directly correlated to the conditions at Lewis & Clark. Additional testing at other units is being conducted by some hydrated lime suppliers, but will not be available until later this year. The SO_2 removal efficiency using hydrated lime at the same injection rates as used currently in the existing scrubber slurry will be lower due to the no longer available benefit of gas-liquid reaction in the slurry. Due to the limited data on high SO_2 removal efficiencies with hydrated lime injection, S&L has assumed that SO_2 removal would be limited to 40%. Testing of the sorbents must be conducted to determine how much SO_2 removal can be expected when the flooded disk scrubber is taken out of service. Hydrated lime typically increases the resistivity of the fly ash, which in turn can reduce the efficiency of an ESP and increases FPM emissions. Because a baghouse is planned to be installed on Lewis & Clark, this potential disadvantage of using lime is not a concern.

S&L assumed that the fly ash would be contaminated with sodium when injecting Trona or SBC, and the fly ash would not be salable and must be landfilled. For hydrated lime, the fly ash is typically not contaminated and may still be sold, but the impacts on the fly ash should be tested by the fly ash marketer. Additional waste generation associated with the injection of any of the sorbents should be considered, but there may be an opportunity for cost savings for the hydrated lime case if the hydrated lime does not impact the fly ash.

The effectiveness of the sorbent is dependent on many factors, including particle surface area, injection location temperature, and particle contact time. Of those factors, particle surface area is particularly significant. One way to increase surface area is to mechanically reduce the particle size by grinding the sorbent. Injecting the sodium sorbents into high-temperature flue gas produces micropores and expands the sorbent particles, which greatly increases the particle surface area and its capture ability. For either Trona or SBC, the sorbent should be injected into flue gas above 275 °F, and kept above this temperature for at least 1 second, to maximize the micropore structure. However, if the flue gas is too hot, the solids will sinter and surface area will be reduced. Sintering occurs at a lower temperature for SBC than for Trona or hydrated lime. Based on industry experience with dry sorbent injection, SBC injection should be limited to gas streams below 700 °F and more preferably below 650 °F. Although, Solvay has stated that SBC can be injected into gas streams as high as 1,500 °F. Trona injection temperatures should be limited to below 900 °F. It was previously thought that hydrated lime is not as influenced by temperature as sodium-based sorbents. Currently, there is no evidence that high temperatures can physically impact hydrated lime. In some plants, hydrated lime has been injected directly into the upper furnace for SO_2 control where temperatures range from 1,800 to 2,200 °F. Hydrated lime may be injected further upstream of the air preheaters, such as in the upper part of the furnace or at the economizer. Maximizing the contact time between the flue gas and sorbent will also improve performance, but will depend on the injection location. During the preliminary design phase of a DSI system, these factors must be evaluated in order to determine which sorbents and which injection locations are best for the unit.

The air heater inlet temperatures at Lewis & Clark have historically shown ranges between 820 °F and 890 °F, which is within the acceptable operating temperature for Trona and hydrated lime, but is outside of the ideal range for SBC, which would only lower the SBC utilization. As previously mentioned, injection of the sorbent above the maximum allowable temperature will cause sintering of the SBC reducing the total active surface area and limiting the capture efficiency. Alternatively, SBC can be injected downstream of the air heater and is expected to be effective at lower temperatures. The advantage of injection ahead of the air heater is that the reagent has more residence time to react; however, this is less of a concern when a baghouse is collecting the reagent.

4.5 *Available Control Technologies for Non-Hg Trace Metal Compliance*

The non-Hg HAP metal requirements under MATS can be met by using individual non-Hg metal emissions, total non-Hg metal emissions, or FPM emissions. Recent testing shows that FPM emissions are above the applicable MATS limit. Lewis & Clark modified its flooded wet disk scrubber with a quench spray system in an effort to reduce FPM emissions below the MATS threshold; however, stack testing results in 2012 indicated no change in FPM removal.

Stack testing conducted for the non-Hg HAP metals has also shown that total non-Hg HAP metal emissions are above the MATS limit. Similarly, stack testing conducted for the individual non-Hg HAP metals has shown that several of the individual metals exceed their respective MATS limits. Review of more recent diagnostic stack test results found that there is a high concentration of manganese (Mn) in the coal, which makes up the majority of the total non-Hg metals measured in the stack, approximately 70%, and this element contributes significantly to the excess total non-Hg metal emissions.

Manganese is a silver-colored, naturally occurring metal that forms compounds in the environment with chemicals such as oxygen, sulfur, and chlorine and these compounds can dissolve in water. Elemental manganese has a boiling point of 3,742°F. Manganese and other trace metals such as beryllium, cobalt, chromium, arsenic, cadmium, lead, antimony, mercury, and selenium, are also products of coal combustion and are required to be controlled within certain limits in order to be compliant with MATS. EPA's *Compilation of Air Pollutant Emission Factors* (AP-42) classifies trace metal emissions into the following three classes (AP-42, Chapter 1.1, pg. 1.1-5):

- Class 1: Elements that are approximately equally concentrated in the fly ash and bottom ash, or show little or no small particle enrichment. Examples include manganese, beryllium, cobalt, and chromium.

- Class 2: Elements that are enriched in fly ash relative to bottom ash, or show increasing enrichment with decreasing particle size. Examples include arsenic, cadmium, lead and antimony.
- Class 3: Elements which are emitted in the gas phase (primarily mercury, and in some cases, selenium).

The highest temperature that a combustion boiler could experience would be a maximum of 3,000 °F at the burner level of the boiler, which is below the boiling point of manganese. Flue gas passing through the boiler's heat transfer surfaces is approximately 1,000 °F to 2,000 °F, and approximately 800 °F leaving the boiler at the economizer outlet. It is expected that little, if any, manganese will reach its boiling point in coal fired combustion. Therefore, it can be assumed that none of the manganese volatilizes, and that all manganese in the fuel will remain as a solid emission. It is also stated in AP-42, that the control of Class 1 metals is directly related to control of total FPM emissions, while control of Class 2 metals depends on the collection of fine particulate. As a result, manganese particles can be controlled by particulate control technologies, with a high enough collection efficiency to meet the MATS limits, such as and ESP, baghouse, wet scrubbers, cyclones, and side stream separators.

As mentioned previously, manganese can dissolve in water; for that reason, it is possible that the manganese measured at the stack could be related to the operation of the scrubber and the efficiency of the "mist eliminator" (ME) vessel. Therefore, there was also a concern that FPM emissions could be due to excessive scrubber carryover because of an inefficient scrubber mist eliminator. Lewis & Clark's ME vessel is tangentially fed and removes droplets in the flue gas through centrifugal forces from the cyclonic flow inside the vessel. Further analysis completed on samples taken for Method 26 from the front-half glass filters and the probe rinses in October 2012 confirmed that the emissions at the stack were primarily due to scrubber slurry being carried over and collected as FPM.

Since Lewis & Clark stack emissions currently exceed the MATS emissions standards for total and individual non-Hg HAP metals, compliance with the MATS Rule 0.030 lb/MMBtu FPM limit, as a surrogate for non-Hg metals, must be considered, along with required modifications to the unit to reduce FPM emissions below this surrogate limit. Control technologies that reduce FPM effectively are also expected to reduce non-Hg metal emissions.

4.5.1 Multiclones and Upgraded Wet Disk Scrubber

Lewis & Clark currently operates two different technologies to control FPM emissions. Multiclones, a type of mechanical collector, are employed as the primary means of FPM control. Multiclones are devices consisting of a collection of small cyclones meant for removal of large-sized particles from the flue gas stream. The cyclones are cylindrical in shape, with a tapered end. Flue gas enters the cyclone through the side and is spun inside the cyclone. The cyclonic flow of gas within the collector and the centrifugal force on the particles drive the larger particulate matter out of the flue gas stream. The flue gas exits the top of the multiclone and the hoppers below the cyclones collect the PM for discharge to an ash removal system. Multiclones are most effective on particles larger than 10 microns (μm); as a result, for smaller particles, the collection efficiency drops significantly below 90%. The multiclones at Lewis & Clark were designed with a target FPM collection efficiency of approximately 75-80%.

Lewis & Clark also uses a wet disk scrubber as the secondary FPM control technology. Flue gas enters through top of the Venturi-style scrubber. Once reaching the flooded disk region, the flue gas comes into contact with a fly ash/lime slurry that is tangentially fed through the throat of the Venturi section. This contact between hot flue gas and the slurry will quench the flue gas down to the adiabatic saturation temperature, removing fly ash particles and SO_2. The elevation of the floating disk can be adjusted to increase pressure drop and collection efficiency of FPM and SO_2 but at the cost of additional auxiliary power consumption. A quench spray system was recently installed ahead of the floating disk to assist in reducing FPM emissions. The saturation/cooling by fresh water reduces flashing of the slurry when it comes in contact with the hot flue gas. This ensures that more liquid droplets are formed to increase the collection of fine particles, which are more difficult to collect.

This system was installed in 2012; however, diagnostic stack testing indicated insignificant changes in FPM removal. The diagnostic stack testing also indicated no reduction of scrubber slurry carryover, and that even with the quench spray system, there is still significant droplet carryover that contributes to FPM measured in the stack. Based on the diagnostic testing it can be concluded that the existing multiclones, upgraded wet disk scrubber, and mist eliminator (ME) vessel is not capable of meeting the MATS FPM emissions limit. Therefore, additional retrofit controls will be needed to reduce FPM and/or total non-Hg HAP metals.

4.5.2 Dry Electrostatic Precipitator

Dry electrostatic precipitator (ESP) technology is a viable, commercially available option for FPM capture. Flue gas flows into the ESP through the inlet plenum past a series of perforated plates to evenly distribute the flow. One of the main components of an ESP consists of a series of parallel, vertical, metallic plates (collecting electrodes) that form gas passages through which the flu gas passes. Also, between the collecting plates are discharge electrodes, which are responsible for creating the electrical field for particle charging. Key parameters determining the overall FPM collection efficiency of an ESP are specific collection area, aspect ratio, electrical and mechanical sectionalization, fly ash resistivity, flue gas temperature, and gas velocity.

The discharge electrodes are suspended from electrical insulators on the top of the ESP casing, where it connects to a high-voltage power source, the transformer-rectifier (T/R) sets. The T/R sets provide the power required for the discharge electrodes for charging the flue gas-entrained particulate matter. The discharge electrode will generate a corona, exhibited by an active blue glow, creating an electrical field between the discharge and collecting electrodes. As they pass through the electrical field, the ash particles will take on the negative charge and be attracted toward the grounded collecting electrodes.

A dust layer will form from the accumulation of the ash particles on the collecting electrode. When the desired thickness is achieved, the particle removal cycle is activated, and the collection electrodes are struck by magnetic impulse gravity impact (MIGI) rappers to dislodge the dust. Because the fly ash particles have agglomerated, the ash layer is removed in sheets and is then collected in hoppers.

Although dry ESPs are often applied to utility units as the primary means for FPM control, this may not be most suitable technology for Lewis & Clark. The unit currently burns Montana lignite, a low-sulfur fuel. At typical air heater outlet temperatures, this will result in a high resistivity fly ash, which would require a large ESP for ash collection. Additionally, Lewis & Clark currently injects activated carbon for mercury capture, a sorbent that is difficult to capture in an ESP (due to its electrical characteristics) and also known for adsorption of SO_3 from the flue gas impacting fly ash resistivity. For all ranges of fuel type, at elevated flue gas temperatures, the resistivity of the fly ash will increase, affecting the ability to capture FPM by the ESP. Lastly, because ESP are designed to achieve a constant FPM removal efficiency, future retrofit of an upstream DSI system for acid gas control could lead to increased FPM emissions. Although sodium-based sorbents can lower fly ash resistivity, the estimated injection rates required at Lewis & Clark for SO_2 control are high enough that the beneficial effects of a resistivity-lowering sorbent would be outweighed by the significant increase in solids loading. Considering these variables, Lewis & Clark would require a large ESP to comply with MATS, rendering this a higher capital cost option as compared with a baghouse.

4.5.3 Wet Electrostatic Precipitator

Wet ESP technology generally follows the same design as dry ESP, consisting of discharge electrodes and a series of metal plates or circular tubes for collecting electrodes. There are, however, some principal factors differentiating the two technologies. First, the wet ESP can be arranged in non-standard ways to be integrated with other existing pollution control technologies. For example, a wet ESP typically is situated at the exit of a wet FGD system, where the flue gas is saturated with water vapor. Flue gas passes vertically through the wet ESP with the collected fine fly ash particles collected on the plates/tubes then conveyed down to the absorber sump by water sprayed on the collecting plates/tubes, dropping into the wet FGD sump below. This configuration is not feasible at Lewis & Clark because the stack is situated over the existing mist eliminators. To retrofit a wet ESP on Lewis & Clark, it is likely that a new stack would be required.

Instead of a conventional rapping system for PM removal as used in a dry ESP, water sprays or deluge system are placed above the electrodes to wash the collecting electrodes. The sprays continually wet the surface of the collection electrodes, and the wetted particles flow down the collection electrodes' walls. Appropriately, the bottom of a wet ESP must be designed to accommodate a wet ash discharge system. As stated previously, because wet ESPs will operate at adiabatic saturation temperature and collect liquid containing sulfuric acid and a high level of chlorides, careful selection of materials is crucial to avoid corrosion of internal components. Metallurgy requirements significantly add to the capital costs of a wet ESP system.

Further, a wet ESP also represents higher capital cost due to the need for corrosion-resistant materials, as well as, in the case of Lewis & Clark, a new stack. A wet ESP also has high O&M cost due to the increased maintenance requirements of the expensive components and because of the water demand. For these reasons, a wet ESP system was not considered to be an appropriate technology for PM control at Lewis & Clark, and it was not evaluated further.

4.5.4 Baghouse

A baghouse, or fabric filter, collects PM by passing ash-laden flue gas flow through filter bags. The vertically supported, small-diameter, bags are enclosed in multiple, isolatable, compartments within the baghouse casing. Flue gas will pass through the filter material, leaving behind a layer of particulates, or dust cake, on the surface of the bags. The formation of a dust cake is crucial as it enhances filtration.

In a typical coal-fired boiler application, flue gas enters the baghouse through an inlet plenum, where it is distributed to compartments containing up to several thousand filter bags. Each bag is closed at the bottom and attached to a tubesheet on top, through which the flue gas will exit. An outlet plenum collects the filtered flue gas exiting the bag assemblies before sending it to an induced draft (ID) fan. Inlet and outlet dampers allow for each compartment to be isolated for filter bag cleaning or online maintenance. As the particulate collects on the filter bags, the dust cake assists in particulate capture by providing a secondary sieving mechanism. In applications with a DSI or ACI system, the sorbent and/or carbon-laden filter cake effectively acts as a packed-bed reactor-enhancing pollutant capture. Similarly, when installed downstream of an SDA, the dust cake will provide additional residence time for control of acid gases.

Pressure drop across the baghouse will increase with the accumulation of a filter cake. After a certain amount of time, or at a set pressure drop, the filter bags must be cleaned. Each compartment can be independently isolated, and in a pulse jet baghouse, a pulse of compressed air will traverse the inside of the filter bag to remove a fraction of the dust cake. The displaced dust is collected in a hopper beneath each bag compartment.

As discussed earlier, diagnostic stack testing conducted at Lewis & Clark suggests that droplet carryover from the wet disk scrubber contributes significantly to total stack FPM emissions. A retrofit baghouse control system at Lewis & Clark would be tied into ductwork upstream of the scrubber and would capture dry fly ash but would not completely resolve the scrubber carryover issue. Based on recent retrofit projects, baghouse vendors can currently guarantee FPM emissions as low as 0.010 lb/MMBtu at the baghouse outlet. However, scrubber carryover may be contributing to as much as 60% of the existing FPM emissions from the unit. Therefore, even though the baghouse reduces fly ash FPM contributions, the unit may not be able to meet the MATS limit with only the baghouse due to scrubber carryover.

With the installation of a baghouse, it is expected that total non-Hg HAP metal emissions from Lewis & Clark would be below the MATS limit. Baghouse control systems provide very effective removal of solid non-Hg metal particles because the filter cake that accumulates on the bag surface provides a large surface area to contact the flue gas and remove particles of varying size. However, it is unknown whether the small fraction of total metals that get through the baghouse will accumulate in the wet scrubber slurry and ultimately become entrained in scrubber carryover droplets, contributing to increased total non-Hg HAP metal emissions. Also, the make up water and lime that are added to the scrubber may have small quantities of non-Hg metals, which may also contribute to total non-Hg HAP metal emissions. Because of these unknowns, relying on the baghouse control system to demonstrate compliance with the MATS total non-Hg HAP metals limit presents some risk of non-compliance.

Baghouses have been widely used in the electric power generating industry and, in S&L's opinion, the installation of a baghouse coupled with modifications to the ME vessel to minimize scrubber carryover would reduce FPM emissions from Lewis & Clark below the MATS limit. If the flooded disk scrubber is taken out of service, and DSI or dry FGD controls are installed upstream of a new baghouse, ME vessel modifications would not be required. In addition to providing FPM control, the baghouse would likely improve the performance of the ACI control system. Although the location at which the baghouse would be tied into the ductwork at Lewis & Clark could experience flue gas temperatures of 400 °F to 450 °F, woven fiberglass with expanded polytetrafluoroethylene (PTFE) membrane bags are capable of handling these higher temperatures. Furthermore, should the unit become subject to more stringent SO_2 emission limits under future Regional Haze Reasonable Progress Goal reviews, a baghouse offers the flexibility to install an upstream DSI system or an SDA to reduce SO_2 emissions.

4.5.5 Mist Eliminator Modifications

As discussed above, the existing multiclones, upgraded wet disk scrubber, and ME vessel are not capable of reducing FPM emissions from Lewis & Clark below the MATS limit, and modifications to the ME vessel would be required to reduce FPM emissions below the MATS limit even with the installation of a baghouse control system if the scrubber remains in service.

Suggested modifications to the ME vessel include the installation of two (2) chevron type mist eliminator levels/stages and an additional washing system for the ME stages, similar to the ME systems that are currently used in more conventional wet FGD scrubbers. The existing ME vessel should provide enough space to slow down the gas flow and reduce the cyclonic flow so that the flow will be generally upward and at a velocity between 8 – 13 feet per second (fps). This would allow conventional chevron ME stages to remove significant amount of droplets.

It is expected that retrofitting the mist eliminator stages only (including any needed turning vanes, distribution plates, etc.) would reduce FPM emissions from the wet scrubber by approximately 20%, which may reduce FPM emissions from the unit below the MATS FPM limit of 0.030 lb/MMBtu with little operating/compliance margin. Therefore, modifications to the ME vessel should be completed as part of a baghouse installation. The baghouse would remove a majority of the FPM before the scrubber inlet, and the mist eliminator layers would provide additional removal of FPM emissions that are attributed to scrubber carryover droplets. FPM emissions at the baghouse outlet should be reduced to 0.01 lb/MMBtu or less, and a chevron ME will reduce droplet carryover by approximately 20%. A baghouse combined with ME modifications would reduce FPM emissions from Lewis & Clark below 0.030 lb/MMBtu with a reasonable operating/compliance margin; however, there remains a slight compliance risk with this option because of the cyclonic flow patterns currently present in the ME vessel.

A baghouse control system will also collect a majority of the non-Hg HAP metals, and little will pass through to the scrubber. It is very probable that this alone will meet the MATS total non-Hg HAP metals limit, but there is a risk that small quantities of manganese and other non-Hg metals that are soluble could get through the baghouse and eventually contribute to emissions as carryover droplets. There is also some potential contribution to total non-Hg metal emissions from make up water and lime. The chevron ME included in this option would reduce this risk, but the quantity of trace metals that get through the baghouse can not be calculated with any certainty, resulting in a potential compliance risk.

Effectiveness of the ME modifications to reduce FPM emissions is dependent upon the elimination of cylindrical flow through the ME vessel. For purposes of this report, it was assumed that a vapor horn turning vane would retrofit to the ME vessel inlet to eliminate cylindrical flow. The vapor horn consists of a tapered "chute" with no bottom that travels 270 degrees around the vessel wall. Six (6) to eight (8) internal baffles will be evenly spaced inside the chute to improve the vapor distribution by "slicing" off segments of vapor as the incoming flue gas travels around the horn. Each baffle slices off flow, directing it down, and then up toward the center of the vessel. Small ridges, attached to the annular side of vapor horn project into the center of the vessel to break any residual swirling motion induced by the tangential flow through the vapor horn.

4.6 *Available NO_X Control Technologies*

This report does not evaluate NO_X mitigation techniques because the Montana RH FIP did not require additional control technologies for NO_X reduction and there were no emission limits in the MATS Rule addressing NO_X. A NO_X reduction study conducted in 2011 by S&L (SL-010551) for Montana-Dakota's Lewis & Clark provides more information on NO_X mitigation techniques for Lewis & Clark.

4.7 *Technology Summary*

Control technologies were evaluated for their ability to reduce HAP emissions, and to ensure compliance with the applicable MATS emission limits. Although baseline HCl emissions from Lewis & Clark with its existing suite of control technologies are below the MATS acid gas requirement, control technologies were also evaluated for their ability to reduce SO_2 emissions below the MATS surrogate emission limit of 0.20 lb/MMBtu. The SO_2 compliance information is presented for information only and is intended to assist Montana-Dakota in assessing the impacts should future Regional Haze Reasonable Progress Goal reviews require additional SO_2 reductions.

A summary of the technologies discussed in the preceding subsections, including the relative capital and O&M costs for each control technology option, are listed in Table 4-2.

Table 4-2. Technology Summary with Associated Capital and O&M Costs

Compliance Technology	Capital Investment	O&M Costs	Reduces Target Pollutant Below MATS Limit
Mercury Compliance Technologies			
Activated Carbon Injection with Fuel Additives	Existing	Existing	Yes
FPM / Non-Hg HAP Metal Compliance Technologies			
Existing Multiclones and Existing Wet Disk Scrubber with Quench Spray System	Existing	Existing	No
Dry Electrostatic Precipitator	High	High	Yes
Wet Electrostatic Precipitator	High	High	Yes
Baghouse	High	High	Marginal
Baghouse with Mist Eliminator Vessel Modifications	High	High	Yes
Acid Gas (HCl) Compliance Technologies			
Existing Multiclones and Existing Wet Disk Scrubber	Existing	Existing	Yes
Dry Sorbent Injection (Hydrated Lime)	Low	Moderate	Yes
FGD Technologies (Note 1)	See SO_2	See SO_2	See SO_2
SO_2 Compliance Technologies to Achieve 0.20 lb/MMBtu			
Existing Wet Disk Scrubber with Quench Spray System	Existing	Existing	No
Wet Limestone FGD	High	High	Yes
Spray Dryer Absorber FGD	High	High	Yes
Circulating Dry Scrubber or NID	High	High	Yes
Dry Sorbent Injection (Trona)	Moderate	High	Requires Testing
Overall Compliance Technologies			
Fuel Switch to PRB or Beulah, ND lignite	Very High	High	Not Feasible
Natural Gas Conversion	Very High	High	Yes

Note 1: SO_2 control technologies capable of achieving a controlled SO_2 emission rate of 0.20 lb/MMBtu or less can be used to meet the MATS acid gas standard in lieu of meeting a controlled HCl emission rate of 0.002 lb/MMBtu.

5. PROPOSED COMPLIANCE STRATEGIES

This study focused on compliance strategies available to Lewis & Clark to comply with the applicable MATS requirements. Table 5-1 reviews the baseline emission rates for Lewis & Clark compared to the MATS requirements.

Table 5-1. MATS Rule Emission Reductions and Baseline Emissions

Hazardous Air Pollutant		Emissions		Emissions Reduction Requirements
		Baseline Emissions	MATS Limit	
Mercury (Hg)		1.35 lb/TBtu	4.0 lb/TBtu	Unit 1 should meet the MATS Hg emission limit with no additional controls.
Non-Hg HAP Metals	**FPM**	0.050 lb/MMBtu	0.030 lb/MMBtu	To demonstrate compliance with Non-Hg HAPS using FPM emissions, FPM must be reduced by approximately 40% to an emission rate of 0.030 lb/MMBtu or below.
	Total Non-Hg Metal HAPs	71.7 lb/TBtu	50 lb/TBtu	To demonstrate compliance with the total non-Hg HAP metal emission limit, emissions must be reduced by approximately 30% to an emission rate of 50 lb/TBtu or below. Additional FPM controls would be required to demonstrate compliance using total non-Hg HAP metals.
	Individual Non-Hg Metal HAPs	See Table 3-5	See MATS Rule	Individual non-Hg emission limits were exceeded for arsenic, beryllium, cadmium, chromium, manganese, nickel and lead. Additional FPM controls would be required to demonstrate compliance using individual non-Hg metals.
Acid Gases	**Hydrogen Chloride (HCl)**	0.00008 lb/MMBtu	0.002 lb/MMBtu	HCl emissions currently meet the MATS emission limit of 0.002 lb/MMBtu.
	SO_2	0.50 lb/MMBtu	0.20 lb/MMBtu	Alternatively for acid gas emissions compliance, SO_2 emissions would need to be reduced by approximately 60% to an emission rate of 0.20 lb/MMBtu or below.

5.1 *Mercury Compliance Strategy*

Lewis & Clark currently uses $CaBr_2$ solution as an additive to the fuel, in conjunction with activated carbon injection into the flue gas to reduce mercury emissions. Based on data shown in Table 3-3, the unit consistently achieves controlled Hg emissions well below the 4.0 lb/TBtu MATS limit. Therefore, no further compliance technologies are required.

5.2 *Non-Hg Metals HAPs Compliance Strategy*

Three alternatives are available to demonstrate compliance with the non-Hg HAP metal requirements under the MATS Rule. The first involves using FPM emissions as a surrogate and maintaining FPM emissions below 0.030 lb/MMBtu. Currently, with the existing multiclones and particulate scrubber, FPM emissions at Lewis & Clark exceed the 0.030 lb/MMBtu limit. In 2012, Lewis & Clark added a quench spray system to the particulate scrubber in an effort to reduce FPM emissions. Diagnostic FPM stack tests conducted after the quench spray system was installed, shown in Table 3-4, indicated an insignificant change in FPM removal. The system has not been fully tested and optimized, but based on preliminary results it appears that the system will not reduce FPM emissions to the extent needed to comply with the MATS requirement.

The second non-Hg HAP metal compliance alternative is to conduct quarterly stack testing at Lewis & Clark to demonstrate compliance with the individual non-Hg HAP metal emission rates listed in the MATS Rule. Results of individual non-Hg metal stack tests conducted at Lewis & Clark are summarized in Table 3-5. It can be seen that the measured emission rates for arsenic, beryllium, cadmium, chromium, manganese, nickel and lead all exceed their respective MATS emission limits; therefore, it is not recommended that quarterly testing for individual non-Hg HAP metals be used to demonstrate compliance.

The third non-Hg HAP metal compliance alternative is to conduct quarterly stack testing at Lewis & Clark to demonstrate compliance with the total non-Hg HAP metal emission rate. Non-Hg metals stack test results obtained in 2012, shown in Table 3-5, indicate that total non-Hg metal emissions exceed the MATS requirement with the current suite of control technologies at Lewis & Clark. Stack test results show that manganese constitutes the majority of the total non-Hg metals measured at the stack, accounting for approximately 70% of the total non-Hg metal emissions. Based on the concentration of manganese in the coal from the June 2012 testing, manganese emissions measured during the 2012 test program are reasonable to expect. Because manganese can dissolve in water, it is possible that the levels of manganese measured at the stack could be related to the operation of the scrubber and the efficiency of the ME vessel. Therefore, it is likely that manganese will consistently prevent the unit from being compliant with the individual and total non-Hg HAP metals emission limits.

The impact of using different coal seams on non-Hg metal emissions cannot be determined at this time. Montana-Dakota indicated that, depending on the seam of coal that is supplied, mercury content can vary. Similarly, all trace metal concentrations in the lignite would likely vary by coal seam. However, firing coals from all of the potential seams to determine the impact this may have on the individual and total non-Hg emissions is not practical, and limiting utilization to any one seam is also not practical. Furthermore, diagnostic stack testing has been completed using an average blend of coal, which shows total non-Hg HAP metal emissions above the MATS limit. Therefore, it is not recommended that quarterly testing for total non-Hg HAP metals be used to demonstrate compliance with the MATS standard.

Control technologies available to provide additional FPM control are described in Section 4.7, and include wet and dry ESPs, fabric filter baghouse, and modifications to the existing ME vessel. It is anticipated that any of the FPM retrofit control technologies, coupled with modifications to the ME vessel, will be capable of reducing FPM emissions below the MATS emission limit of 0.030 lb/MMBtu.

5.3 *Acid Gas Compliance Strategy*

Two alternatives are available to demonstrate compliance with the MATS acid gas requirements. The first involves using an HCl continuous emissions monitoring system (CEMS or CEM system) or quarterly stack testing to verify that HCl emissions are below the MATS requirement. The results of 2012 diagnostic stack testing, shown in

Table 3-6, confirmed that HCl emissions from Lewis & Clark are very low, measured at 0.00008 lb/MMBtu compared to the MATS limit of 0.002 lb/MMBtu.

Montana lignite fuel properties include relatively low chlorine levels (averaging less than 31.3 parts per million weight dry (ppmwd) from coal during the June 2012 testing and less than 31.5 ppmwd from coal during the

September 2012 testing). The Lewis & Clark lignite fuel also has a high alkaline content, with calcium oxide (CaO) content in the fly ash ranging from approximately 10% to 25%, and the total alkalinity ranging from 12% to 27%, including sodium and potassium oxides (Na_2O and K_2O). Calcium levels in the Lewis & Clark fuel are typically 15% which is indicative of a top and mid-seam coal blend. Lower levels of calcium concentrations (less than 12%) are indicative of bottom seam coal. The upper end of calcium alkalinity concentrations (20% - 25%) is indicative of coal from a top seam. Due to the combination of low chlorides and high alkalinity, S&L expects that Lewis & Clark will consistently achieve low HCl emissions. Montana-Dakota has conducted multiple stack tests to confirm this conclusion.

The second alternative for demonstrating MATS acid gas compliance is to use an SO_2 CEMS to verify that SO_2 emissions are below 0.20 lb/MMBtu on a 30-day rolling average basis. In order to use SO_2 as a surrogate for acid gas compliance, an FGD technology must be in operation. Because Montana-Dakota uses a flooded wet disk particulate scrubber that aids in SO_2 removal, it is appropriate to use this alternative; however, the current SO_2 emission rates are above the MATS surrogate SO_2 emission limit. Therefore, in order to use SO_2 emissions to demonstrate acid gas compliance under MATS, additional SO_2 control would be needed. Because Lewis & Clark can successfully use HCl emissions to demonstrate compliance, S&L's analysis of the technical requirements to achieve a controlled SO_2 emission rate of 0.20 lb/MMBtu was provided for Montana-Dakota's consideration in the event future Regional Haze Reasonable Progress Goal reviews to require additional SO_2 reductions.

5.4 *Compliance Strategy Options*

The focus of this study is to develop a MATS compliance strategy for Lewis & Clark. The following discussion reviews the potential compliance strategies for Lewis & Clark to meet the MATS requirements.

Because baseline Hg and HCl emissions are currently below the applicable MATS limits with the existing suite of controls, compliance strategies focus on meeting the non-Hg HAP metals emission limit, using FPM as a surrogate. The feasible compliance alternatives for Lewis & Clark are listed by pollutant and divided into primary and secondary alternatives. Primary alternatives are the methods presented that, in S&L's opinion, will ensure MATS compliance. The secondary alternatives are presented for Montana-Dakota's information. These would be recommended only as future Regional Haze Reasonable Progress Goal reviews require additional SO_2 control. The options are listed from lowest capital cost and highest risk to the highest capital cost and least risk.

5.4.1 Option 1

Option 1 includes installation of the quench spray system to the existing particulate scrubber to reduce FPM emissions to below 0.030 lb/MMBtu, and maintain HCl emissions below 0.002 lb/MMBtu. This option assumed HCl and FPM emissions would be measured using CEMS. Water injection nozzles for the quench spray system were installed in 2011 and early 2012. After this system began operation in 2012, diagnostic FPM stack testing found that the quench spray system did not improve FPM removal efficiencies, and FPM emission remained above the MATS requirement. Based on the 2012 diagnostic testing, it was concluded that the existing scrubber cannot effectively reduce FPM emissions below the MATS limit; therefore, Option 1 will not be evaluated further in this report.

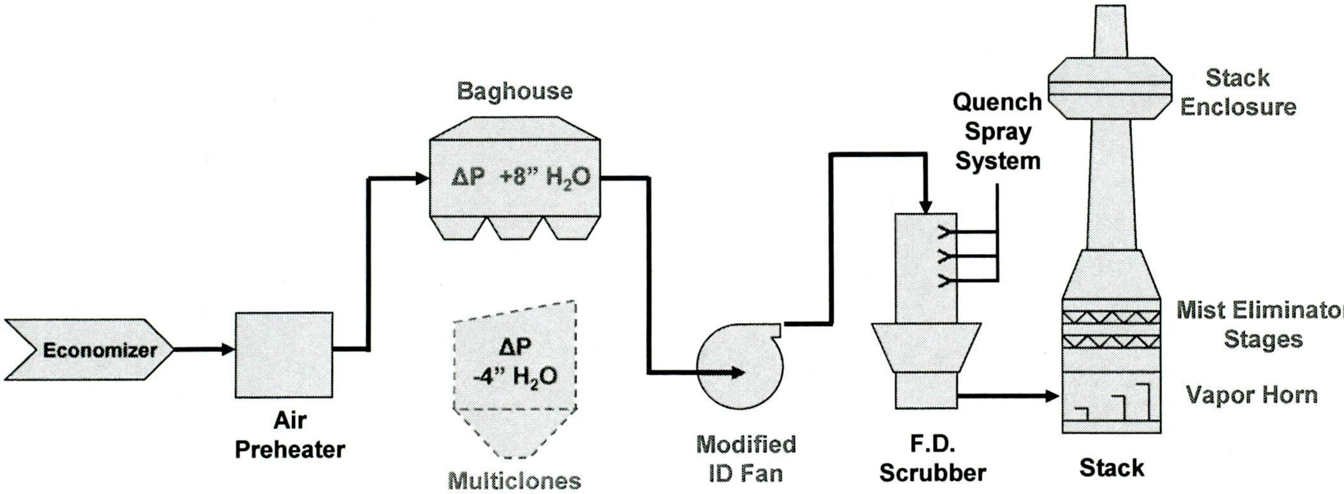
5.4.2 Option 2

Option 2 includes the scrubber modifications mentioned in Option 1 couple with modifications to the stack to allow year-round quarterly stack testing for total non-Hg HAP metals and HCl. However, as with the 2012 FPM stack test results, non-Hg metals stack testing conducted in 2012 with the quench spray system in operation did not show emission reductions sufficient to provide compliance with the MATS total or individual non-Hg HAP metal requirements. The 2012 stack test results showed total non-Hg HAP metals were above the MATS limit. Therefore, Option 2 will not be included in further evaluation in this report as a compliance strategy option.

5.4.3 Option 3

Option 3 includes taking the mechanical collectors out of service and using a baghouse for particulate control, while maintaining the flooded wet disk scrubber in operation to continue to achieve moderate SO_2 and HCl removal. It is expected that HCl removal would also be maximized with a baghouse in place because the filter cake accumulated on the bag surface would contain the alkali material from the fly ash and would provide a large surface area to contact the flue gas. Therefore, Option 3 also includes the modifications necessary to ensure year-round quarterly stack testing can be conducted for HCl emissions in order to demonstrate compliance with the MATS acid gas emissions limit. Baghouses are well demonstrated to achieve FPM levels below 0.015 lb/MMBtu; however, the baghouse would be installed upstream of the disk scrubber, which is still needed for SO_2 control, and would not be able to eliminate FPM attributed to scrubber slurry carryover. Therefore, this option also incorporates modifications to the ME vessel to ensure compliance with the MATS FPM limit with sufficient operating/compliance margin. ME modifications would include two stages of chevron mist eliminators and a vapor horn turning vane configuration to eliminate the existing cyclonic flow in the vessel. Also, in order to install the baghouse in the most optimal location, this option includes the demolition of the abandoned in-place chimney on-site.

Figure 5-1. Compliance Option 3 Simplified Process Flow Diagram



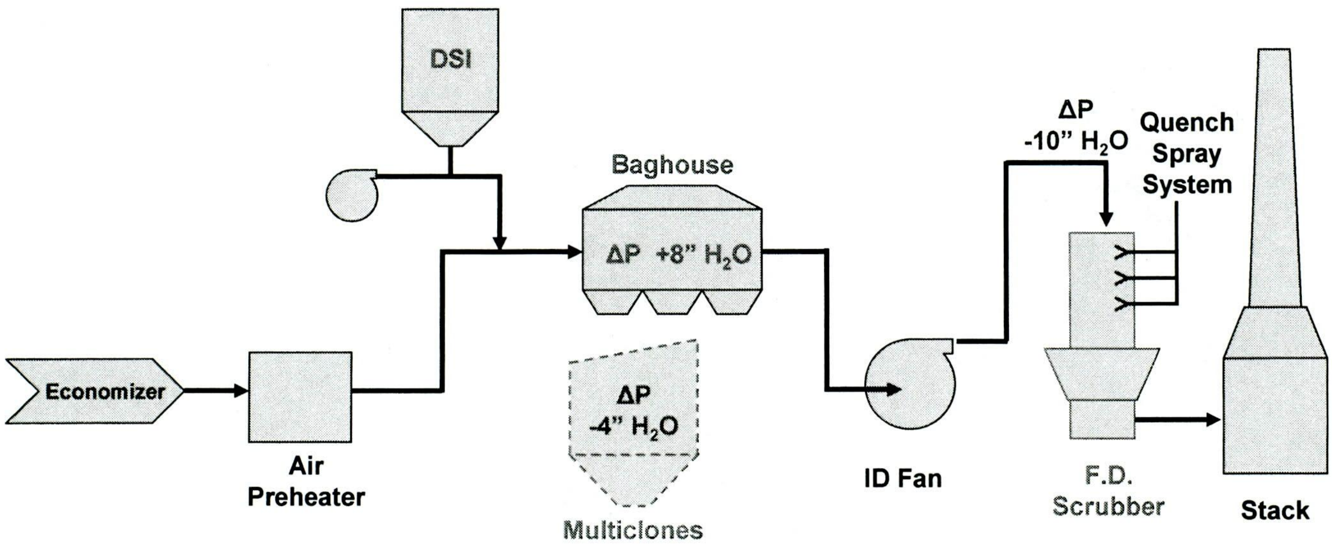
5.4.4 Option 4

Options 4 and 5 involve using SO_2 emissions to demonstrate compliance with the MATS acid gas requirements. These options are not expected to be required because HCl levels at Lewis & Clark are very low, and Lewis & Clark can demonstrate compliance with the MATS acid gas requirements based on HCl emissions. However, these options are provided for Montana-Dakota's information should future regulations require additional SO_2 emission reductions.

Option 4 involves injecting a sodium-based sorbent, Trona, into the flue gas upstream of a baghouse to achieve SO_2 emission levels below 0.20 lb/MMBtu, measured with the current SO_2 CEMS. Because the baghouse could experience temperatures from 400 °F – 450 °F, if the existing scrubber vessel is bypassed (once it is taken out of service) to reduce pressure drop, the stack liner would need to be removed to accommodate higher flue gas temperatures. Bypassing the scrubber, however, would also require a new breaching into the stack. Therefore, to avoid the additional cost of stack liner removal and a new stack breaching, it was determined that this option would follow the existing flue gas path, with the scrubber out of service, and utilize the newly installed quench system to reduce the flue gas to an acceptable temperature before entering the stack. Although S&L is confident that the SO_2

emission rate is achievable using this option, it may not be favorable to Montana-Dakota because sodium is a highly soluble metal that may require additional capital and O&M costs associated with ash disposal. Disposal costs that may be incurred are not included in this analysis, as S&L has assumed that Montana-Dakota will address these costs as part of a separate coal combustion residual (CCR) compliance plan, as needed.

Figure 5-2. Compliance Option 4 Simplified Process Flow Diagram



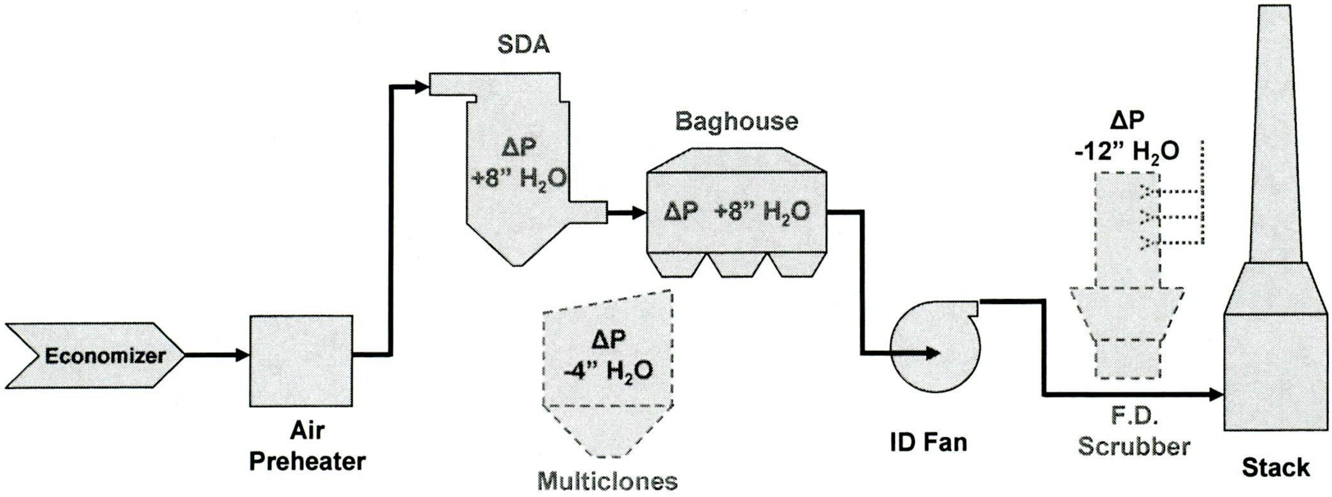
5.4.5 Option 5

As mentioned previously, Options 5 involves using SO_2 emissions to satisfy the acid gas emissions requirements under MATS. Option 5 uses a lime spray dryer absorber (SDA) in conjunction with a baghouse to achieve SO_2 emission levels below 0.20 lb/MMBtu, measured with the current SO_2 CEMS. This option represents the highest capital and least risk to achieve reduced SO_2 emissions.

The absorber is normally operated 30 °F to 40 °F above the gas saturation temperature preventing moisture condensation in the SDA vessel and the downstream particulate collection device; therefore, the lower temperatures would not require fiber glass bags. The existing scrubber would be bypassed, and a new stack breaching would be installed to save costs in pressure drop.

In an SDA, calcium reacts with the SO_2 to form waste solids. Approximately one-third of the waste is calcium sulfate ($CaSO_4$) and two-thirds is calcium sulfite ($CaSO_3$). The solid byproduct and fly ash would be collected downstream in the baghouse and conveyed to a storage silo before disposal. Because the byproduct is mixed with fly ash, it generally cannot be sold and must be sent to landfill. Disposal costs that may be incurred are not included in this analysis, as S&L has assumed that Montana-Dakota will address these costs as part of a separate coal combustion residual (CCR) compliance plan, as needed.

Figure 5-3. Compliance Option 5 Simplified Process Flow Diagram



5.4.6 Compliance Options Summary

Based on a review of the existing plant configuration, operating parameters, and available emissions data, Lewis & Clark should be able to comply with all MATS requirements through installation of a baghouse and modifications to the mist eliminator (Option 3). As discussed above, Hg and HCl emissions from Lewis & Clark are already below the applicable MATS limits with the existing suite of control technologies. Compliance strategies available to Lewis & Clark to reduce FPM emissions below the MATS limit are summarized in Table 5-2. Table 5-2 also lists SO_2 control technologies available to Lewis & Clark in the event future Regional Haze Reasonable Progress Goal reviews require additional SO_2 reductions.

Compliance alternatives for Lewis & Clark are listed by pollutant and divided into primary and secondary alternatives. Primary alternatives focus on MATS compliance, using HCl to demonstrate compliance with the MATS acid gas requirement. Options 1 and 2 listed under the primary alternatives were included for discussion purposes only, as stack testing conducted in 2012 did not show emission reductions sufficient to provide compliance with the MATS FPM or total non-Hg HAP metal requirements. The secondary alternatives are presented for Montana-Dakota's information. These alternatives would be recommended only if future Regional Haze Reasonable Progress Goal reviews require additional SO_2 control. The options are listed from lowest capital cost and highest compliance risk to highest capital cost and least compliance risk. The control technology used to address each particular pollutant is listed in the applicable column.

Table 5-2. Compliance Options Summary

Primary Compliance Alternatives					
Compliance Option	**Non-Hg Metal HAPS**		**Acid Gases**		**Comments**
	FPM	**Total Non-Hg Metals**	**HCl**	**SO_2**	
Option 1	Flooded Wet Disk Scrubber Modifications and PM CEMS	Not used	No Control System Modifications (HCl CEMS)	Not used	Least capital. However, testing has shown the quench spray system does not provide the FPM control needed for MATS compliance.
Option 2	Not used	Flooded Wet Disk Scrubber modifications and Stack Modifications for Quarterly Compliance Testing	Stack Modifications for Quarterly Compliance Testing	Not used	Low capital. However, testing has shown the quench spray system does not provide the non-Hg HAP metal emissions control needed for MATS compliance.
Option 3	Baghouse and Mist Eliminator Vessel Modifications and PM CEMS	Not used	Stack Modifications for Quarterly Compliance Testing	Not used	Low risk, high capital.
Secondary Compliance Alternatives – Not Currently Required					
Compliance Option	**Non-Hg Metal HAPS**		**Acid Gases**		**Comments**
	FPM	**Total Non-Hg Metals**	**HCl**	**SO_2**	
Option 4	Baghouse and PM CEMS	Not used	Not used	Dry Sorbent Injection (DSI - Trona) (SO_2 CEMS)	High capital. Achieves MATS compliance with low compliance risk. SO_2 control is not required at this time as Lewis & Clark can demonstrate compliance with the MATS HCl limit.
Option 5	Baghouse and PM CEMS	Not used	Not used	Lime Spray Dryer (SO_2 CEMS)	High capital. Achieves MATS compliance with low compliance risk. SO_2 control is not required at this time as Lewis & Clark can demonstrate compliance with the MATS HCl limit.

6. CAPITAL COST ESTIMATES FOR IMPLEMENTATION OF PROPOSED COMPLIANCE STRATEGIES

S&L developed conceptual capital costs in 2013 dollars for each of the potential compliance options. Estimated capital costs are summarized below, and the bases for the cost estimates are presented in Appendix B. The estimates are based on a total installed cost and include the following:

- Equipment and materials
- Direct field labor
- Indirect field costs and engineering
- Contingency
- Startup and commissioning

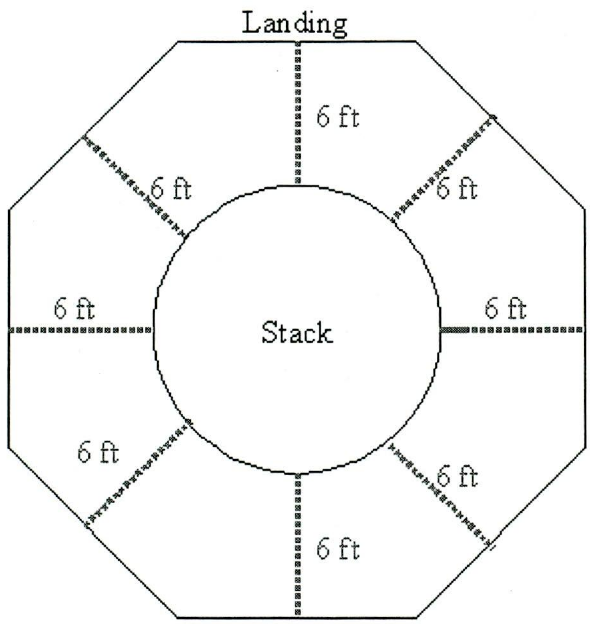
Capital costs presented do not include sales taxes, property taxes, license fees and royalties, owner costs, or AFUDC (Allowance for Funds Used During Construction). Total installed costs of the baghouse and chimney demolition for Option 3, and Option 4 were estimated from specific quotes obtained from vendors. Option 3 total installed costs also incorporate vendor quotes for the stack enclosure and mist eliminator modifications. The DSI portion of the Option 4 costs utilized pricing obtained by S&L on recent similar projects. Option 5 costs were calculated using the EPA's IPM Algorithm cost calculations for an SDA FGD. Cost algorithms in EPA's IPM model were prepared by S&L. Because Option 5 costs were estimated using the IPM model, these costs should not be used for detailed budgeting or solicitation of pollution control bonds.

Option 3 includes taking the mechanical collectors out of service and using a baghouse for FPM control, while maintaining the flooded wet disk scrubber in operation to continue to achieve moderate SO_2 and HCl removal, and installing the modifications necessary to ensure year-round quarterly stack testing for HCl emissions. The detailed Option 3 cost estimate can be found in Appendix B. The basis for this estimate uses the general arrangement generated by S&L, and included in Appendix D.

Stack modifications include the major scope items listed below:

- At elevation 2,140 feet, the testing level would be provided with additional grating and supports as required to maintain a minimum platform width of 6 feet (see Appendix D).
- A sided enclosure will be required at both the 2,121-foot elevation as well as the 2,140-foot elevation.
- The 2,140-foot elevation will require windows/openings to accommodate stack test probes.

Figure 6-1. Schematic of Modified Grating at Elevation 2,140 Feet



Other major scope items included in the Option 3 cost are:

- A six-compartment pulse-jet fabric filter baghouse with a 3.8 gross air-to-cloth ratio installed in the flue gas path between the existing air heater and existing ID fan.
- The baghouse is designed for a temperature of 400 °F – 450 °F with fiber glass bags.
- The baghouse includes an internal bypass to protect the bags in case of a temperature excursion. Note that the bypass cannot be operated during startup and shutdown, per MATS startup and shutdown work practice standards.
- Ductwork from the air heater outlet to the baghouse and from the baghouse to the modified ID fans.
- Blanking plates to isolate, and demolition of the multiclones.
- No major modifications to the auxiliary power system were included. However, the cost for cables and other electrical equipment was included.
- Demolition of the abandoned-in-place chimney to provide the optimal tie-in location for the baghouse.
- The existing ID fans will be modified to account for a net increase in system pressure drop by four inches. Removing the multiclones from service eliminates four inches of pressure drop, whereas the addition of the baghouse adds eight inches of pressure drop.
- Pneumatic ash handling equipment to convey the fly ash to a storage silo, where it can either be dispositioned for sale or for landfill disposal. It is assumed for this study that a dry fly ash system

is preferred to render Lewis & Clark more adaptable to the potential CCR and effluent limitation guidelines and regulations.

- Mist eliminator vessel modifications including two ME stages, a vapor horn turning vane configuration, and a washing system for the ME stages.

Option 4 involves injecting a sodium-based sorbent (this study assumes Trona) into the flue gas upstream of a baghouse to achieve SO_2 emission levels below 0.20 lb/MMBtu. The scope is essentially equivalent to that of Option 3 without the ME vessel or ID fan modifications and with the addition of the DSI equipment. The following major scope items are included in the estimate:

- A six-compartment pulse-jet fabric filter baghouse with a 3.8 gross air-to-cloth ratio installed in the flue gas path between the existing air heater and existing ID fan.
- The baghouse is designed for a temperature of 400 °F- 450 °F with fiber glass bags.
- The baghouse includes an internal bypass to protect the bags in case of a temperature excursion. Note that the bypass cannot be operated during startup and shutdown, per MATS startup and shutdown work practice standards.
- Ductwork from the air heater outlet to the baghouse and from the baghouse to the ID fans.
- Blanking plates, and demolition of the multiclones.
- Demolition of the abandoned-in-place chimney to provide the optimal tie-in location for the baghouse.
- No major modifications to the auxiliary power system were included. However, the cost for cables and other electrical equipment was included.
- The existing ID fans and motors will be reused. Removing the multiclones from service eliminates four inches of pressure drop and taking the existing particulate scrubber out of service, but still using the quench system eliminates 10 inches of pressure drop. With the addition of the baghouse adding eight inches of pressure drop, the pressure drop is anticipated to be within the current operation.
- Pneumatic ash handling equipment to convey the fly ash to a storage silo, where it can either be dispositioned for sale or for landfill disposal. It is assumed for this study that a dry fly ash system is preferred to render Lewis & Clark more adaptable to the potential CCR and effluent limitation guidelines and regulations.
- DSI equipment, including truck unloading equipment, a storage silo, conveying blowers and injection lances. The injection lances ideally would be located upstream of the air heater. If sodium bicarbonate is used in lieu of Trona, the injection location would be downstream of the air heater to avoid sintering.

Option 5 involves using a lime SDA in conjunction with a baghouse to achieve SO_2 emission levels below 0.20 lb/MMBtu. The estimate was developed to reflect the current scope, and capital costs were calculated using the IPM Algorithm Cost calculations for an SDA FGD. The following major scope items are included in the estimate:

- A six-compartment pulse-jet fabric filter baghouse with a 3.6 gross air-to-cloth ratio installed in the flue gas path between the existing air heater and existing ID fan.
- In this option, the baghouse is designed for 200 °F with bags made from PPS.
- A dry FGD absorber for SO_2 removal.
- The baghouse includes an internal bypass to protect the bags in case of a temperature excursion. Note that the bypass cannot be operated during startup and shutdown, per MATS startup and shutdown work practice standards.
- Ductwork from the air heater outlet to the spray dryer absorber, from the absorber to the baghouse, and from the baghouse to downstream of the existing particulate scrubber.
- Blanking plates to isolate the multiclones and existing particulate scrubber.
- No major modifications to the auxiliary power system were included. However, the cost for cables and other electrical equipment was included.
- The existing ID fans and motors will be reused. Removing the multiclones from service eliminates four inches of pressure drop and removing the existing particulate scrubber from service eliminates 12 inches of pressure drop. With the addition of an SDA FGD, a baghouse, and the new ductwork, the pressure drop is anticipated to be equivalent to current operation.
- Pneumatic ash handling equipment to convey the fly ash to a storage silo, where it can either be dispositioned for sale or for landfill disposal. It is assumed for this study that a dry fly ash system is preferred to render Lewis & Clark more adaptable to the potential CCR and effluent limitation guidelines and regulations.

Table 6-1 summarizes the capital costs that were estimated for each of the options evaluated.

Table 6-1. Capital Cost Summary ($2013)

Compliance Strategies	**Primary MATS Compliance Alternatives**	**Secondary MATS Compliance Alternatives**	
Option:	**Option 3**	**Option 4**	**Option 5** Note 1
Modification:	Baghouse + ME Vessel Modifications	Baghouse + DSI	Baghouse + Dry FGD
Total	**$26,142,000**	**$33,851,000**	**$43,869,000**

Note 1 - Option 5 Capital Cost calculated using the IPM Algorithm Cost calculations for SDA FGD, prepared by S&L for the EPA.

The Primary MATS Compliance Alternative, Option 3, requires minimal capital investment compared to the two Secondary MATS Compliance Alternatives, Options 4 and 5. Both Option 4 and Option 5 require significant capital expenditures, with Option 5 representing the greater cost at approximately $44 million.

7. O&M COST ESTIMATES FOR IMPLEMENTATION OF PROPOSED COMPLIANCE STRATEGIES

S&L developed conceptual variable and fixed O&M costs in 2013 dollars for each of the compliance options. O&M cost estimates are summarized below and presented in detail in Appendix C.

All variable O&M costs presented are incremental costs, meaning they are presented relative to Option 3, which is considered the base cost option, as it is the recommended MATS compliance option and has the least capital requirement. For Options 4 and 5, lost fly ash revenue was not included in the annual O&M costs, although there would be a loss in the ability to sell fly ash. Option 5 O&M costs are calculated using the IPM Algorithm Cost calculations for SDA FGD. The variable O&M costs include the following:

- Incremental reagent costs
- Incremental disposal costs
- Incremental auxiliary power
- Incremental water costs
- Bag and cage replacement
- Quarterly stack testing

Fixed O&M costs were estimated, in all cases, based on the assumption that no additional administrative labor would be required. The fixed O&M costs include the following:

- Operating labor
- Maintenance labor
- Maintenance materials

O&M costs are summarized for each option in Table 7-1.

Table 7-1. O&M Cost Summary ($2013)

Compliance Strategies	Primary MATS Compliance Alternatives	Secondary MATS Compliance Alternatives	
Option:	**Option 3**	**Option 4**	**Option 5**
Modification:	Baghouse + ME Vessel Modifications	Baghouse + DSI	Baghouse + Dry FGD Note 1
Variable O&M Costs			
TRADE SECRET			
Fixed O&M Costs			
TRADE SECRET			
Total O&M Costs	**$531,000**	**$1,929,000**	**$1,452,000**

Note 1 - Option 5 O&M Costs calculated using the IPM Algorithm Cost calculations for SDA FGD, prepared by S&L for the EPA.

8. IMPLEMENTATION SCHEDULE FOR COMPLIANCE

In general, compliance with the MATS emission standards is required within three years of publication of the rule in the *Federal Register* (i.e., April 16, 2015). However, if an existing source is unable to comply within the three years, or needs additional time for the installation of controls, the permitting authority (generally the state) has the ability to grant up to a one-year extension. Permitting authorities have the discretion to issue an extension to address a range of situations in which installation schedules may take more than three years. These situations include staggering installations for reliability reasons or other site-specific challenges that might arise related to source-specific construction, permitting, labor, procurement, or resource challenges. In the preamble to the final rule, EPA stated that the "fourth year should be broadly available to enable a facility owner to install controls within 4 years if the 3-year time frame is inadequate for completing installation."[5]

Options 1 and 2 were eliminated from consideration because stack testing indicates that neither option can meet the MATS requirements for FPM (or total non-Hg HAP metals). The recommended Primary Compliance Alternative is Option 3, installing a baghouse and modifying the ME vessel. This option carries the least risk associated with meeting emission requirements. The baghouse project is estimated to have a 23-month duration from project authorization. An implementation schedule for Option 3 is included in Appendix E. Because Option 3 includes installation of a baghouse, Montana-Dakota should receive an additional year for MATS compliance; thus, compliance would be required by April 16, 2016. Based on a 23-month schedule, Montana-Dakota must authorize work on a baghouse no later than October 2013. It is possible that because of the relatively small size of the equipment required, engineering, fabrication, and erection activities could be streamlined; however, S&L's schedule does not reflect this potential benefit because market activity may extend equipment lead times as the compliance deadline approaches.

The DSI system engineering work could be executed in parallel to the baghouse; therefore, the duration of Option 4 is anticipated to not exceed 23 months, and would have a similar schedule to Option 3. The expected duration to implement a dry FGD system in combination with a baghouse (Option 5) is estimated to be 40 months. As the Secondary Compliance Alternatives are not required at this time; only a level 1 schedule for Option 5 is included in Appendix E for Montana-Dakota's information.

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[5] MATS Final Rule, 77 FR 9410.

9. RECOMMENDED COMPLIANCE STRATEGY

Table 9-1 summarizes the economic evaluation of the Primary and Secondary Compliance Alternatives evaluated by S&L as part of this study.

Table 9-1. Net Present Value Comparison of Primary and Secondary MATS Compliance Alternatives

Compliance Strategies		Primary MATS Compliance Alternatives	Secondary MATS Compliance Alternatives	
Option:		Option 3	Option 4	Option 5
Modification:		Baghouse + ME Modifications	Baghouse + DSI	Baghouse + Dry FGD Note 1

TRADE SECRET

Capital Cost	$	$26,142,000	$33,851,000	$43,869,000
Total O&M (First Year)	$/yr	$531,000	$1,929,000	$1,452,000
Net Present Value	$	$39,385,000	$65,266,000	$72,539,000
Levelized Revenue Requirement	$/yr	$5,329,000	$8,830,000	$9,815,000

Note 1 - Option 5 Capital & O&M Costs calculated using the IPM Algorithm Cost calculations for SDA FGD, prepared by S&L for the EPA. Option 5 costs should not be used for detailed budgeting or solicitation of pollution control bonds.

Stack testing conducted in 2012 verified that the least-capital cost compliance options (Options 1 and 2) do not provide the FPM or total non-Hg HAP metal emission reductions needed for MATS compliance. Therefore, S&L recommends MATS compliance Option 3. Option 3 includes decommissioning the multiclones, demolishing the abandoned-in-place chimney, installing a baghouse, modifying the ME vessel for particulate removal, and installing the stack test port enclosure for quarterly HCl compliance testing. Baghouse technology coupled with the ME vessel modifications, should reduce FPM emissions from Lewis & Clark below the MATS limit of 0.030 lb/MMBtu, while maintaining Hg and HCl emissions below the applicable MATS requirements.

For information, S&L also provided Secondary Compliance Alternatives, whereby SO_2 emissions would be used as a surrogate to comply with the MATS acid gas emission standard. Because the final Montana Regional Haze FIP did not require Lewis & Clark to achieve any additional SO_2 reductions, using HCl for MATS acid gas compliance is the least capital MATS compliance approach. The Secondary Compliance Alternatives would be recommended only if future Regional Haze Reasonable Progress Goals, or other regulations, require additional SO_2 control. As such, S&L has provided a comparison between using DSI with a baghouse (Option 4) and dry FGD with a baghouse (Option 5). For these Secondary Compliance Alternatives, S&L found that the overall economics tend to favor the dry FGD (Option 5) over DSI (Option 4). This conclusion is based on considering the NPV associated with the capital and incremental O&M costs that would be incurred with each system. Although the capital cost is higher for the dry FGD option, the O&M costs are significantly higher for the DSI option. Since lime currently is being injected to achieve 60% SO_2 removal at Lewis & Clark, the increase in lime consumption for the dry FGD to operate at 0.20 lb/MMBtu (approximately 82% reduction) is moderate compared to the amount of Trona that would be required for a DSI system to control SO_2 emissions to 0.20 lb/MMBtu. For the DSI plus baghouse option, the existing particulate scrubber would be decommissioned and, therefore, the Trona would need to accomplish all of the 82% reduction, resulting in high O&M costs.

9.1 *Cash Flows of Recommended Compliance Strategy*

The cash flow forecast for Option 3, included in Appendix F, shows the anticipated total monthly expenditures that Montana-Dakota could expect for the baghouse and ME vessel modification project at Lewis & Clark. These cash flows include the estimated construction, engineering, and equipment costs to be incurred every month. The procurement of the major equipment, the baghouse, ME modifications, and the ash handling system, is expected to have a 10% payment one (1) month after the award (receipt of first drawings), 20% corresponding to the start of fabrication, 35% upon delivery, and the remaining 35% when general construction starts. This cash flow can be used as a visual representation of the implementation plan for the Option 3 MATS compliance strategy, as expressed through the budget, assuming the project proceeds as anticipated.

APPENDIX A.
REGULATORY REVIEW

Montana-Dakota Utilities Co.

Lewis & Clark Generating Station
Environmental Compliance Study
Appendix A – Regulatory Review

Project No. 08336-051

Report No. SL - 011198

June 12, 2013

Prepared by:

Sargent & Lundy LLC

55 East Monroe Street
Chicago, IL 60603-5780 USA
312-269-2000

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EXECUTIVE SUMMARY

Recently promulgated and proposed environmental regulations may have a significant impact on operations at existing fossil fuel-fired power plants. These regulations will require existing coal-fired steam electric generating units to control hazardous air pollutant emissions, and will likely require additional reductions of criteria air pollutants including sulfur dioxide (SO_2), nitrogen oxides (NO_X), and particulate matter (PM, including PM_{10} and $PM_{2.5}$). This Appendix reviews the status of recently published and proposed environmental regulations, and identifies the regulatory requirements as they apply to Montana-Dakota Utilities Co.'s (Montana-Dakota) Lewis & Clark Generating Station (Lewis & Clark).

Environmental regulations that will have the most immediate impact on operations at Lewis & Clark are the federal Regional Haze Rule and the Mercury and Air Toxics Standard (MATS Rule). The Regional Haze Rule requires that each state develop and adopt an implementation plan to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment to visibility in Class I Areas which result from man-made pollutants. The MATS Rule regulates hazardous air pollutant ("HAP") emissions from coal- and oil-fired electric generating units ("EGUs"). The rule includes emission standards for mercury (Hg), non-Hg trace metals, and acid gas emissions from existing coal-fired boilers.

On September 18, 2012, EPA published in the *Federal Register* its final Federal Implementation Plan (FIP) addressing the regional haze requirements in Montana. Based on EPA's evaluation of the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of the Lewis & Clark generating unit, and taking into consideration the small size of the unit and the relatively small reduction in visibility impacts that may be achieved with the installation of advanced air pollution control systems, EPA concluded that no additional PM, NOx, or SO_2 controls would be required for Lewis & Clark for this regional haze implementation period (i.e., through about 2018). Based on EPA's September 18, 2012 final rule, this regulatory review assumes that no additional emission reductions or control technologies will be required on Lewis & Clark for regional haze compliance through 2018.

Lewis & Clark will be subject to emission limits and work practice standards in the MATS Rule. The rule includes emission limits for mercury, acid gases (regulated as HCl or SO_2), and trace metal HAP emissions (regulated as filterable particulate matter (FPM), total non-Hg metals, or individual non-Hg metals). Table ES-1 provides a comparison of existing baseline HAP emissions from Lewis & Clark to the applicable MATS emission limits.

Table ES-1
Lewis & Clark - Baseline HAP Emissions vs. MATS Emission Limits

<table>
<tr><th>HAP</th><th>Baseline Existing HAP Emissions</th><th>MATS Emission Limit</th><th>Emission Reduction Requirements</th></tr>
<tr><td>Hg</td><td>1.35 lb/TBtu</td><td>4.0 lb/TBtu</td><td>Lewis & Clark is expected to meet the MATS Hg emission limit with no additional controls.</td></tr>
<tr><td colspan="4">Acid Gas Emissions</td></tr>
<tr><td>HCl</td><td>0.00008 lb/MMBtu</td><td>0.002 lb/MMBtu</td><td rowspan="2">Lewis & Clark is expected to meet the MATS HCl emission limit with no additional controls. This conclusion assumes that the existing flooded wet disk scrubber remains in operation. Modifications to the existing scrubber, or installation of advanced flue gas desulfurization would be required to meet the MATS SO_2 emission limit.</td></tr>
<tr><td>SO_2</td><td>0.50 lb/MMBtu</td><td>0.20 lb/MMBtu</td></tr>
<tr><td colspan="4">Particulate Matter</td></tr>
<tr><td>FPM</td><td>0.050 lb/MMBtu</td><td>0.030 lb/MMBtu</td><td rowspan="2">Baseline FPM and total non-Hg HAP metals are above the applicable MATS limits. Additional controls are needed for compliance to be demonstrated through FPM or total non-Hg HAP metals.</td></tr>
<tr><td>Total Non-Hg HAP Metals</td><td>71.7 lb/TBtu</td><td>50.0 lb/TBtu</td></tr>
</table>

The following regulatory findings are based on a comparison of existing HAP emissions data available from Lewis & Clark to the applicable MATS emission limits, taking into consideration fuel characteristics and existing air pollution control systems:

- Existing mercury emissions from Lewis & Clark are below the MATS Hg emission limit of 4.0 lb/TBtu. Lewis & Clark is expected to meet the MATS Hg emission limit with no additional controls.
- Existing FPM and total non-Hg HAP metal emissions are above the MATS emission limits of 0.030 lb/MMBtu and 50 lb/TBtu, respectively. Upgrades or modifications to the existing flooded wet disk scrubber, or installation of advanced particulate matter control systems (including wet and dry electrostatic precipitation or fabric filter baghouse) are needed to reduce FPM and/or total non-Hg HAP metal emissions below the applicable MATS limits.

- Based on stack test results from Lewis & Clark, existing HCl emissions are well below MATS limit of 0.002 lb/MMBtu. Lewis & Clark should meet the MATS HCl emissions limit with no additional controls. This conclusion is based on the assumption that the existing flooded wet disk scrubber remains in place and operational.
- Existing SO_2 emissions from Lewis & Clark are above the MATS SO_2 emission limit of 0.20 lb/MMBtu (30-day average). Upgrades or modifications to the existing flooded wet disk scrubber, on installation of advanced flue gas desulfurization (FGD) controls, would be needed to reduce SO_2 emissions below the MATS limit. However, Lewis & Clark is not required to meet the SO_2 emissions limit if it can demonstrate compliance with the alternative HCl emissions limit.

Montana-Dakota will be required to develop and implement a boiler tune-up program meeting the requirements of the MATS Rule. Initial compliance with this work practice standard must be demonstrated by October 16, 2015; thus, it is recommended that Montana-Dakota plan on performing the required tune-up and inspections during the unit outage preceding the October 16, 2015 compliance deadline. The work practice standard for the control of organic HAP emissions also requires that Montana-Dakota tune-up the Lewis & Clark burner and combustion control systems at least once each 36 calendar months, or each 48 calendar months if neural network combustion optimization software is installed. The work practice standard involves maintaining and inspecting the burners and associated combustion controls, tuning the specific burner type to optimize combustion, and obtaining and recording CO and NO_X values before and after burner adjustments. Montana-Dakota must submit a report for each tune up conducted to the Montana Department of Environmental Quality.

Montana-Dakota will also be required to meet specific work practice standards that apply during boiler startup and shutdown. In general, work practice standards that apply during periods of startup and shutdown require the use of "clean fuels" (i.e., natural gas or distillate oil) for ignition during startup, and that all applicable control technologies (except dry scrubbers and SCRs) are engaged and operating once the unit converts to firing coal. Based on information provided by Montana-Dakota, natural gas is used as the startup fuel and all applicable control technologies are engaged prior to firing coal. Thus, Lewis & Clark will meet the MATS startup/shutdown work practice standards with no modifications or operational changes.

Finally, Montana-Dakota will be required to implement a comprehensive emissions testing and monitoring program to demonstrate both initial and continuous compliance with the applicable MATS emission limits. In general, the rule includes two basic emission monitoring approaches: (1) Continuous Emissions Monitoring Systems (CEMS) or PM Continuous Parameter Monitoring Systems (CPMS); or (2) periodic quarterly stack testing for all pollutants other than SO_2 and Hg. The rule also includes less stringent monitoring requirements for units that qualify as a low emitting EGU (or "LEE"). Based on a comparison of existing HAP emissions data from Lewis & Clark to the applicable LEE emissions limits:

- Baseline Hg emissions from Lewis & Clark, controlled using fuel additive and activated carbon injection (ACI) control systems, are below the applicable LEE standard of 29 lbs. Hg emissions per year, and it is anticipated that Lewis & Clark could achieve LEE status for Hg with no additional controls.
- Baseline HCl emissions are below the applicable LEE standards, and it is anticipated that Lewis & Clark could achieve LEE status for HCl with no additional controls.
- Baseline FPM and total, as well as individual, non-Hg HAP metal emissions are above the applicable MATS limits. Upgrades or modifications to the existing flooded wet disk scrubber, or installation of advanced particulate matter control systems (including wet and dry electrostatic precipitation or fabric filter baghouse) are needed to reduce FPM and/or total non-Hg HAP metal emissions below the applicable LEE standards.

Assuming that the unit qualifies for LEE status for Hg and HCl, S&L recommends a combination of annual Hg LEE performance tests (30-day Method 30B Test) and quarterly HCl stack testing for three years to demonstrate LEE status for these constituents. Similar to demonstrating HCl LEE status, with additional FPM controls implemented to meet the non-Hg HAP metals emissions limits, the unit may qualify for LEE status for FPM and/or total non-Hg HAP metals. Lewis & Clark could demonstrate LEE status for FPM by conducting three years of quarterly FPM stack testing. For LEE status to be attained for HCl and FPM, the three years of stack testing must show the unit achieves 50% or less of the respective MATS emission limit. Assuming Lewis & Clark is able to establish LEE status for FPM and HCl, compliance testing will be reduced to once every 36 months.

The regulatory requirements and emission limits summarized above will be used to establish the baselines for S&L's Environmental Control Technology Strategy and air pollution control technology evaluation. The control technology evaluation will focus on control system upgrades and modifications needed to comply with the both the Regional Haze and MATS Rules. Because the final Montana Regional Haze FIP does not require additional SO_2 or NO_X controls, the environmental control technology evaluation will focus on meeting the applicable MATS emission limits, including mercury, total non-Hg HAP metals or FPM, and HCl or SO_2.

1. ENVIRONMENTAL REGULATORY ISSUES AND CONTROLS

Recently promulgated and proposed environmental regulations may have a significant impact on operations at existing fossil fuel-fired power plants. These regulations will require existing coal-fired steam electric generating units to control hazardous air pollutant emissions, and will likely require additional reductions of criteria air pollutants including sulfur dioxide (SO_2), nitrogen oxides (NO_X), and particulate matter (PM, including PM_{10} and $PM_{2.5}$).

This appendix to the Lewis & Clark Environmental Control Technology Strategy Report reviews the status of two recently promulgated environmental regulations that may impact operations at Montana-Dakota Utilities Co.'s (Montana-Dakota) Lewis & Clark Generating Station (Lewis & Clark): the Mercury and Air Toxics Standard and the Regional Haze Rule. A detailed summary of each regulation is provided, including the applicable emission limits and work practice standards, emission control requirements, and potential compliance strategies. Emission limits and compliance timelines established in this report serve as the basis for the air pollution control technology review and evaluation in S&L's Environmental Control Technology Strategy.

2. BACKGROUND

Montana-Dakota provides retail natural gas and electric service to parts of Montana, North Dakota, South Dakota, and Wyoming. Montana-Dakota owns and operates the Lewis & Clark Station, a lignite-based steam electric generating station located near Sidney, Montana. The station consists of one dry-bottom tangentially-fired boiler designed to fire lignite coal, but is capable of co-firing lignite with subbituminous Power River Basin (PRB) coal and natural gas on a limited basis. Commercial operation of Lewis & Clark commenced in 1958.

Lignite, the primary fuel fired in Lewis & Clark, is supplied from the Savage Mine, which is owned and operated by Westmoreland Savage Corporation. The mine is an 874-acre single pit surface mine, located near Savage, Montana, approximately 20 miles southwest of Sidney, Montana. The Savage Mine currently has a full-requirements contract with Lewis & Clark.

The maximum capacity of Lewis & Clark is dependent on the type of fuel fired, but is in the range of 48 MW gross electrical output (MWg) when firing 100% lignite (the normal operating scenario). Unit 1 is equipped with a multi-cyclone dust collector for PM control and a flooded disc wet particulate scrubber. Design control efficiency of the multi-cyclone dust collector is in the range of 75-80%. An overall PM removal efficiency of approximately 98% is achieved with the multi-cyclone and wet particulate scrubber. Although the flooded disc scrubber is primarily designed for PM control, it also provides co-benefit SO_2 removal. Depending on the presence of calcium in the fly ash, the wet scrubber can achieve SO_2 removal efficiencies of approximately 60%. Additional SO_2 control, up to approximately 70%, can be achieved by adding lime to the flooded disc scrubber.

NO_X controls on Lewis & Clark include low NO_X burners (LNBs) and a close-coupled overfire air (CCOFA) control system installed in 1996. Montana-Dakota recently installed mercury controls on Lewis & Clark to comply with mercury control requirements in the Administrative Rules of Montana (ARM) §17.8.771. Mercury controls include a fuel additive system to enhance mercury oxidation and activated carbon injection (ACI) control.

3. REGIONAL HAZE RULE

On July 6, 2005, the U.S. Environmental Protection Agency (EPA) published the final "Regional Haze Regulations and Guidelines for Best Available Retrofit Technology Determinations" (the "Regional Haze Rule").[1] EPA issued the Regional Haze Rule under the authority and requirements of sections 169A and 169B of the Clean Air Act (CAA). Sections 169A and 169B require EPA to address regional haze visibility impairment in 156 federally-protected parks and wilderness areas (Class I Areas).

As mandated by the CAA, the Regional Haze Rule requires that each state develop and adopt an implementation plan to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment of visibility in Class I Areas which results from man-made air pollutants. The Regional Haze Rule requires that states modify their State Implementation Plans (SIPs), giving specific attention to existing stationary emission sources that cause or contribute to visibility impairment in one or more Class I Areas. States are directed to conduct a Best Available Retrofit Technology (BART) determination, and require the installation of BART controls, for such "BART-eligible" emission sources.

The rule required each state to submit their regional haze SIPs no later than December 17, 2007; however, on June 19, 2006, the Montana Department of Environmental Quality (MDEQ) informed EPA that the State of Montana was withdrawing its efforts to adopt the provisions of the federal Regional Haze Rule. Because the

[1] 70 Fed. Reg. 39104

State of Montana did not address the federal regional haze requirements, EPA Region 8 moved forward with the technical and rulemaking work needed to implement the Regional Haze requirements under a Federal Implementation Plan (FIP).

3.1 Final Montana Regional Haze Federal Implementation Plan

On September 18, 2012, EPA published in the *Federal Register* its final FIP addressing the regional haze requirements in Montana (the "Final RH FIP").[2] As required by the Regional Haze Rule, the Final RH FIP includes a determination of the baseline, natural, and current visibility conditions in Class I areas affected by emission sources located in Montana; identifies the existing stationary emission sources in Montana subject to the BART requirements; and establishes BART control technologies and emission limits for the subject-to-BART sources.

BART-eligible sources are defined by the Regional Haze Rule to include those sources that:

- have the potential to emit 250 tons or more of a visibility-impairing air pollutant;
- were in existence on August 7, 1977 but not in operation prior to August 7, 1962; and
- whose operations fall within one or more of the specifically listed source categories in 40 CFR 51.301 (including fossil-fuel fired steam electric plants of more than 250 MMBtu/hr heat input and fossil-fuel boilers of more than 250 MMBtu/hr heat input).

Because Lewis & Clark commenced commercial operation prior to August 7, 1962, it does not meet the definition of a BART-eligible source under the Regional Haze Rule, and was not identified as a source subject to the BART requirements in the Final RH FIP.

3.2 Regional Haze Reasonable Progress Standards

In addition to requiring BART controls on certain existing stationary sources, Regional Haze Rule implementation plans must include milestones to ensure continuing progress toward achieving the rule's visibility goals. The rule does not mandate specific milestones or rates of progress, but requires EPA to establish goals that provide for "reasonable progress" towards achieving natural visibility conditions by 2064, referred to as Reasonable Progress Goals (RPGs). In setting RPGs, EPA must provide for an improvement in visibility for the most impaired days over the 10-year implementation period of the FIP, and ensure no

[2] 77 Fed. Reg. 57864, September 18, 2012.

degradation in visibility for the least impaired days over the same period.[3] Plans developed to meet the RPGs may expand emission control requirements beyond the BART-eligible sources and require emission reductions for other sources and source categories affecting visibility in the Class I Areas.

The Final RH FIP includes a Reasonable Progress (RP) determination and establishes RPGs for Montana. In selecting RPGs for mandatory Class I Areas within Montana, EPA relied on emission inventories developed by the Western Regional Air Partnership (WRAP) for 11 source categories to identify those categories contributing most to visibility impairment. Based on its analysis of the emission inventories, EPA concluded that the non-BART-eligible point source subcategory, including existing sources such as Lewis & Clark, were the dominant source of SO_2 and NO_X emissions, and the only category necessary to evaluate further under reasonable progress.[4]

To identify point sources that potentially affect visibility in a Class I area, EPA divided actual NO_X and SO_2 emissions (Q) in tons per year from each source by their distance (D) in kilometers to the nearest Class I Area. EPA then undertook a more detailed analysis of sources with a Q/D of greater than 10, including Lewis & Clark which was determined to have a Q/D of 29.[5] EPA requested a four-factor analysis from each RP source. The four-factor analysis includes an evaluation of: (1) the costs of compliance; (2) the time necessary for compliance; (3) the energy and non-air quality environmental impacts of compliance; and (4) the remaining useful life of any potentially affected source. Montana-Dakota submitted its emission control analysis for Lewis & Clark to EPA in February 2011, including an evaluation of the following air pollution control technologies:[6]

SO_2: Fuel switch to natural gas
Lime Spray Dryer Absorber (SDA) and Baghouse
Dry Sorbent Injection (DSI) and Baghouse
Optimization of the existing Wet PM scrubber (scrubber modifications)

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[3] See, 40 CFR 51.308(d), (f).

[4] 77 Fed. Reg. pg. 24057-24058.

[5] See, 77 Fed. Reg., Table 157, pg. 24059.

[6] *Emission Control Analysis for Lewis & Clark Station Unit 1 – Response to November 2010 US EPA Request for Additional Reasonable Progress Information*, Prepared by Barr Engineering, February 2011,revised June 2011 (the "*Control Analysis for Lewis & Clark Station Unit 1 - June 2011*").

NO_X: Combustion Controls:

Low NOx Burners (LNB) and Separated Overfire Air (SOFA)
Post Combustion Controls:
Selective Non-Catalytic Reduction (SNCR)
Selective Catalytic Reduction (SCR)

Taking into consideration technical information and costs provided in Montana-Dakota's *Control Analysis for Lewis & Clark Station Unit 1 - June 2011*, EPA prepared its own four-factor analysis for the Lewis & Clark Station. Based on its evaluation of the costs of compliance, and taking into consideration the small size of Lewis & Clark, the baseline Q/D of the facility, and the relatively small reduction in Q/D achieved with the installation of advanced air pollution control systems, EPA published the following RP requirements for Lewis & Clark:[7]

PM Emissions: EPA concluded that modeling tends to confirm that PM emissions from point sources do not have a very large impact on visibility in the Class I Areas; therefore, EPA determined that additional PM controls on existing point sources are not necessary for this control period.

SO_2 Emissions: EPA eliminated from consideration the more expensive SO_2 control options, including switching to natural gas, SDA and baghouse, and DSI with baghouse, based on costs of compliance and the relatively small baseline Q/D. EPA found that scrubber modifications (the most cost-effective SO_2 control option) would reduce SO_2 emissions by 100 tpy, which equates to a 5.5% reduction in overall emissions of $SO_2 + NO_X$ from the facility, or a reduction of Q/D from 29 to 27. EPA determined, based on the costs of compliance, the baseline Q/D, and the modest reduction in Q/D, that it was reasonable to eliminate this option from consideration. Thus, EPA determined that no additional SO_2 controls were required for Lewis & Clark for this planning period.

NOx Emissions: EPA eliminated the more expensive NO_X control options (e.g., fuel switching to natural gas, high-dust SCR+SOFA/LNB, SNCR, and SNCR+SOFA/LNB) based on costs of compliance and the relatively small baseline Q/D. EPA also found that SOFA/LNB (the most cost effective NO_X control option) would reduce NO_X emissions by approximately 300 tpy, which equates to a 16.6% reduction in overall emissions of $SO_2 + NO_X$, or a reduction of Q/D from 29 to 24. EPA found, based on the cost of compliance and the modest reduction in Q/D, that it was reasonable to

[7] See, 77 Fed. Reg. pg. 24070 – 24074 (Proposed Rule). See also, response to comments in the Final Rule, 77 Fed. Reg. pg. 57905 – 57906.

eliminate this option from consideration. Thus, EPA determined that no additional NO_X controls were required for Lewis & Clark for this planning period.

3.3 Potential Future Regional Haze Requirements

As noted above, Montana, or EPA, is required to re-visit its regional haze RPGs once every 10 years. RPGs included in the September 18, 2012 final rule are established for the initial implementation period which extends through about 2018. It is possible that during the next implementation period (scheduled to begin in the 2018 timeframe) more aggressive Reasonable Progress Goals could require Lewis & Clark to reduce emissions of NO_X and/or SO_2 to meet the next phase RPGs. However, emission reductions that may be required during the next Regional Haze implementation phase cannot be predicted with any level of confidence.

Based on EPA's four-factor RP control technology evaluation, it was determined for this study that no additional emission reductions or air pollution control technologies will be required for regional haze compliance for this planning period (i.e., 2012 through about 2018).

4. MERCURY AND AIR TOXICS STANDARD

On February 16, 2012, EPA published in the *Federal Register* a final rule regulating hazardous air pollutant (HAP) emissions from coal- and oil-fired electric generating units.[8] The rule, referred to as the Mercury and Air Toxics Standards ("MATS Rule" or "Utility MACT Rule") requires coal- and oil-fired electric utility steam generating units to meet HAP emission standards reflecting the application of the maximum achievable control technology (MACT). The rule includes emission standards and work practice standards that apply to all existing and new coal- and oil-fired EGUs. The rule became effective on April 16, 2012, and compliance with the MACT standards will be required within 3 to 4 years of the effective date (i.e., April 16, 2015 or 2016).

4.1 Applicability

The MATS Rule applies to new and existing coal- and oil-fired EGUs. An EGU is defined in the rule as a fossil fuel-fired combustion unit of more than 25 MW that serves a generator that produces electricity for sale. Coal-fired EGUs are defined in the rule as:

> Coal-fired EGUs include units burn coal (either as a primary fuel or as a supplementary fuel) where the coal accounts for more than 10% of the average annual heat input during any 3

[8] 77 Fed. Red. 9304, February 16, 2012.

consecutive calendar years or for more than 15% of the annual that heat input during any one calendar year.

Combustion units serving smaller generators, and natural gas-fired electric generating units, are not subject to the MATS requirements. Based on the definition of EGU in the final rule, Lewis & Clark is subject to the applicable coal-fired EGU standards in the MATS Rule.

EPA subcategorized the coal-fired EGU source category as follows:

Subcategory	Description
Unit designed for coal >8,300 Btu/lb	Coal-fired EGU that is not in the "unit designed for low rank virgin coal" subcategory.
Unit designed for low rank virgin coal (<8,300 Btu/lb)	Coal-fired EGU designed to burn and is burning nonagglomerating virgin coal having a calorific value (moist, mineral matter-free basis) of less than 8,300 Btu/lb that is constructed and operates at or near the mine that produces such coal.

EPA concluded that subcategories were warranted because EGUs firing lower rank coals had significantly different Hg emissions than the other coal-fired units. The "designed for low rank coal" (or "<8,300 Btu/lb") subcategory applies to lignite-fired units located at or near the mine producing the coal. EPA determined that EGUs firing the lower rank coals were universally constructed at or near the mine because it is not cost-effective to transport large quantities of such fuel long distances.

As noted above, lignite, the primary fuel fired in Lewis & Clark, is supplied to the Lewis & Clark Station from the Savage Mine. The mine is located approximately 20 miles south of the generating station, within a distance considered to be "at or near" the mine. Thus, Lewis & Clark is in the <8,300 Btu/lb subcategory, and will be subject to the emission limits and work practice standards applicable to EGUs in that subcategory.

4.2 MATS Emission Limits

The final rule includes HAP emission limits for mercury (Hg), non-Hg HAP metals, and acid gases. Work practice standards were included to control organic HAP emissions. For the non-Hg HAP metals, the final rule includes alternative emission limits for filterable particulate matter (FPM), total non-Hg HAP metals, and individual HAP metals. For the acid gases, the rule includes alternative emission standards for either HCl or SO_2 as a surrogate for all acid gas emissions. MATS emission limits for the <8,300 Btu/lb existing coal-fired EGU subcategory are summarized in Table 4-1.

Table 4-1. MATS Emission Limits for Existing Coal- Fired EGUs[(1)]

Existing Coal-Fired EGUs	Non-HG Metals	Acid Gases	Hg
Existing coal-fired unit designed for low rank virgin coal (i.e., <8,300 Btu/lb)	**Filterable PM[(2)]** 0.030 lb/MMBtu (0.3 lb/MWh) or **Total non-Hg HAP Metals[(3)]** 0.000050 lb/MMBtu (0.5 lb/GWh) or **Individual HAP Metals[(3)]**	**HCl** 0.0020 lb/MMBtu (0.02 lb/MWh) [~2 ppmvd @ 3% O_2] or **SO_2[(4)]** 0.20 lb/MMBtu or 1.5 lb/MWh	**Hg** 4.0 lb/TBtu (0.04 lb/GWh)

(1) MATS emission limits are based on 30-boiler operating day averages.
(2) The PM emission limit in the final rule includes filterable PM emissions only.
(3) The Total non-Hg HAP Metals emission limits equals the sum of: Antimony (Sb), Arsenic (As), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Lead (Pb), Manganese (Mn), Nickel (Ni), and Selenium (Se). As an alternative to the total non-Hg metals limit, owners/operators can choose to demonstrate compliance with the individual non-Hg metal limits included in Table 2 to Subpart UUUUU of Part 63
(4) The alternate SO_2 limit is available only for coal-fired EGUs using a flue gas desulfurization (FGD) control system.

Emission limits summarized above are based on a 30-boiler operating day average and apply at all times excluding periods of startup and shutdown. For periods of startup and shutdown, the rule includes work practice standards in lieu of numeric emission limits.

4.3 Baseline Lewis & Clark HAP Emissions

Montana-Dakota has conducted a limited number of HAP emissions tests at Lewis & Clark. Stack test results provided by Montana-Dakota are summarized in Table 4-2[9]

[9] Due to the limited emissions data available from Lewis & Clark, S&L reviewed HAP emissions data from similar sources available in EPA's ICR Database (http://utilitymacticr.rti.org/). Although the ICR Database includes HAP emissions data from several coal-fired boilers, the database includes only a limited number of stack test results from units firing North Dakota lignite, and none of the North Dakota lignite-fired units were equipped with air pollution control systems similar to those on Lewis & Clark. Therefore, it was concluded that emissions data in the ICR Database from units firing North Dakota lignite were not necessarily representative of emissions from Lewis & Clark, and an evaluation of the ICR emissions data was not included in this report.

Table 4-2
Lewis & Clark Summary of Available HAP Emissions Data

HAP or Surrogate	Unit 1 Emissions	Test Date / Notes
Mercury	1.35 lb/TBtu	Hg CEMS: Actual Annual Average 2012
FPM	0.050 lb/MMBtu	Stack Tests: 2012 MATS diagnostic testing (June 23-27, 2012 and September 6, 2012) Average of all test runs FPM emissions determined using EPA Method 29
Non-Hg HAP Metals*	71.7x 10^{-6} lb/TBtu	Stack Test: 2012 MATS diagnostic testing Average of all test runs Non-Hg Metal emissions determined using EPA Method 29
HCl	0.00008 lb/MMBtu (<0.06 ppm)	Stack Tests: 2012 MATS diagnostic testing Average of all test runs HCl emissions determined using EPA Method 26A
SO_2	0.50 lb/MMBtu	SO_2 CEMS (average annual SO_2 emissions)

* Total non-Hg HAP metals are reported as the sum of the following non-Hg metals: Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Manganese, Nickel, Selenium.

4.4 Emission Reduction Requirements and Control Technologies

The final rule does not require affected units to install specific emission control technologies. Coal- and oil-fired EGUs are simply required to meet the applicable HAP emission limits using whatever control technology, or combination of technologies, they deem appropriate for their specific situation. The following subsections compare the MATS emission limits to stack test data available from Lewis & Clark, and identify emission reduction requirements and potential control technologies that may be considered for MATS compliance.

4.4.1 Mercury Emissions and Controls

Mercury emissions from coal-fired boilers are a complex function of fuel characteristics (including the concentration of mercury and halogens in the coal), fly ash characteristics, combustion controls, and post-combustion air pollution control systems. During combustion, mercury readily volatilizes from the fuel and is found in the flue gas predominantly in the vapor phase as elemental mercury (Hg^0). As the flue gas cools, a series of complex reactions begin to convert Hg^0 to gaseous ionic (or oxidized) mercury (Hg^{2+}) compounds, and Hg compounds that are in a solid-phase at flue gas temperatures (Hg^p).[10] Mercury speciation testing indicates

[10] See e.g., "Control of Mercury Emissions From Coal-Fired Electric Utility Boilers," U.S. Environmental Protection Agency, Office of Research and Development, Air Pollution Prevention and Control Division, Research Triangle Park, NC.

that the distribution of Hg^0, Hg^P, and Hg^{2+} varies with coal type, and is dependent upon the chloride concentration in the coal.

Based on trace element data published by the National Coal Resources Data System, the concentration of chlorine in North Dakota lignite is typically less than 70 ppm.[11] Coal analyses provided by Montana-Dakota as part of this study reported chlorine concentrations of less than 20 ppm (as received basis). Because of the relatively low chlorine concentration, it is anticipated that mercury primarily speciate as elemental mercury in lignite-fired boilers. Mercury speciation data published by EPA as part of its initial mercury control rulemaking effort supports this conclusion, as mercury emissions from North Dakota lignite-fired boilers averaged approximately 80% Hg^0; 11% Hg^P; and 9% Hg^{+2}.

Mercury concentrations in North Dakota lignite samples available from the National Coal Resources Data System average approximately 13 ppm (dry basis). Assuming a fuel heating value of 10,200 Btu/lb (dry), potential uncontrolled Hg emissions will be approximately 12.7 lb/TBtu. Using these fuel characteristics, overall Hg removal efficiencies of approximately 70% are required to meet the MATS limit of 4.0 lb/TBtu. Mercury removal is a function of the mercury speciation in the flue gas and the unit's air pollution control systems. In general, particulate matter control systems will capture particulate forms of mercury, and FGD control systems will effectively capture oxidized Hg^{2+}. Elemental Hg^0, the primary species in lignite-generated flue gas, is more difficult to capture, and may not be effectively captured in the air pollution control systems designed to capture more conventional pollutants.

Mercury control options capable of reducing mercury emissions from lignite-fired boilers include fuel additives, primarily consisting of chlorinated or brominated compounds, that promote mercury oxidation and mercury capture in the units' existing PM and FGD control systems, and activated carbon injection (ACI) control systems. Montana-Dakota installed mercury control systems on Lewis & Clark to meet the mercury control requirements of ARM §17.8.771.[12] Mercury control systems installed on Lewis & Clark include both a fuel additive to enhance mercury oxidation and an ACI control system. Based on 2012 cumulative emissions monitoring data provided by Montana-Dakota, Lewis & Clark achieved controlled Hg emissions of 1.35 lb/TBtu (12-month average, ranging between approximately 1.2 and 1.6 lb/TBtu on a 30-

[11] Trace element data are available at: http://energy.er.us.gs.gov/products/databases/coalqual/intro.htm.

[12] ARM §17.8.771 required that by January 1, 2010, generating units that combust lignite limit mercury emissions to an emission rate equal to or less than 1.5 lb/TBtu (12-month rolling average), unless an alternative mercury emissions limit has been established pursuant to the rule, beginning January 1, 2010.

day average) with the existing suite of controls. Based on mercury emissions achieved in 2011 and 2012, Lewis & Clark is currently capable of meeting the MATS Hg emission limit with no additional controls.

4.4.2 Acid Gas Emissions

The MATS Rule includes acid gas emission limits for coal-fired EGUs. For existing coal-fired EGUs in the <8,300 Btu/lb subcategory, the final rule includes an HCl emission limit of 0.002 lb/MMBtu (30-day average). As an alternative, for existing units equipped with an FGD control system, the rule includes an SO_2 emission limit of 0.20 lb/MMBtu (30-day average) as a surrogate for the acid gas emissions. Existing coal-fired units equipped with an FGD control system can choose to demonstrate compliance with the MATS acid gas requirement by demonstrating compliance with either the HCl or SO_2 emission limits (demonstrating compliance with both limits is not required).

4.4.2.1 SO_2 Alternative

The SO_2 option is available only to units equipped with an FGD control system and SO_2 continuous emissions monitoring system installed. The term "flue gas desulfurization system" is defined in §63.10042 of the final rule to include "any add-on air pollution control system located downstream of the steam generating unit whose purpose or effect is to remove at least 50 percent of the SO_2 in the exhaust gas stream." Thus, the SO_2 alternative will be available to Lewis & Clark only if the existing wet disk scrubber is capable of achieving SO_2 removal efficiencies of 50% or more.

Based on fuel analyses and SO_2 CEMS data provided by Montana-Dakota, potential uncontrolled SO_2 emissions are typically in the range of 1.3 to 1.6 lb/MMBtu, while controlled SO_2 emissions from Lewis & Clark average approximately 0.50 lb/MMBtu (annual average). Based on these values, the Lewis & Clark wet disk scrubber is capable of SO_2 removal efficiencies in the range of 60% to 70%, qualifying the system as an FGD under the MATS Rule. However, modifications to the scrubber would be required to achieve removal efficiencies of approximately 87.5% or greater to meet the MATS SO_2 emission limit of 0.20 lb/MMBtu (30-day average). Potential modifications and upgrades to the existing wet disk scrubber, as well as alternative retrofit FGD control technologies, will be included in S&L's control technology evaluation.

4.4.2.2 HCl Alternative

As an alternative to meeting the SO_2 emission limit, Montana-Dakota could demonstrate compliance with the MATS acid gas standard by meeting an HCl emission limit of 0.002 lb/MMBtu (30-day average). Based on the results of stack tests conducted in June 2012 and September 2012, current HCl emissions from Lewis & Clark are well below the MATS standard. HCl emissions from Lewis & Clark were measured at approximately 0.00008 lb/MMBtu, or less than 3.5% of the MATS emissions limit. These test results are not unexpected given the relatively low chlorine content and high alkalinity of the lignite fired at Lewis & Clark and use of the wet disk particulate scrubber. Based on HCl stack test results, Lewis & Clark is currently capable of meeting the MATS HCl emission limit with no additional controls. This conclusion is based on the assumption that the flooded wet disk scrubber will remain in place and operational.

4.4.3 Non-Hg Metal HAPs

The MATS Rule includes non-Hg HAP metal emission limits for coal-fired EGUs. For existing EGUs in the <8,300 Btu/lb subcategory, the rule includes an FPM emission limit of 0.030 lb/MMBtu (30-day average) as MACT for the non-Hg HAP metals. As an alternative to meeting the FPM limit, existing units have the option of meeting a total non-Hg HAP metals emission limit of 0.00005 lb/MMBtu (50 lb/TBtu), or complying with individual non-Hg HAP metal emission limits.

4.4.3.1 Filterable Particulate Matter Alternative

Based on Title V permit performance tests conducted over the previous 5-year period, and MATS diagnostic testing conducted in June and September, 2012, FPM emissions from Lewis & Clark currently average 0.050 lb/MMBtu, approximately 40% above the MATS limit of 0.030 lb/MMBtu. The 2012 stack tests were conducted after Montana-Dakota made modifications to the flooded wet disk scrubber quench spray system. These modifications were made in an effort to reduce FPM emissions below the MATS threshold; however, the 2012 stack tests showed no significant increase in FPM removal in the wet disk scrubber. Based on the June 2012 and September 2012 stack test results, installation of advanced particulate matter controls would be needed to meet the MATS FPM emissions standard. Particulate matter control technologies will be included in S&L's control technology evaluation.

4.4.3.2 Non-Hg Trace Metal Alternatives

As an alternative to demonstrating compliance with the FPM emission limit, owners/operators can choose to demonstrate compliance with a total non-Hg HAP metals emission limit of 50 lb/TBtu, or the individual non-Hg HAP metal emission limits in Subpart UUUUU Table 2.

Montana-Dakota provided individual non-Hg trace metal emissions data from stack tests conducted on Lewis & Clark in June 2012 and September 2012. Results of the June 2012 and September 2012 non-Hg HAP metal stack tests are compared to the individual non-Hg HAP metal emission limits in Table 4-3.[13] Test results shown in green are below the applicable MATS limit, while test results shown in red are above the applicable limit. Although all individual non-Hg trace metals are present at very low levels, the measured emission rates for arsenic, beryllium, cadmium, chromium, manganese, nickel and lead all exceed their respective MATS emission limit. Because of the low non-Hg HAP metal emission limits, and the anticipated variability in trace metal concentrations in the lignite, choosing this compliance option is not recommended, as an exceedence of any individual emission limit would be a deviation from the rule's emission standards.

Table 4-3
Lewis & Clark Non-Hg Trace Metal Test Results
Compared to the Total non-Hg and Individual Non-Hg Metal MATS Emission Limits

Pollutant	MATS Emission Limit	Lewis & Clark Stack Test Results
Antimony	0.80 lb/TBtu	**0.57 lb/TBtu[DLL]**
Arsenic	1.1 lb/TBtu	**6.44 lb/TBtu[DLL]**
Beryllium	0.20 lb/TBtu	**0.26 lb/TBtu[DLL]**
Cadmium	0.30 lb/TBtu	**0.45 lb/TBtu[DLL]**
Chromium	2.8 lb/TBtu	**3.86 lbTBtu[ADL]**
Cobalt	0.80 lb/TBtu	**0.51/TBtu[DLL]**
Lead	1.2 lb/TBtu	**4.80 lb/TBtu[ADL]**
Manganese	4.0 lb/TBtu	**46.38 lb/TBtu[ADL]**
Nickel	3.5 lb/TBtu	**3.59 lb/TBtu[ADL]**
Selenium	5.0 lb/TBtu	**4.78 lb/TBtu[ADL]**
Total non-Hg HAP metals	**50 lb/TBtu**	**71.7 lb/TBtu[DLL]**

ADL All analytical values used to calculate and report stack emissions value were greater than the analytical laboratory's reported detection level(s).

DLL At least one, but not all values used to calculate and report stack emission values were greater than the analytical laboratory's reported detection level(s).

Non-Hg HAP metal emissions from Lewis & Clark measured in June and September, 2012 averaged 71.7 lb/TBtu, approximately 30% above the MATS standard. Based on the June 2012 stack test, total non-Hg HAP

[13] Although individual non-Hg trace metal emissions were measured in 2011 and 2012, this evaluation is based on the averaged results of all 2012 stack tests. Based upon a review of the June 2011 testing report, certain assumptions used to determine emissions, including the sample temperature and the fuel factor used to determine emissions rates, appeared to be inconsistent with the Method 29 procedures. Therefore, it was concluded that the June 2012 test results are more representative of actual non-Hg trace metal emissions from Lewis & Clark, and the 2012 test results were used for this regulatory evaluation.

metal emissions, and certain individual non-Hg metal emissions, exceed their respective MATS limits. As with FPM, the 2012 stack tests were conducted after Montana-Dakota made changes to the flooded wet disk scrubber quench spray system in an effort to reduce both FPM and non-Hg metal emissions. Therefore, installation of advanced particulate matter controls would be needed to meet the MATS non-Hg HAP metal emissions standard. Furthermore, trace metal concentrations in the lignite will likely vary within and between coal seams at the mine, introducing significant risk if Montana-Dakota chose to demonstrate compliance with the individual non-Hg HAP metal emission limits. It is unlikely that sufficient coal data and stack test data could be developed to ensure continued compliance when taking into consideration potential fuel variability. Potentially available particulate matter control technologies will be included in S&L's control technology evaluation.

4.4.4 Emission Reduction Requirements - Summary

Based on a comparison of existing emissions data from Lewis & Clark to the applicable MATS emission limits, Lewis & Clark is expected to meet the MATS Hg emissions limit with the existing suite of air pollution control technologies. Baseline Hg emissions are well below the applicable MATS emission limit. Stack test data from Lewis & Clark also support the expectation that Lewis & Clark can meet the MATS HCl emissions limit with the existing control technologies. Additional emission controls, or control system modifications, would be needed if Montana-Dakota chooses to comply with the SO_2 surrogate standard; however, Montana-Dakota is not required to meet the SO_2 standard if it can show compliance with the HCl alternative. Lewis & Clark will be required to reduce FPM and/or total non-Hg HAP metal emissions to meet the MATS requirements for these pollutants. Baseline FPM and total non-Hg HAP metal emissions from the unit are above the respective MATS limits. Particulate control systems capable of reducing FPM and non-Hg metal emissions will be evaluated in S&L's control technology report.

A comparison of the existing Lewis & Clark HAP emissions and the applicable MATS emission limits is provided in Table 4-4.

Table 4-4
Lewis & Clark - Baseline HAP Emissions vs. MATS Emission Limits

HAP	Baseline Existing HAP Emissions	MATS Emission Limit	Emission Reduction Requirements and Control Technologies
Hg	1.35 lb/TBtu	4.0 lb/TBtu	Lewis & Clark is expected to meet the Hg emission limit with no additional controls.
Acid Gas Emissions			
HCl	0.00008 lb/MMBtu	0.002 lb/MMBtu	Lewis & Clark is expected to meet the HCl emission limit with no additional controls. This conclusion assumes that the existing flooded wet disk scrubber will remain in place and operational. Modifications to the existing wet disk scrubber, or installation of advanced FGD controls would be required to meet the SO_2 emission limit.
SO_2	0.50 lb/MMBtu	0.20 lb/MMBtu	
Particulate Matter			
FPM	0.050 lb/MMBtu	0.030 lb/MMBtu	Baseline FPM and total non-Hg HAP metals are above the applicable MATS limits. Modifications to the existing wet scrubber, or installation of advanced particulate controls would be required to meet the FPM or total non-Hg metals emission limits.
Total Non-Hg HAP Metals	71.7 lb/TBtu	50 lb/TBtu	

4.5 MATS Work Practice Standards

Emission limits included in the MATS Rule are based on a 30-boiler operating day average and apply at all times excluding periods of startup and shutdown. For periods of startup and shutdown, the final rule includes work practice standards in lieu of numeric emission limits. In addition, the final rule includes a work practice standard for the control of organic HAP emissions, including emissions of dioxins and furans (D/F), non-D/F organic compounds, and hazardous volatile organic compounds, for all EGU subcategories. A summary of the MATS work practice standards, as they apply to Lewis & Clark, is provided below.

4.5.1 Work Practice Standards for the Control of Organic HAP Emissions

For the control of organic HAP emissions, owners/operators must conduct a tune-up of the EGU burner and combustion control systems at least each 36 calendar months, or each 48 calendar months if neural network combustion optimization software is employed. The final rule does not include a definition for "neural network" combustion optimization software; however, in the preamble to the final rule EPA stated that the rule recognized "the value of automated boiler optimization tools such as neural network systems."[14] Thus, at a

[14] 77 Fed. Reg. pg. 9380.

minimum, the neural network system must be an automated system capable of adjusting burner and combustion system controls.

The work practice standard involves maintaining and inspecting the burners and associated combustion controls, tuning the specific burner type to optimize combustion, and obtaining and recording CO and NO_X values before and after burner adjustments. Tune-up work practice standards include (as applicable):

- Inspect the burner and combustion controls, and clean or replace any components of the burner or combustion controls as necessary upon initiation of the work practice program and at least once every required inspection period.
- Inspect the flame pattern and make any adjustments to the burner or combustion controls necessary to optimize the flame pattern, consistent with the manufacturer's specifications or in accordance with best combustion engineering practices for that burner type.
- Observe the damper operations as a function of mill and/or cyclone loadings, cyclone and pulverizer coal feeder loadings, or other pulverizer and coal mill performance parameters, making adjustments and effecting repair to dampers, controls, mills, pulverizers, cyclones, and sensors.
- Evaluate windbox pressures and air proportions, making adjustments and effecting repair to dampers, actuators, controls, and sensors.
- Inspect the system controlling the air-to-fuel ratio and ensure that it is correctly calibrated and functioning properly. Any component out of calibration, in or near failure, or in a state that is likely to negate combustion optimization efforts prior to the next tune-up, should be corrected or repaired as necessary.
- Optimize combustion to minimize generation of CO and NO_X. This optimization should be consistent with the manufacturer's specifications, if available, or best combustion engineering practice for the applicable burner type.
    - NO_X optimization includes burners, overfire air controls, concentric firing system improvements, neural network or combustion efficiency software, control systems calibrations, adjusting combustion zone temperature profiles, and add-on controls such as SCR and SNCR.
    - CO optimization includes burners, overfire air controls, concentric firing system improvements, neural network or combustion efficiency software, control systems calibrations, and adjusting combustion zone temperature profiles.
- While operating at full load (or the predominately operated load), the work practice standard requires facilities to measure the concentration of CO and NO_X (ppm by volume) in the flue gas, before and after the tune-up adjustments are made. Facilities can use portable CO, NO_X, and O_2 meters for these measurements. Electric generating units employing neural network optimization systems need only provide a single pre- and post-tune-up value rather than continual values before and after each optimization adjustment made to the system.

Facilities are required to maintain on-site and submit, if requested, an annual report containing the information summarized above, including the concentrations of CO and NO_X in the effluent stream measured before and after an adjustment of the EGU combustion system. Facilities are required to report any instance in which it failed to conduct a required tune-up. These instances are deviations from the requirements of Subpart UUUUU, and must be reported according to §63.10031.

Facilities are required to conduct performance tune-ups of their EGUs as part of their initial compliance demonstration. Provisions in §63.10005(f) state that for existing affected sources a tune-up may have occurred prior to April 16, 2012; thus, the initial demonstration for the tune-up work practice standard for existing units without neural networks must occur by October 16, 2015 (i.e., 36 months from rule promulgation plus 180 days).[15] To meet the initial compliance demonstration deadline, it is recommended that Montana-Dakota plan on performing the required tune-up and inspections during the unit outage preceding the October 16, 2015 compliance date.

4.5.2 Work Practice Standards – Startup/Shutdown

The final rule also includes work practice standards that apply during periods of unit startup and shutdown. The terms "startup" and "shutdown" are defined in the final rule as:

> **Startup** means either the first-ever firing of fuel in a boiler for the purpose of producing electricity, or the firing of fuel in a boiler after a shutdown event for any purpose. Startup ends when any of the steam from the boiler is used to generate electricity for sale over the grid or for any other purpose (including on-site use).
>
> **Shutdown** means the cessation of operation of a boiler for any purpose. Shutdown begins either when none of the steam from the boiler is used to generate electricity for sale over the grid or for any other purpose (including on-site use) or at the point of no fuel being fired in the boiler, whichever is earlier. Shutdown ends when there is both no electricity being generated and no fuel being fired in the boiler.

Work practice standards that apply during periods of startup and shutdown include:

- Sources must use "clean fuels" (i.e., natural gas or distillate oil) or a combination of clean fuels, for ignition during startup.
- All CEM systems used for MATS compliance must be operated during periods of startup and shutdown.

[15] Facilities that conducted a tune-up procedure prior to April 16, 2012 must maintain adequate records to show that the tune-up met the requirements of the standard.

- Once the unit converts to firing coal, residual oil, or solid oil-derived fuel, operators must:
    - Engage all of the applicable control technologies, except dry scrubbers and SCRs; and start the dry scrubber and SCR control systems, if present, appropriately to comply with relevant standards applicable during normal operation.

Montana-Dakota currently uses natural gas as the startup fuel for Lewis & Clark, meeting the MATS work practice standard requiring the use of a "clean fuel" during startup. Based on information provided by Montana-Dakota, Lewis & Clark does not bypass the multi-cyclones or the wet disk scrubber during startup, and both control systems are engaged prior to converting to firing coal. Therefore, Lewis & Clark should meet the MATS startup work practice standard with no modifications or operational changes.

4.6 Demonstrating Compliance with the MATS Emission Limits

The MATS Rule includes both initial compliance testing requirements, and emissions monitoring requirements to demonstrate continuous compliance with the applicable emission limits. In general, the rule includes two basic emission monitoring approaches: (1) use of continuous emissions monitoring systems (CEMS); or (2) periodic quarterly stack testing for all air pollutants other than SO_2 and Hg. The final rule clarifies that where options for emission limits apply (e.g., FPM vs. non-Hg metals, or SO_2 vs. HCl), owners/operators need only perform stack testing to demonstrate compliance with the selected emission limit.[16] Monitoring requirements are summarized in Table 4-5 and discussed in more detail below.

[16] See, 77 Fed. Reg. pg. 9383, col. 3.

Table 4-5
MATS Rule Monitoring Requirement

Regulated Pollutant		Monitoring Requirement
Hg		Hg CEM System or Sorbent Trap Monitoring or Annual Stack Test (LEE only)
Acid Gases	HCl or SO_2	HCl CEM System or Stack Testing (Quarterly)
		SO_2 CEM System
Non-Hg HAP Metals	FPM or Total or Individual non-Hg HAP Metals	PM CEM System or PM CPMS and annual Stack Test or Stack Testing (Quarterly)
		Stack Testing (Quarterly) or PM CPMS and annual Stack Test

4.6.1 Initial Compliance Requirements

Initial compliance requirements are included in §§63.10005 and 63.10011 of the final rule. In general, each affected unit is required to demonstrate initial compliance with each applicable emissions limit through performance testing. Initial performance tests can include stack testing (for all pollutants other than SO_2 and Hg) and/or continuous emissions monitoring. Compliance with the SO_2 option must be demonstrated using a certified SO_2 CEMS and does not include a stack test option.

To demonstrate initial compliance with the HCl, FPM, or non-Hg HAP metals emission limits using stack testing, the initial performance test generally consists of three stack test runs at specified process operating conditions using approved EPA test methods. Initial compliance is demonstrated if the average of the three test runs is below the applicable emissions limit. Approved test methods and performance testing requirements are detailed in §63.10007 and listed in Subpart UUUUU Table 5, and include:

- Filterable PM: Method 5 with front-half temperature at be 320°F ± 25°F[17]
- Total or Individual Non-Hg HAP Metals: Method 29
- HCl: Method 26, 26A or Method 320 (for units such as Lewis & Clark with a wet stack)

Coal-fired units must use an Hg CEMS or a sorbent trap monitoring system for both initial and continuous compliance, except where the low emitting EGU (LEE) requirements apply. Mercury CEMS and sorbent traps are described in more detail in subsection 4.8.3 of this report, and the LEE testing requirements are discussed in Subsection 4.7.

As an alternative to conducting stack tests to demonstrate initial compliance, owners/operators can demonstrate initial compliance with the FPM, HCl, SO_2, and Hg emissions limits using a continuous monitoring system. If a continuous monitoring system is used to demonstrate initial compliance, §63.10005(d)(1) of the final rule states that initial compliance is achieved if the arithmetic average of 30-boiler operating days of quality-assured CEMS data meet the applicable FPM, HCl, SO_2, or Hg emissions limit.

4.6.2 Continuous Compliance Requirements

The MATS Rule also provides two basic approaches to demonstrating continuous compliance: (1) continuous emissions monitoring; or (2) periodic quarterly stack testing. Facilities that demonstrate compliance with any applicable emissions limits using a continuous monitoring system are required to develop a site-specific monitoring plan (see, Subsection 4.6.3 of this report and §63.10000(d)). The requirement to develop a site-specific monitoring plan does not apply to affected sources with existing monitoring plans that apply to CEMS prepared under 40 CFR Part 75 or 40 CFR Part 60 Appendix B (and that meet the requirements of §63.10010).

4.6.2.1 Continuous Compliance Requirements – Quarterly Stack Testing

Except for units that qualify for LEE status (see, Subsection 4.7), EGU owners/operators can choose to conduct quarterly testing to demonstrate compliance with the HCl, FPM or non-Hg HAP metals (either individual or total) emission limits. The quarterly performance testing requirements, including the approved test methods, are listed in Table 5 to Subpart UUUUU. Note that the rule does not include a quarterly performance testing option

[17] The facility's Title V Operating Permit currently requires Lewis & Clark to demonstrate compliance with its FPM emission standard using EPA Test Method 5. Method 5 requires that the front-half filter be maintained at a temperature of 248 ± 25 °F, which is different than the temperature mandated by the MATS Rule. Lewis & Clark will likely have to run both FPM tests to meet its Title V and MATS compliance obligations, or modify its Title V permit to allow the use of the higher filter temperature.

for facilities that choose to demonstrate compliance with the SO_2 emissions limit, nor does it include a quarterly stack test option to demonstrate compliance with the Hg emission limit.

Facilities that use quarterly performance testing to demonstrate compliance with one or more applicable emissions limits may skip performance testing in those quarters which less than 168 boilers operating hours occur (except that a performance test must be conducted at least once every calendar year). Continuous compliance is demonstrated if quarterly stack test results are below the applicable emissions limit.

4.6.2.2 Continuous Compliance Requirements – Continuous Emissions Monitoring

The continuous monitoring requirements for each HAP (or surrogate) are described in §63.10010(a) through §63.10010(i) of the final rule. In general, to demonstrate continuous compliance using a continuous monitoring system (CEMS or continuous parametric monitoring system (CPMS)), the owner/operator must install, certify, operate, maintain, and quality-assure the data from the monitoring system in accordance with the applicable monitoring standard. Monitoring standards include: Subpart UUUUU Appendix A for Hg CEMS; Subpart UUUUU Appendix B for HCl CEMS; 40 CFR 60 Appendix B-Performance Specification 11 for FPM; and 40 CFR Part 75 Appendix B for SO_2.[18]

Facilities that use a CEMS (or sorbent trap) to measure SO_2, FPM, HCl, or Hg emissions, must demonstrate continuous compliance by using all quality-assured hourly data recorded by the CEMS to calculate the arithmetic average emissions rate on a continuous 30-boiler operating day rolling average basis using the following equation (see §63.10021(a)):

$$30\ boiler\ operating\ day\ average = \frac{\sum_{i=1}^{n} Her_i}{n}$$

Where:

Her_i is the hourly emissions rate for hour "i" and n is the number of hourly emissions rate values collected over 30-boiler operating days.

Facilities must calculate and record the 30-boiler operating day rolling average, updated after each new boiler operating day. Each 30-boiler operating day average emission rate is the average of all the valid hourly

[18] In addition to the SO_2, HCl, FPM, or Hg CEMS (or sorbent trap), each unit using a CEMS system for continuous compliance must also install, certify, maintain, operate, and quality-assure all additional CEM systems needed to convert pollutant concentrations to units of the emissions standard. Additional CEMS may include O_2 or CO_2 concentration, stack gas flow rate, and, if default moisture values are not used, moisture content. Where appropriate, additional CEM systems must be certified and quality-assured in accordance with 40 CFR Part 75.

emission rates in the preceding 30-boiler operating days. Section 63.10020(c) of the final rule states that owners/operators cannot "use data recorded during EGU startup or shutdown or monitoring system malfunctions or monitoring system out-of-control periods, repairs associated with monitoring system malfunctions or monitoring system out-of-control periods, or required monitoring system quality assurance or control activities in calculations used to report emissions or operating levels." However, owners/operators "must use all the data collected during all other periods in assessing the operation of the control device and associated control system."

Any data collected during monitoring system malfunctions or out-of-control periods, as specified in the facility's site-specific monitoring plan, are not used in the calculation of the 30-boiler operating-day average. Furthermore, facilities that use a SO_2 CEMS to demonstrate continuous compliance with the SO_2 emission limit must use only unadjusted, quality-assured SO_2 concentration values in the emissions calculation, and cannot apply bias adjustment factors to the Part 75 SO_2 data, nor use Part 75 substitute data values.

4.6.3 Site-Specific Monitoring Plan

Facilities that demonstrate compliance with any applicable emissions limits through use of a CEM system are required to develop a site-specific monitoring plan (see §63.10000(d)). The monitoring plan must address the provisions in §63.10000(d)(2) through (5), including the following items:

- Installation of the CEM system or sorbent trap monitoring system probe must be located such that the measurement is representative of the exhaust emissions (e.g., on or downstream of the last control device).
- Performance and equipment specifications for the sample interface, the pollutant concentration or parametric signal analyzer, and the data collection and reduction systems.
- Schedule for conducting initial and periodic performance evaluations.
- Performance evaluation procedures and acceptance criteria, including ongoing data quality assurance procedures.
- Ongoing operation and maintenance procedures.
- Ongoing recordkeeping and reporting procedures.
- Conditions that define a CEM system that is "out-of-control" consistent with the provisions of 40 CFR 63.8(c)(7)(i) and for responding to out-of-control periods consistent with §§63.8(c)(7)(ii) and (c)(8).[19]

[19] Provisions in §63.8(c)(7)(i) define a CMS as out-of-control if:

The monitoring plan must be submitted to the regulatory authority, if requested, at least 60 days before the initial performance evaluation.

4.6.4 Notifications and Reporting

All new and existing sources in all subcategories must comply with certain requirements of the General Provisions in 40 CFR Part 63 Subpart A. General Provisions that apply to the Subpart UUUUU requirements are listed in Table 9 to Subpart UUUUU, and include specific requirements for notifications, recordkeeping, and reporting. Notification requirements listed in §63.10030 include all notifications required by:

- §63.7(b): Notification of performance tests (at least 60 calendar days before the performance test is initially scheduled to begin);
- §63.7(c): Quality assurance program (develop, and submit if requested by the Administrator, a site-specific test plan);
- §63.8(e): Performance Evaluation of CEMS;
- §63.8(f)(4): Request to Use Alternative Monitoring Procedures; and
- §63.8(f)(6): Alternative to Relative Accuracy Tests.

As specified in §63.9(b)(2) of the General Provisions, existing sources such as Lewis & Clark must submit an Initial Notification no later than August 14, 2012 (i.e., 120 days after the effective date of the rule). The Initial Notification must provide:

- The name and address of the owner or operator;

(A) The zero (low-level), mid-level (if applicable), or high-level calibration drift (CD) exceeds two times the applicable CD specification in the applicable performance specification or in the relevant standard; or

(B) The CMS fails a performance test audit (e.g., cylinder gas audit), relative accuracy audit, relative accuracy test audit, or linearity test audit; or

(C) The COMS CD exceeds two times the limit in the applicable performance specification in the relevant standard.

When the CMS is out-of-control, the owner or operator of the affected source shall take the necessary corrective action and shall repeat all necessary tests which indicate that the system is out-of-control. The owner or operator shall take corrective action and conduct retesting until the performance requirements are below the applicable limits. The beginning of the out-of-control period is the hour the owner or operator conducts a performance check (e.g., calibration drift) that indicates an exceedance of the performance requirements established under this part. The end of the out-of-control period is the hour following the completion of corrective action and successful demonstration that the system is within the allowable limits. During the period the CMS is out-of-control, recorded data shall not be used in data averages and calculations, or to meet any data availability requirement established under this part.

§63.8(c)(8) states that "[t]he owner or operator of a CMS that is out-of-control as defined in paragraph (c)(7) of this section shall submit all information concerning out-of-control periods, including start and end dates and hours and descriptions of corrective actions taken, in the excess emissions and continuous monitoring system performance report required in §63.10(e)(3)."

- The address of the affected source;
- Identification of the relevant standard that is the basis of the notification and the source's compliance date and;
- A brief description of the nature, size, design, and method of operation of the source and an identification of the types of emission points within the affected source subject to the standard and the types of hazardous air pollutants emitted.

Montana-Dakota submitted Lewis & Clark's initial notification to the Montana Department of Environmental Quality on August 2, 2012.

The final rule requires that certain reports be submitted electronically. Reports to be submitted electronically include all performance test reports, notification of compliance status reports, compliance, and continuous monitoring data summaries specified in §63.10031. Section 63.10031(a) requires that owner/operators comply with the compliance reporting requirements in Subpart UUUUU Table 8. Compliance reports must be submitted on a semiannual basis, and must include information required by §63.10031(c)(1) through (c)(4), including the summary report information required by §63.10(e)(3)(vi). Information required by the §63.10(e)(3)(vi) summary report includes, but is not limited to:

a) The total operating time of the affected source during the reporting period;
b) An emission data summary, including total duration of excess emissions during the reporting period;
c) A CMS performance summary, including
    a. the total CMS downtime during the reporting period (recorded in hours for gases);
    b. the total duration of CMS downtime expressed as a percent of the total source operating time during that reporting period; and
    c. a breakdown of the total CMS downtime during the reporting period into periods that are due to monitoring equipment malfunctions, non-monitoring equipment malfunctions, quality assurance/quality control calibrations, other known causes, and other unknown causes.

Subpart UUUUU Table 8 reporting requirements also include:

- ➢ If there are no deviations from any emission limitation (emission limit and operating limit) that applies to you and there are no deviations from the requirements for work practice standards in Table 3 to this subpart that apply to you, a statement that there were no deviations from the emission limitations and work practice standards during the reporting period. If there were no periods during which the CMSs, including continuous emissions monitoring system and operating parameter monitoring systems, were out-of-control as specified in §63.8(c)(7), a statement that there were no periods during which the CMSs were out-of-control during the reporting period; and

- If you have a deviation from any emission limitation (emission limit and operating limit) or work practice standard during the reporting period, the report must contain the information in §63.10031(d). If there were periods during which the CMSs, including continuous emissions monitoring systems and continuous parameter monitoring systems, were out-of-control, as specified in §63.8(c)(7), the report must contain the information in §63.10031(e).

4.6.5 Monitoring System Downtime and Deviations

Deviations from any emission limitation, operating limit, or work practice standard must be reported in the facility's semiannual compliance report. The term "deviation" is defined in §63.10042 to mean any instance in which an affected source, or an owner or operator of such a source:

(i) Fails to meet any requirement or obligation established by Subpart UUUUU, including, but not limited to, any emission limit, operating limit, work practice standard, or monitoring requirement; or

(ii) Fails to meet any term or condition that is adopted to implement an applicable requirement in Subpart UUUUU and that is included in the operating permit for any affected source required to obtain such a permit.

Quarterly stack test results that exceed an applicable emissions limit, and failure to meet applicable monitoring requirements would be two examples of deviations from the MATS standard. Deviations must be included in the facility's semiannual compliance report, and could constitute a violation of the rule's standards. It should be noted, however, that a deviation is not always considered a violation, and that the determination of whether a deviation constitutes a violation of the standard is up to the discretion of the entity responsible for enforcement of the standards.

4.7 Low-Emitting EGU Status

The MATS Rule includes less stringent monitoring requirements for units that qualify as a low emitting EGU or LEE. Coal-fired EGUs may qualify for LEE status for Hg, HCl, FPM, total non-Hg HAP metals, or individual non-Hg HAP metals. Units may qualify for LEE status for one or more pollutants, and are not required to meet the LEE requirements for all regulated HAPs. Units qualify for LEE status if:

- For all pollutants except Hg, performance test emission results are less than 50% of the applicable emissions limit for all required testing for 3 consecutive years.
- For Hg emissions from an existing EGU, either:
  - Average emissions are less than 10% of the applicable Hg emissions limit (i.e., 0.40 lb/TBtu or 0.004 lb/GWh); or
  - Potential Hg mass emissions from an affected unit are 29.0 lb/yr or less, and the unit is in compliance with the applicable Hg emissions limit.

For all pollutants except Hg, facilities must conduct all required performance tests described in §63.10007 to demonstrate that a unit qualifies for LEE status. Performance testing requirements in §63.10007 (summarized in Section 4.6 of this appendix) include either continuous emissions monitoring or quarterly stack testing. When conducting emissions testing to demonstrate LEE status, facilities must increase the minimum sample volume (specified in Table 2 of the rule) nominally by a factor of two. Test results for all performance tests required for 3-consecutive years must be less than 50% of the applicable standard to qualify for LEE status for all pollutants except Hg.

For Hg, facilities must conduct a 30-boiler operating day performance test using Method 30B in 40 CFR Part 60 Appendix A-8 to determine whether a unit qualifies for LEE status. Method 30B is a test procedure for measuring total vapor phase Hg emissions from coal-fired combustion sources using sorbent trap sampling and an extractive or thermal analytical technique. The facility must conduct at least three nominally equal length Method 30B test runs during the 30-boiler operating day test period. Mercury emissions during the 30-day test period are calculated (in $\mu g/m^3$ dry basis) as the arithmetic average of all Method 30B sorbent trap results. Facilities are also required to measure and calculate, as applicable, the average values of CO_2 or O_2, stack gas flow rate, stack gas moisture content, and electrical load for the test periods.

To calculate potential annual Hg mass emissions, facilities are required to multiply the average lb/TBtu Hg emission rate determined using Method 30B by the maximum potential annual heat input to the unit (TBtu).[20] Assuming a maximum full load hourly heat input to Lewis & Clark of 600 MMBtu/hr, the average Hg emission rate that the unit would have to achieve to keep potential annual Hg emissions below 29 lb/yr would be 5.5 lb/TBtu, calculated as follows:

$$(600 \text{ MMBtu/hr} \times 8{,}760 \text{ hr/yr}) / 10^6 = 5.256 \text{ TBtu/yr [potential annual heat input]}$$

[20] The rule includes an alternative, but essentially equivalent, methodology to calculate annual emissions using the maximum potential annual electricity generating capacity (GWh) and a mercury emission rate expressed in lb/GWh (§63.10005(h)(3)(iii)).

29 lb Hg/yr / 5.256 TBtu/yr = 5.5 lb/TBtu

Because coal-fired units must maintain annual Hg emissions below 29 lb/yr and meet the applicable Hg emissions limit, Lewis & Clark would have to meet the MATS emission limit of 4.0 lb/TBtu to qualify for LEE status.

Baseline existing HAP emissions from Lewis & Clark[21] are compared to the applicable LEE status emissions limits in Table 4-6. Using the baseline HAP emission rates established in Section 4.3 of this report, it appears likely that Lewis & Clark can qualify for LEE status for both Hg and HCl emissions.

Table 4-6
Lewis & Clark Baseline HAP Emissions versus MATS LEE Emission Limits

HAP	Baseline Existing HAP Emissions	MATS LEE Emission Limit	Notes
Hg	1.35 lb/TBtu	4.0 lb/TBtu & 29.0 lb/yr or 10% of applicable standard	At a controlled emission rate of 4.0 lb/TBtu, potential Hg annual Hg emissions from Lewis & Clark will be 21.0 lb/yr, which is less than the LEE limit of 29 lb/yr.
Acid Gas Emissions			
HCl	0.00008 lb/MMBtu	0.001 lb/MMBtu	Baseline HCl emissions from Lewis & Clark are below the MATS LEE emission rate. HCl emissions are expected to remain below LEE status with the existing flooded wet disk scrubber. This conclusion assumes that the existing flooded wet disk scrubber remains in place and operational.
Particulate Matter			
FPM	0.050 lb/MMBtu	0.015 lb/MMBtu	Baseline FPM and total non-Hg HAP metal emissions from Lewis & Clark are above the applicable MATS LEE standards. Installation of advanced particulate control systems, such as an ESP or fabric filter baghouse, would be required to reduce FPM and/or total non-Hg HAP metal emissions below the LEE standards.
Total Non-Hg HAP Metals	71.7 lb/TBtu	25 lb/TBtu	

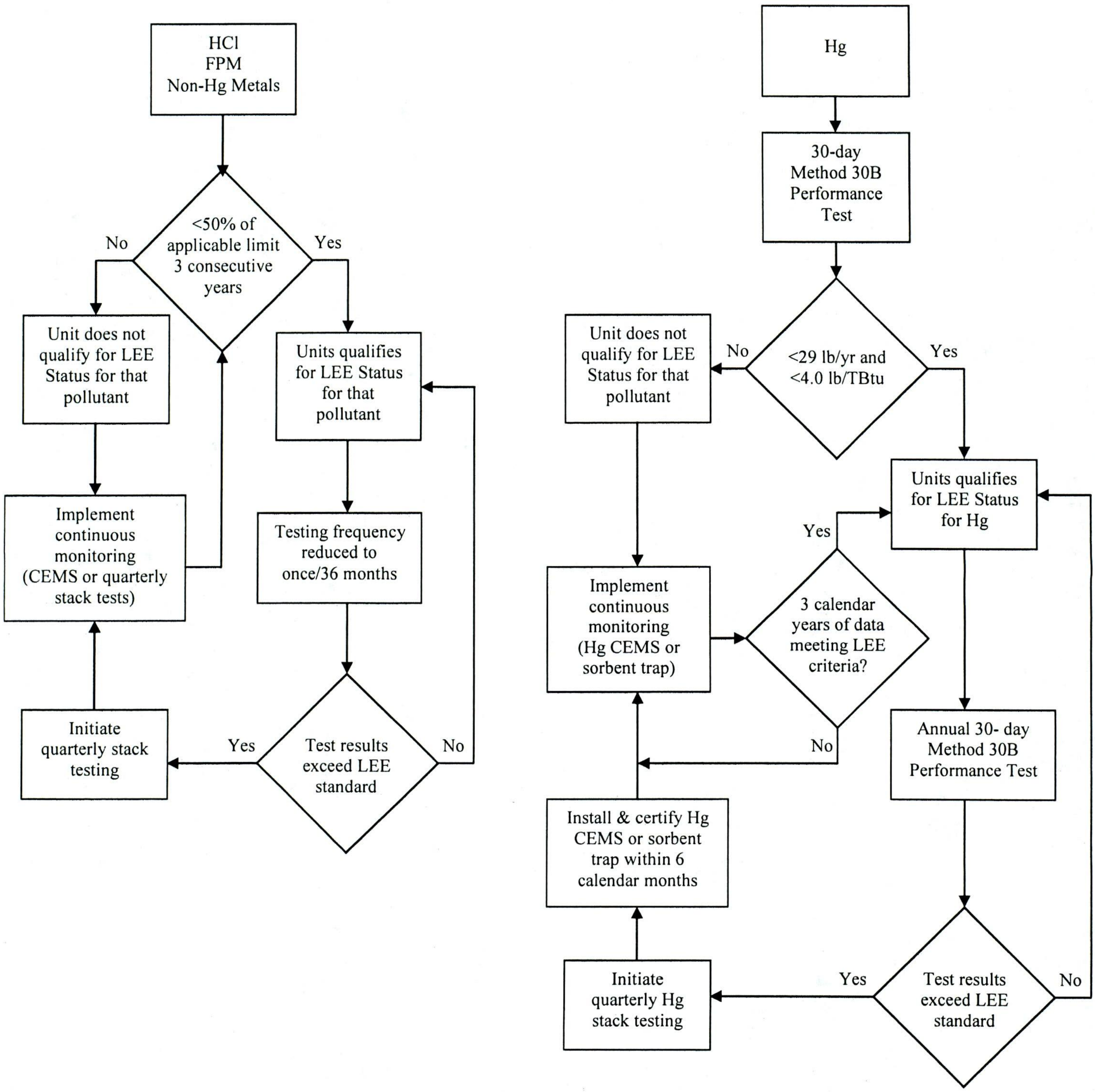
LEE status reduces the performance testing frequency requirements. After a three-year period during which every emissions test for a specific pollutant shows emissions no greater than 50% of the emissions limit, facilities may reduce the emissions testing frequency for that specific non-Hg pollutant to once every 36 months. For Hg, subsequent LEE testing must be conducted on an annual basis using Method 30B to conduct a 30-boiler operating day performance test.

If any subsequent emissions test exhibits emissions greater than the applicable LEE emissions limit, the facility

[21] Baseline existing HAP emissions from Lewis & Clark are established in Section 4.3 of this report.

must revert to the emissions testing frequency described in Section 4.6 of this report (i.e., CEM system or quarterly stack testing). For HCl, FPM, and total non-Hg HAP metals, quarterly stack testing must be implemented until continuous monitoring systems are installed (if the facility chooses to demonstrate continuous compliance using the CEMS option). Facilities must comply with all emissions testing/monitoring requirements until they are able to reestablish a three-year period of test results no greater than 50% of the applicable standard. For Hg, facilities must install, certify, maintain, and operate an Hg CEMS or sorbent trap monitoring system within six calendar months of losing LEE eligibility. Until the Hg CEMS or sorbent trap monitoring system is installed, facilities must conduct quarterly Hg emissions testing. The LEE status and testing requirements are shown schematically in Figure 4-1.

Figure 4-1. LEE Status and Testing Requirements



4.8 Emissions Monitoring Evaluation

The final MATS Rule requires affected facilities to monitor their HAP emissions to demonstrate continuous compliance with the applicable emission limits. As discussed in Section 4.6, the rule includes two basic emissions monitoring approaches: (1) continuous emissions monitoring; or (2) periodic quarterly stack testing (except for SO_2 and Hg). This section of the report reviews the stack testing methodologies required by the MATS Rule, and provides a description of the potentially available CEM systems.

4.8.1 Particulate Matter

Coal-fired EGUs that do not qualify as a LEE for total non-Hg HAP metals, individual non-Hg HAP metals, or FPM, must demonstrate compliance with the applicable emissions limit based on an initial performance test, and must monitor continuous performance using either a PM CEMS, PM continuous parametric monitoring system (PM CPMS), or by conducting quarterly compliance testing.

4.8.1.1 PM Stack Testing

4.8.1.1.1 Filterable PM Stack Tests

Performance test requirements in Subpart UUUUU Table 5 require FPM stack testing using the following test methods:

Test Method	Description
Part 60 Appendix A-1 Method 1	Selecting sampling port locations and the number of traverse points.
Part 60 Appendix A-1 or A-2, Method 2, 2A, 2C, 2F, 2G, or 2H	To determine velocity and volumetric flow-rate of the stack gas.
Part 60 Appendix A-2 Method 3A or 3B	Determination of O_2 and CO_2 concentrations of the stack gas.
Part 60 Appendix A-3 Method 5	Measure FPM concentration in the flue gas. Note that the Method 5 front-half temperature must be 320 ± 25°F.
Part 60 appendix A-7 Method 19	To convert emission concentrations to emission rates (e.g., lb/MMBtu) using F-factors.

The FPM test method specified by the MATS Rule differs from the test method typically specified for wet scrubber-controlled utility boilers. Test Method 5B is typically specified for boilers with a wet stack to address potential concerns related to sulfuric acid mist condensation onto the filter media. Nevertheless, EPA excluded using Method 5B form demonstrating compliance with the FPM emissions standard in the MATS Rule.

The primary difference between Methods 5 and 5B relate to the temperature of the sample. Under Method 5, the sample is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature of 248 ± 25 °F (or such other temperature as specified by an applicable regulation). The MATS Rule specifies that the front-half filter should be maintained at 320 ± 25 °F, which can be described as a modified Method 5 test. The PM mass, which includes any material that condenses at or above the filtration temperature, is determined gravimetrically after removal of uncombined water.

Under Method 5B the sample is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature of 320 ± 25 °F (the same temperature as that specified for the modified Method 5 test); however, the collected sample is then heated in an oven at 320 °F for six hours to volatilize any condensed sulfuric acid, or other condensable compounds, that may have been collected on the filter. The non-sulfuric acid particulate mass is then determined gravimetrically.

FPM emissions data provided by Montana-Dakota for this report were determined using Method 29 with a Method 5 filter box maintained at 320 ± 25 °F (June 2012 and September 2012 stack tests). Because the 2012 MATS diagnostic testing was conducted at the higher filter temperature, the 2012 FPM test results are consistent with the compliance testing methodology mandated by the MATS Rule.

4.8.1.1.2 Non-Hg HAP Metal Stack Tests

Sources can also choose to demonstrate compliance with the total or individual non-Hg HAP metals emission limits. Performance testing requirements in Subpart UUUUU Table 5 require non-Hg metal stack testing using the following test methods:

Test Method	Description
Part 60 Appendix A-1 Method 1	Selecting sampling port locations and the number of traverse points.
Part 60 Appendix A-1 or A-2, Method 2, 2A, 2C, 2F, 2G, or 2H	To determine velocity and volumetric flow-rate of the stack gas.
Part 60 Appendix A-2 Method 3A or 3B or ANSI/ASME PTC 19.10-1981	Determination of O_2 and CO_2 concentrations of the stack gas.
Part 60 Appendix A-3 Method 4	Measure the moisture content of the stack gas.
Part 60 Appendix A-8 Method 29	Measure HAP metals emissions concentrations and determine each individual HAP metals concentration, as well as the total filterable HAP metals emissions concentration and total HAP metals emissions concentration.
Part 60 Appendix A-7 Method 19	To convert emission concentrations to emission rates (e.g., lb/MMBtu) using F-factors.

Method 29 is used to determine metals emissions from stationary sources. A stack sample is withdrawn isokinetically from the source, particulate emissions are collected in the probe and on a heated filter, and gaseous emissions are then collected in an aqueous acidic solution of hydrogen peroxide and an aqueous solution of potassium permanganate (analyzed only for Hg, if applicable). The recovered samples are digested, and appropriate fractions are analyzed for the individual metals by inductively coupled argon plasma emission spectroscopy (ICAP) or atomic absorption spectroscopy (AAS). Graphite furnace atomic absorption spectroscopy (GFAAS) is used for analysis of certain metals if greater analytical sensitivity than can be obtained by ICAP is required.

Method 29 has been used to measure metals emissions from stationary sources, and has demonstrated the ability to detect metals in the $\mu g/m^3$ (ppb) range; however, several individual test results from the June 2012 L&C stack tests, as well as several test results in EPA's ICR Database, were reported as being below the method detection limit. Provisions in §63.10007(e) of the final rule state that if measurement results for any pollutant are reported as below the method detection level, facilities must use the method detection limit as the measured emissions level for that pollutant in calculating compliance. This requirement could introduce additional compliance risk into the total non-Hg HAP metal compliance option.

4.8.1.2 PM CEMS

Continuous compliance with the non-Hg HAP metals emissions standard can also be demonstrated using FPM as a surrogate and demonstrating compliance with the FPM emissions limit using a PM CEMS. Several types of PM CEM systems are available in the U.S., which use a variety of measurement principles. Regulatory agencies have only recently started to recommend, or mandate, the use of PM CEMS on coal-fired EGUs in the U.S.; thus, there is limited operating experience with PM CEM systems on coal-fired power plants and operators continue to experience significant operational and reliability issues.

Various analytical principles are used to continuously measure flue gas PM concentrations including:

- Light scattering – Measures the amount of light scattered in a particular direction and outputs a signal proportional to the amount of scattering material (e.g., particulate matter) in the sample stream;
- Beta attenuation – Measures the amount of energy absorbed by beta particles which correlates to the mass of the PM in the sample;
- Probe electrification – Monitors the current produced by the charge transfer when particulate strikes the probe;
- Light extinction – Measures the decrease in light intensity detected across the stream of flue gas due to particulates; and
- Optical scintillation – Measures the variation in the amplitude of the beam of light received as particles momentarily interrupt the beam.

There is still debate as to which measuring principle provides the most accurate and reliable PM measurement. A majority of PM CEM systems installed on large stationary sources in the U.S. use either light scattering or beta attenuation technology.

Coal-fired units that elect to demonstrate compliance using a PM CEMS can use it to demonstrate both initial and continuous compliance with the FPM emissions limit. The CEMS must be installed and certified in accordance with 40 CFR Part 60 Appendix B Performance Specification (PS) 11 (Specifications and Test Procedures for Particulate Matter Continuous Emission Monitoring Systems at Stationary Sources), using Method 5 and ensuring that the front-half filter temperature is maintained at 320 ± 25 °F. The PM CEMS must be operated and maintained in accordance with the procedures and requirements in 40 CFR Part 60 Appendix A Procedure 2 (Quality Assurance Requirements for

Particulate Matter Continuous Emission Monitoring Systems at Stationary Sources). A relative response audit (RRA) of the PM CEMS must be conducted at least once annually.

Using a PM CEMS to demonstrate initial and continuous compliance with the FPM emissions limit eliminates the necessity for quarterly stack testing; however, the PS 11 certification procedures and Procedure 2 QA requirements are sufficiently onerous that operation of the PM CEMS could require significant resources. Certification procedures in PS 11 require facilities to conduct correlation tests using the PM CEMS and PM reference method (i.e., modified Method 5). To ensure that the range of data that will be used to establish correlation of the PM CEMS, certification testing should be conducted at three emissions levels, if possible, by varying process operating conditions, varying PM control device conditions, or by means of PM spiking.

PM CEMS operators have reported having difficulty detecting small changes in PM loading, and facilities may need to significantly reduce particulate collection efficiency to establish these correlations. Another problem reported with a PM CEMS is inaccuracy with operation on wet stacks. Condensable water droplets or condensible acid gas aerosols can also be an interference of PM CEMS, especially if the CEMS is installed downstream of a wet scrubber. Use of a monitor with a heated umbilical can help mitigate this problem, but they also are not 100% reliable and the additional equipment and technology can add significantly to the price of the CEMS.

4.8.1.3 PM CPMS

As an alternative to demonstrating compliance using a PM CEMS, facilities may choose to demonstrate continuous compliance with the FPM or total non-Hg HAP metals emission limit using a PM continuous parameter monitoring system (CPMS). Operating principles of the PM CPMS are the same as the PM CEMS principles, and must be based on in-stack or extractive light scatter, light scintillation, beta attenuation, or mass accumulation detection of the exhaust gas or a representative sample. However, rather than directly measuring and reporting FPM emissions (i.e., lb/MMBtu), the reportable measurement output from the PM CPMS may be expressed as milliamps, stack concentration, or other raw data signal. The PM CPMS option is described as an "operating limit monitor" in the final rule, and not a direct FPM emissions monitor meeting the requirements of PS 11.

Coal-fired units that choose this option to demonstrate compliance must demonstrate initial compliance with the applicable emissions limit and establish, at the same time, a site-specific PM CPMS operating limit. Continuous compliance is demonstrated by meeting the site-specific operating limit established during the initial performance test. The site-specific operating limit will be set to correspond to the results of the performance test demonstrating compliance with the applicable emissions limit. The operating limit will be set using the highest hourly average obtained from the PM CPMS during the performance test.

The site-specific operating limit established during the initial performance test will be, by necessity, more stringent than the corresponding FPM emission limit, especially on units equipped with high efficiency particulate control systems. Although compliance with the PM CPMS operating limit will be based on a 30-boiler operating day rolling average, facilities that achieve low controlled PM emissions during the performance test could have difficulty demonstrating continuous compliance with the operating limit. Facilities must repeat the performance test annually for the selected pollutant and reassess and adjust the site-specific operating limit in accordance with the test results.

4.8.2 Acid Gases

Facilities can demonstrate compliance with the MATS acid gas emissions standard by demonstrating compliance with the HCl or alternative SO_2 emissions limit. Compliance with the HCl emissions limit can be demonstrated using an HCl CEMS or quarterly stack testing. Units equipped with an FGD control system can demonstrate compliance with the surrogate SO_2 emission limit of 0.20 lb/MMBtu using an SO_2 CEMS.

4.8.2.1 HCl Stack Testing

Facilities can demonstrate compliance with the MATS HCl emission limit by conducting quarterly stack tests. Performance testing requirements in Subpart UUUUU Table 5 require HCl testing using the following test methods:

Test Method	Description
Part 60 Appendix A-1 Method 1	Selecting sampling port locations and the number of traverse points.
Part 60 Appendix A-1 or A-2, Method 2, 2A, 2C, 2F, 2G, or 2H	To determine velocity and volumetric flow-rate of the stack gas.
Part 60 Appendix A-2 Method 3A or 3B or ANSI/ASME PTC 19.10-1981	Determination of O_2 and CO_2 concentrations of the stack gas.
Part 60 Appendix A-3 Method 4	Measure the moisture content of the stack gas.
Part 60 Appendix A-8 Method 26 or 26A, or Part 63 Appendix A Method 320	Measure HCl concentrations in the flue gas.
Part 60 Appendix A-7 Method 19	To convert emission concentrations to emission rates (e.g., lb/MMBtu) using F-factors.

Method 26 is used to determine emissions of hydrogen halides, including HCl, from stationary sources; however, sources controlled by wet scrubbers must be sampled using Method 26A. Method 26A collects the emission sample isokinetically and is, therefore, better suited for sampling sources controlled by wet scrubbers. Gaseous and particulate pollutants are withdrawn from the source and collected in a cyclone, on a filter, and in absorbing solutions. The filter collects particulate matter including halide salts but is not routinely recovered or analyzed. Acidic and alkaline absorbing solutions collect the gaseous hydrogen halides and halogens, respectively. Method 26A reports a typical analytical detection limit for HCl of 0.2 μg/ml, or an analytical detection limit of HCl in the stack gas of approximately 0.03 to 0.04 ppm.

HCl stack test results provided by Montana-Dakota for this report were measured Method 26A. All but one of the six HCl test runs conducted in June 2012 were reported below the method detection limit of 0.03 ppm. HCl emissions measured in June 2012 averaged below 0.00007 lb/MMBtu.

4.8.2.2 SO_2 CEMS

Facilities equipped with an FGD control system can use their SO_2 CEMS to demonstrate initial and continuous compliance with the MATS SO_2 surrogate limit of 0.20 lb/MMBtu. SO_2 CEMS have been installed and operated on coal-fired boilers for a number of years to measure SO_2 emissions for Acid Rain Program compliance. A majority of the SO_2 CEMS installed on coal-fired boilers are reported to be dilution-extractive systems (rather than non-dilution extractive) because dilution-extractive systems provide wet basis concentrations which work more economically with flue gas flow rate monitors that also provide wet-basis stack flow rate values. Facilities that choose to demonstrate compliance with the MATS SO_2 emissions limit must install the monitor at the outlet of the EGU, downstream of all emission control devices, and must certify, operate, and maintain the CEMS according to 40 CFR Part 75.

4.8.2.3 HCl CEMS

Facilities can also demonstrate initial and continuous compliance with the MATS HCl emissions limit using an HCl CEMS. Although HCl CEMS have not been used on coal-fired power plants until recently, the analytical principles have been used in the chemical and incinerator industry for many years. Several methods which use light absorption technology have been developed for HCl CEMS, including:

- Non-dispersive infrared (NDIR) – which measures the amount of single wavelength light absorbed by HCl by using gas filters;
- Fourier transform IR (FTIR) – which measures light absorption by the HCl gas by using various wavelengths of light and creating an interferogram; and
- Tunable laser diode – which measures energy absorption of a very specific band of light using a tuned laser.

Commenters to the proposed MATS Rule argued that HCl CEMS do not have an approved performance specification and are not widely demonstrated as a proven technology. EPA disagreed with the commenters' contention that HCl CEMS are not an available monitoring technique, noting that HCl CEMS are being used on source categories such as municipal waste combustors. EPA also reviewed HCl CEMS vendor claims and found sufficient capability to support the HCl CEMS monitoring option in the final rule. EPA noted that it was engaged with representative stakeholders to develop a generic performance specification for HCl CEMS. In the meantime, PS 15 (Performance Specification for Extractive FTIR Continuous Emissions Monitor Systems in Stationary Sources) can be used to certify FTIR style HCl CEMS that are on the market. The office of air quality planning and standards (OAQPS) is currently developing a new Performance Specification (PS-18) for the HCl CEMS to support emissions monitoring for electric utility MATS compliance.

Although these analytical principles have been used to measure HCl concentrations at waste incinerators, a number of difficulties and challenges have been reported when the technologies are applied to coal-fired boilers. HCl emissions from coal-fired boilers equipped with an FGD control system are typically very low (i.e., less than 1.0 ppm), and utilities have reported difficulties with proper certification and calibration of the HCl CEMS. Based on anecdotal information from existing utility sources, currently available HCl CEM systems require significant attention and calibration to provide valid test results, and need additional operating history to be considered a robust, reliable, and accurate monitoring alternative. It is anticipated that HCl CEMS would require significantly more attention than the alternative SO_2 CEMS to achieve similar availability factors.

As noted above, stack tests conducted at Lewis & Clark in June 2012 reported HCl concentrations below the method detection limit of test Method 26A (i.e., <approximately 0.10 ppm). HCl CEMS operators have reported difficulty accurately reading HCl concentrations in the flue gas below approximately 0.5 ppm with any consistency and reliability. Because of the low HCl concentrations in the Lewis & Clark flue gas, Montana-Dakota may have difficulty meeting the HCl CEMS certification and QA/QC requirements.

4.8.3 Mercury CEMS and Sorbent Traps

Except for coal-fired EGUs that qualify as an LEE for Hg emissions, initial and continuous compliance with the MATS Hg emission limit must be demonstrated using an Hg CEMS or sorbent trap continuous monitoring system. Mercury CEMS have only recently been required on coal-fired boilers, but currently available Hg CEMS can be considered second generation technology.

Hg emissions monitoring provisions included in Appendix A to Subpart UUUUU, require initial certification and periodic quality assurance (QA) testing of the Hg CEMS and sorbent trap monitoring systems. Certification tests required for the Hg CEMS include a seven-day calibration error test; a linearity check using NIST-traceable elemental Hg standards; a three-level system integrity check using NIST-traceable oxidized Hg standards; a cycle time test; and a relative accuracy test audit (RATA). For ongoing QA of the Hg CEMS, Appendix A requires daily calibrations, weekly single-point system integrity checks, quarterly linearity checks (or 3-level system integrity checks), and annual RATAs.

Sorbent trap monitoring systems are generally considered to be simpler than Hg CEMS, but still require significant QA/QC including trap exchanges every 14 days (at a maximum) and laboratory analyses. For sorbent trap monitoring systems, a RATA is required for initial certification, and annual RATA are required for ongoing QA. The performance specifications for these RATA are the same as for the Hg CEMS RATA. For day-to-day operation of a sorbent trap system, Appendix A requires facilities to follow the procedures and QA/QC criteria in 40 CFR Part 60 Appendix B Performance Specification 12B. Procedure 5 in Appendix F to 40 CFR Part 60 includes the quality assurance requirements for sorbent trap monitoring systems used for compliance determination at stationary sources.

Based on discussions with operators at existing sources, meeting the Hg CEMS QA/QC requirements can be difficult, and will be complicated by very low Hg concentrations in the flue gas (below approximately 0.5 $\mu g/m^3$). To satisfy Hg compliance monitoring per ARM §17.8.771, Montana-Dakota installed an Hg CEM system on Lewis & Clark. The CEM system has proven to be reliable and has consistently met all applicable QA/QC requirements. It is recommended that Montana-Dakota continue to utilize the existing Hg CEMS to demonstrate compliance with the MATS Hg standards.

4.8.4 Emissions Monitoring – Summary

The final MATS Rule allows facilities to demonstrate continuous compliance with the applicable emission limits through quarterly stack testing or the use of CEMS. Although CEMS, including SO_2, CO_2, O_2, and stack gas flow monitors, have been in use for a number of years, there is significantly less experience with HCl, Hg, and FPM CEMS. SO_2 CEMS have proven to be robust, reliable, and accurate monitoring systems, and with proper maintenance these CEMS have demonstrated the ability to achieve availability factors of 99% or more (excluding periods of planned QA/QC). Nevertheless, experience shows that all continuous monitoring systems will experience downtime, malfunctions, and out-of-control periods; thus, an important factor in deciding which monitoring approach to implement (i.e., CEMS or quarterly stack testing) is how CEMS downtime is reported under the MATS Rule.

Although all periods of CEMS downtime (except downtime caused by poor maintenance or careless operation) may be reported as such in the facility's semiannual compliance report pursuant to the general reporting requirements in §§63.8(c)(8) and 63.10(e)(3)(vi), language in the preamble to the final rule suggests that enforcement authorities (i.e., EPA or MDEQ) have discretion when determining whether a source is meeting its monitoring system operating requirements.[22] CEMS downtime that is not related to a monitoring system malfunction or out-of-control period (as that term is defined in §63.8(c)(7)(i)) may be considered a deviation from the rule's monitoring requirements. Determination of whether a deviation constitutes a violation of the standard is also up to the discretion of the entity responsible for enforcement of the standards.

[22] See 77 Fed. Reg. pg. 9421 col. 3.

Monitoring options available to Montana-Dakota are summarized in Table 4-6. Options are based on a review of baseline HAP emissions from Lewis & Clark, the reliability of available CEM monitoring systems, and the assumption that Lewis & Clark will likely qualify for LEE status for Hg and may qualify for LEE status for HCl and total non-Hg HAP metals. Monitoring options that include quarterly stack testing assume that a cost-effective stack testing option is available year round.

Table 4-6
MATS Compliance Monitoring Options

	Option 1	Option 2	Option 3
Hg	LEE testing for Hg 30-boiler operating day performance test using Method 30B Hg emissions <4.0 lb/TBtu and <29 lb/yr. If unit qualifies for LEE status, repeat performance test annually	Hg CEMS (may be required for compliance with Montana §17.8.771)	Hg sorbent trap
Acid Gas (SO_2 or HCl)	LEE Testing for HCl Quarterly stack tests for 3-years HCl < 0.001 lb/MMBtu (approx. 1.0 ppm) If units qualify for LEE status, testing frequency is reduced to once every 36 months.	Quarterly HCl stack tests or HCl CEMS Reliability and accuracy of HCl CEMS, as well as QA/QC requirements may be challenging because of the low HCl concentrations in the flue gas	Use the existing SO_2 CEMS Available only if modifications to the wet disk scrubber, or new control systems, reduce SO_2 emissions below 0.20 lb/MMBtu (30-day average) MATS limit
Non-Hg HAP Metals	Quarterly FPM stack tests or PM CEMS	Quarterly total non-Hg HAP metal stack tests	LEE Testing for FPM Quarterly stack tests for 3-years FPM < 0.015 lb/MMBtu Available only if new particulate matter control systems reduce FPM emissions below the 0.015 lb/MMBtu LEE standard If unit qualifies for LEE status, testing frequency is reduced to once every 36 months.

5. ENVIRONMENTAL REVIEW - SUMMARY

Environmental regulations that will have the most immediate impact on operations at the Lewis & Clark Station are the Regional Haze Rule and the Mercury and Air Toxics Standard (MATS Rule). The Regional Haze Rule requires that each state develop and adopt an implementation plan to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment to visibility in Class I Areas which result from man-made pollutants. The MATS Rule, published as a final rule on February 16, 2012, regulates HAP emissions from coal- and oil-fired electric generating units. The rule includes emission standards for mercury, non-mercury trace metals, and acid gas emissions from existing coal-fired boilers.

On September 18, 2012, EPA published in the *Federal Register* its final Federal Implementation Plan (FIP) addressing the regional haze requirements in Montana. Based on EPA's evaluation of the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of Lewis & Clark; and taking into consideration the small size of the unit, the baseline Q/D (emissions divided to by the distance to the nearest Class I Area) of the facility, and the relatively small reduction in visibility impacts that may be achieved with the installation of advanced air pollution control systems on Lewis & Clark, EPA concluded that no additional PM, NOx, or SO_2 controls were required for this regional haze planning period (through about 2018).

Lewis & Clark will be subject to emission limits and work practice standards in the MATS Rule. The rule includes emission limits for mercury, acid gases (HCl or SO_2), and trace metal HAP emissions (FPM, total non-Hg metals, or individual non-Hg metals). MATS compliance findings listed below are based on a review of baseline HAP emissions from Lewis & Clark, taking into consideration fuel characteristics and existing air pollution control systems:

- Existing mercury emissions from Lewis & Clark are below the MATS Hg emission limit of 4.0 lb/TBtu. Lewis & Clark is expected to meet the MATS Hg emission limit with no additional controls.
- Existing FPM and total non-Hg HAP metal emissions are above the MATS emission limits of 0.030 lb/MMBtu and 50 lb/TBtu, respectively. Upgrades or modifications to the existing flooded wet disk scrubber, or installation of advanced particulate matter control systems (including wet and dry ESP or fabric filter baghouse) are needed to reduce FPM and/or total non-Hg HAP metal emissions below the applicable MATS limits.

- Based on stack test results from Lewis & Clark, existing HCl emissions are well below MATS limit of 0.002 lb/MMBtu. Lewis & Clark should meet the MATS HCl emissions limit with no additional controls. This conclusion is based on the assumption that the existing flooded wet disk scrubber, or equivalent control system, remains in place and operational.
- Existing SO_2 emissions from Lewis & Clark are above the MATS SO_2 emission limit of 0.20 lb/MMBtu (30-day average). Upgrades or modifications to the existing wet disk scrubber, or installation of advanced FGD controls would be needed to reduce SO_2 emissions below the MATS limit. However, Lewis & Clark is not required to meet the SO_2 emissions limit if it can demonstrate compliance with the alternative HCl emissions limit.
- Baseline Hg emissions from Lewis & Clark are below the applicable LEE standard, and it is anticipated that Lewis & Clark could achieve LEE status for Hg with no additional controls.
- Baseline HCl emissions are below the applicable LEE standard, and it is anticipated that Lewis & Clark could achieve LEE status for HCl with no additional controls. This conclusion is based on the assumption that the existing wet disk scrubber, or equivalent control system, remains in place and operational.

Montana-Dakota will be required to develop and implement a boiler tune-up program meeting the requirements of the MATS Rule. Initial compliance with this work practice standard must be demonstrated by October 16, 2015; thus, it is recommended that Montana-Dakota plan on performing the required tune-up and inspections during the unit outage preceding the October 16, 2015 compliance deadline. The work practice standard for the control of organic HAP emissions also requires owners/operators to tune-up the EGU burner and combustion control systems at least each 36 calendar months, or each 48 calendar months if neural network combustion optimization software is employed. The work practice standard involves maintaining and inspecting the burners and associated combustion controls, tuning the specific burner type to optimize combustion, and obtaining and recording CO and NO_X values before and after burner adjustments.

Montana-Dakota will also be required to meet specific work practice standards that apply during boiler startup and shutdown. In general, work practice standards that apply during periods of startup and shutdown require the use of "clean fuels" (i.e., natural gas or distillate oil) for ignition during startup, and that all applicable control technologies (except dry scrubbers and SCRs) are engaged and operating once the unit converts to firing coal. Based on information provided by Montana-Dakota, Lewis & Clark should meet the MATS startup/shutdown work practice standards with no modifications or operational changes.

Finally, Montana-Dakota will be required to implement a comprehensive emissions testing and monitoring program to demonstrate both initial and continuous compliance with the applicable MATS emission limits. In general, the rule includes two basic emission monitoring approaches: (1) continuous emissions monitoring systems; or (2) periodic quarterly stack testing for all pollutants other than SO_2 and Hg. The rule also includes less stringent monitoring requirements for units that quality for LEE status. Based on a review of existing HAP emissions from Lewis & Clark, and assuming that the unit qualifies for LEE status for Hg and HCl, S&L recommends a combination of annual Hg LEE performance tests and quarterly stack testing for three years to demonstrate LEE status for HCl. It may be possible for Lewis & Clark to demonstrate LEE status for FPM as pollution controls are implemented to address compliance with the MATS non-Hg metal HAPs emission limit. Assuming Lewis & Clark is able to establish LEE status for HCl and/or FPM emissions, compliance testing will be reduced to once every 36 months.

The regulatory requirements and emission limits summarized in this Appendix will be used to establish the baselines for S&L's Environmental Control Technology Strategy study and air pollution control technology evaluation. The control technology evaluation will focus on control system upgrades and modifications needed to comply with the both the Regional Haze and MATS Rules. Because the Final Montana Regional Haze FIP does not require Lewis & Clark to install any additional SO_2 or NOx controls, the Environmental Control Technology Strategy evaluation focuses on meeting the applicable MATS emission limits, including Hg, total non-Hg HAP metals or FPM, and HCl or SO_2.

APPENDIX B.

CAPITAL COST FOR IMPLEMENTATION OF PROPOSED COMPLIANCE STRATEGIES

- APPENDIX B.1 OPTION 3 – BAGHOUSE, ME & STACK MODIFICATIONS CAPITAL COST
- APPENDIX B.2 OPTION 4 – BAGHOUSE & DSI CAPITAL COST
- APPENDIX B.3 OPTION 5 – BAGHOUSE & SDA FGD CAPITAL COST

APPENDIX B.1
OPTION 3 – BAGHOUSE, ME & STACK MODIFICATIONS
CAPITAL COST

Sargent & Lundy LLC

02/27/2013

Montana-Dakota Utilities
Lewis & Clark Station, Unit 1
Baghouse, Ash Handling, Mist Eliminator and Stack Modifications

BASIS OF COST ESTIMATE

Project No.: 08336-051
Estimate No. 31987A
Preparer: Joseph A. Evanchik

General Information

Type of estimate – Conceptual Cost Estimate
Project location – Sidney, MT
Unit of measurement in cost estimate – US
Currency – USD
Unique site issues – Single unit plant
Contracting strategy – Multiple lump sum contracts.

Construction

Labor wage rate selected for the estimate - 2013 union craft rates for Billings, MT, as published in the RS Means Labor Rates for the Construction Industry, 2013 Edition. The craft rates are then incorporated into work crews appropriate for the activities by adding allowances for small tools, construction equipment, insurance, and site overheads to arrive at crew rates detailed in the cost estimate. Regional labor productivity multiplier 1.1 is included based on Compass International Global Construction Yearbook.
Labor productivity work rates have been applied based on job difficulty.
Labor Work Schedule - Assumed 5x10's work weeks.

Estimate Development

A cost estimate was developed utilizing engineering drawings, equipment sketches, and engineering scope information for a new Baghouse, new Ash Handling system, demolition of an existing chimney and Mist Eliminator improvements, plus, existing Stack modifications featuring new walkways, expanding existing walkway platforms, and the addition of new metal siding enclosures at two elevations on existing stack.

- Take –off quantities were developed using GA's, sketches and engineering provided information.

- Varying types of crew mixes are considered for the required crafts.

02/27/2013

Montana-Dakota Utilities
Lewis & Clark Station, Unit 1
Baghouse, Ash Handling, Mist Eliminator and Stack Modifications

Procurement – Cost Basis

- S&L cost database was used for all commodity items.
- Mechanical vendor budget pricing was used for the major equipment. For the remaining equipment, S&L database pricing was used.

Project Direct and Construction Indirect Costs

- Small construction equipment and tools costs are included with wage rates.
- Allowance for overtime is included.
- Mobilization and De-Mobilization: Included in the crew wage rates
- Per Diem: Is not included.
- Consumables: Included at 0.5% of total material & labor costs.
- Contractor's G&A and Profit: G&A at 10% and Profit at 5% of total material and labor costs are included.
- Freight: Included at 5% of total material cost for commodity items, and not included separately for mechanical equipment, as freight is included within the vendor pricing.

Project Indirects

- Engineering: Included at 10% of total direct and construction indirect costs.
- Construction Management is included.
- Start-up and Commissioning is included.

Escalation

- Cost Escalation is not included, overnight pricing is considered.

Contingency

- Contingency: 20.0% is included on material, labor, subcontractor and indirect costs. 15% is used on equipment costs.

Scope Excluded or By Others

- Owner's costs, bond costs and interest during construction are not included.
- No costs are included, if applicable, for handling or disposing of any asbestos, lead abatement or any Haz-Mat materials.
- Permitting costs or licensing fees.

Assumptions

- Project installation is based on assuming unrestricted access to the site during the construction process.
- It is assumed that coordinated scheduling with Owner will be in force for portions of work requirements.
- ID fan access platforms, or housing, do not require modifications.
- Sufficient construction laydown space is available to support the new activities.
- No modifications, additions, or extensions, are required for roadways, due to construction work or crane locations.

MONTANA-DAKOTA UTILITIES
LEWIS AND CLARK
CONCEPTUAL

Project name

Estimator

Labor rate table

Project
Project No.
Version
Client
Station Name
Unit
Issue Date
Estimate Date
Reviewed By
Approved By
Status
Estimate No.

TRADE SECRET

Report format

Cost index

ESTIMATE NO.: 31987A
PROJECT NO.
ISSUE DATE:
PREP./REV.: Joseph Evanchik/R. KINSINGER
APPROVED: M. OZAN

MONTANA-DAKOTA UTILITIES
LEWIS AND CLARK
CONCEPTUAL

AREA	GROUP	PHASE	DESCRIPTION	LABOR MAN HRS	LABOR AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	PROCESS EQUIP AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

ESTIMATE NO.: 31987A
PROJECT NO.:
ISSUE DATE:
PREP./REV.: Joseph Evanchik/R. KINSINGER
APPROVED: M. OZAN

MONTANA-DAKOTA UTILITIES
LEWIS AND CLARK
CONCEPTUAL

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

ESTIMATE NO.: 31987A
PROJECT NO.:
ISSUE DATE:
PREP./REV.: Joseph Evanchik/R. KINSINGER
APPROVED: M. OZAN

MONTANA-DAKOTA UTILITIES
LEWIS AND CLARK
CONCEPTUAL

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

MONTANA-DAKOTA UTILITIES
LEWIS AND CLARK
CONCEPTUAL

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

AREA	GROUP	PHASE	DESCRIPTION	NOTES	TAKEOFF QUANTITY	PROCESS EQUIP AMOUNT	MATERIAL AMOUNT	SUB AMOUNT	LABOR MAN HRS	LABOR PRICE	LABOR AMOUNT	TOTAL AMOUNT

TRADE SECRET

Estimate Totals

Description	Amount	Totals	Hours	Percent of Total

TRADE SECRET

APPENDIX B.2
OPTION 4 – BAGHOUSE & DSI CAPITAL COST

Sargent & Lundy LLC

04/25/2013

Montana-Dakota Utilities
Lewis & Clark Station, Unit 1
Option 4, DSI and Baghouse

BASIS OF COST ESTIMATE

Project No.: 08336-051
Estimate No. 32077A
Preparer: Joseph A. Evanchik

General Information

Type of estimate – Conceptual Cost Estimate
Project location – Sidney, MT
Unit of measurement in cost estimate – US
Currency – USD
Unique site issues – Single unit plant
Contracting strategy – Multiple lump sum contracts.

Construction

Labor wage rate selected for the estimate - 2013 union craft rates for Billings, MT, as published in the RS Means Labor Rates for the Construction Industry, 2013 Edition. The craft rates are then incorporated into work crews appropriate for the activities by adding allowances for small tools, construction equipment, insurance, and site overheads to arrive at crew rates detailed in the cost estimate. Regional labor productivity multiplier 1.1 is included based on Compass International Global Construction Yearbook.
Labor productivity work rates have been applied based on job difficulty.
Labor Work Schedule - Assumed 5x10's work weeks.

Estimate Development

A cost estimate was developed utilizing engineering drawings, equipment sketches, and engineering scope information for new DSI system and Baghouse.

- Take –off quantities were developed using GA's, sketches and engineering provided information.

- Varying types of crew mixes are considered for the required crafts.

04/25/2013

Montana-Dakota Utilities
Lewis & Clark Station, Unit 1
Option 4, DSI and Baghouse

Procurement – Cost Basis

- S&L cost database was used for all commodity items.
- Mechanical vendor budget pricing was used for the major equipment, except for the DSI System which was factored from another estimate. For the remaining equipment, S&L database pricing was used.

Project Direct and Construction Indirect Costs

- Small construction equipment and tools costs are included with wage rates.
- Allowance for overtime is included.
- Mobilization and De-Mobilization: Included in the crew wage rates
- Per Diem: Is not included.
- Consumables: Included at 0.5% of total material & labor costs.
- Contractor's G&A and Profit: G&A at 10% and Profit at 5% of total material and labor costs are included.
- Freight: Included at 5% of total material cost for commodity items, and not included separately for mechanical equipment, as freight is included within the vendor pricing.

Project Indirects

- Engineering: Included at 10% of total direct and construction indirect costs.
- Construction Management is included at 2%.
- Start-up and Commissioning is included at 1%.

Escalation

- Cost Escalation is not included, overnight pricing is considered.

Contingency

- Contingency: 20.0% is included.

Scope Excluded or By Others

- Owner's costs, bond costs and interest during construction are not included.
- No costs are included, if applicable, for handling or disposing of any asbestos, lead abatement or any Haz-Mat materials.
- Permitting costs or licensing fees.

Assumptions

- Project installation is based on assuming unrestricted access to the site during the construction process.
- It is assumed that coordinated scheduling with Owner will be in force for portions of work requirements.
- No modifications, additions, or extensions, are required for roadways, due to construction work or crane locations.

Estimator

Labor rate table

Project No.
Client
Station Name
Unit
Estimate Date
Reviewed By
Approved By
Estimate No.

Cost index

TRADE SECRET

LEWIS AND CLARK
OPTION 4, DSI, BAGHOUSE

Sargent & Lundy

Area	Group	Description	Subcontract Cost	Scrap Value	Material Cost	Man Hours	Labor Cost	Total Cost

TRADE SECRET

Estimate Totals

Description	Amount	Totals	Hours	Percent of Total

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process/ Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

Area	Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Crew Rate	Labor Cost	Total Cost

TRADE SECRET

APPENDIX B.3
OPTION 5 – BAGHOUSE & SDA FGD CAPITAL COST

Variable	Designation	Units	Value	Calculation
			TRADE SECRET	

Costs are all based on 2010 dollars, and scaled to 2013 dollars

Capital Cost Calculation **Example** **Comments**

TRADE SECRET

APPENDIX C.
O&M COST ESTIMATES FOR IMPLEMENTATION OF PROPOSED COMPLIANCE STRATEGIES

Input Data:	Option 3	Option 4

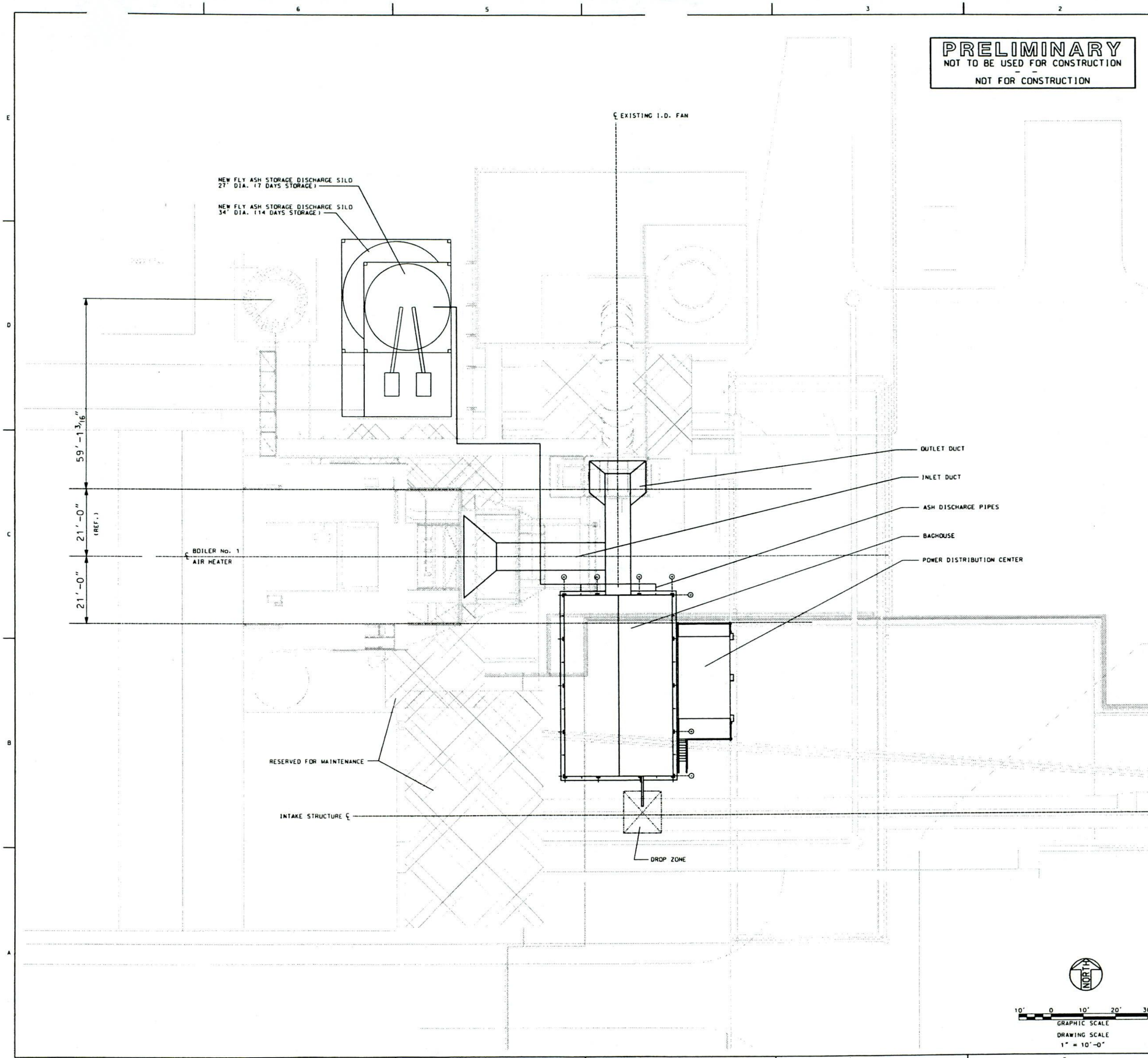
TRADE SECRET

TRADE SECRET

Costs are all based on 2010 dollars, and scaled to 2013 dollars

TRADE SECRET

APPENDIX D.
GENERAL ARRANGEMENT OF PROPOSED COMPLIANCE STRATEGY



NO.	DATE	DESCRIPTION
△		

CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE. INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUB-CONTRACTOR(S)) PERFORMING THE WORK.

RELEASE INFORMATION

REV.	DATE	DESCRIPTION
A	01/23/13	FOR CLIENT COMMENT

ISSUE PURPOSE:

SPECIFICATION:

PROJECT NO.: 08336-051

I HEREBY CERTIFY THAT THIS ENGINEERING DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT PERSONAL SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF ENTER NAME.

ENTER NAME
ENTER DATE

MY LICENSE RENEWAL DATE IS: ENTER DATE
PAGES OR SHEETS COVERED BY THIS SEAL:
THIS DOCUMENT ONLY.

CAD FILE NAME: SK-GA-LC-001.DGN

PREPARED BY: R. MILLER

REVIEWED BY: D. PETLICKI

APPROVED BY:

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY. IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY.

Sargent & Lundy LLC
SARGENT & LUNDY LLC
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603-5780
WWW.SARGENTLUNDY.COM
CERTIFICATE OF AUTHORIZATION NO. 6938

PROJECT

LEWIS AND CLARK STATION
MERCURY REMOVAL SYSTEM
UNIT 1
MONTANA-DAKOTA UTILITIES

DRAWING TITLE

PRELIMINARY
GENERAL ARRANGEMENT
SITE PLAN

DRAWING NUMBER	REVISION
SK-GA-LC-001	A

SHEET 1 OF 1

APPENDIX E.
LEVEL 1 IMPLEMENTATION SCHEDULES

Lewis & Clark Baghouse Project

Activity ID	Activity Name	Original Duration	Start	Finish	2013														2014												2015												2016				
					N	D	Jan	F	M	Apr	M	Jun	Jul	A	S	Oct	N	D	Jan	F	M	Apr	M	J	Jul	A	S	Oct	N	D	Jan	F	M	Apr	M	J	Jul	A	S	Oct	N	D	J	F	M	Apr	M

TRADE SECRET

Lewis & Clark Baghouse Project

Current Date: 05-31-13

.	Activity ID	Activity Name	Original Duration	Start	Finish		2013													2014													2015													2016				
						N	D	Jan	F	M	Apr	M	Jun	Jul	A	S	Oct	N	D	Jan	F	M	Apr	M	J	Jul	A	S	Oct	N	D	Jan	F	M	Apr	M	J	Jul	A	S	Oct	N	D	J	F	M	Apr	M

TRADE SECRET

Sargent & Lundy

Lewis & Clark DFGD + Baghouse Project

Activity ID	Activity Description	Orig Dur	Months
			-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 [illegible] 36 [illegible] 41 42 43

TRADE SECRET

APPENDIX F.
OPTION 3 – BAGHOUSE AND MIST ELIMINATOR VESSEL MODIFICATIONS CASH FLOW FORECAST

Lewis & Clark Cash Flow

TRADE SECRET

Sargent & Lundy