Air Quality Division

State of Oregon
Department of
Environmental
Quality

ASH GROVE MERCURY REDUCTION

Advisory Committee's Report

December 21, 2007

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Ash Grove Mercury Reduction

Advisory Committee's Report

I. Executive Summary

Ash Grove owns and operates a cement kiln and associated quarrying operation in Durkee, Oregon. The kiln processes limestone and other materials which contain naturally occurring mercury. The thermal process used to manufacture cement liberates the mercury, releasing it to the atmosphere. This atmospheric mercury can be deposited onto land and water on a local to global scale. Bacteria in soils and sediments convert mercury to methylmercury which is then taken up by tiny aquatic plants and animals. Fish that eat these organisms build up methylmercury in their bodies. As larger eat smaller ones, methylmercury is concentrated up the food chain.

Ash Grove conducted comprehensive testing to gain a better understanding of the quantity and form of mercury emitted from its cement manufacturing process. The testing and comparison with other mercury sources suggests that Ash Grove's Durkee Plant is the largest industrial source of mercury in Oregon.

The Energy & Environmental Research Center (EERC) conducted a 6-week project to assess and evaluate mercury (Hg) emission controls suitable for use on Ash Grove's cement kiln. The EERC identified powdered activated carbon (PAC) injection as the most promising technology for controlling Hg from cement plants. The EERC arranged for the temporary installation of a slipstream baghouse (SSBH) and PAC injection system at the Durkee Plant. This project demonstrated that Hg removal efficiencies between 65 and 90% are possible at Ash Grove's Durkee Plant, depending on the PAC injection rate and whether the raw mill is off-line or on-line.

The Committee recommended a percent reduction target of 85% with a fallback target of 75% if it is demonstrated that 85% is not achievable despite the best efforts of Ash Grove Cement to achieve 85%. The Committee recommended that the MAO not penalize Ash Grove as long as the plant ultimately achieves a minimum control efficiency of 75%. The Committee recommended the use of alternative limits if 75% is not achievable, similar to those established in the recently adopted Utility Mercury Rule.

The Committee accepted EERC's recommendation that sorbent traps be used to monitor Hg emissions at the facility and to demonstrate the performance of PAC injection. The Committee recommended that Ash Grove do some testing to verify the effectiveness and accuracy of the sorbent traps after installation. EERC suggested that the Ontario Hydro Method would be the best test for verification purposes. The Committee left the details of the monitoring program as well as reporting and recordkeeping to DEQ.

The Committee recommended an installation period of 24 months and an additional 18 months for optimization of the PAC injection system. After 42 months, Ash Grove should be required demonstrate achievement of the percent reduction target(s).

II. Overview and Purpose

The Department of Environmental Quality (DEQ) formed an Advisory Committee to make recommendations regarding issues related to the reduction of mercury emissions from the Ash Grove Cement Company (Ash Grove) in Durkee, Oregon.

III. Committee Membership

The invited Committee members were:

Mark Reeve (Chair)	Reeve Kearns PC
Dean Atkinson, PhD	PSU Chemistry Department
Deanna E. Conners, PhD	Office of Environmental Public Health
John Cox, PhD	Confederated Tribes of the Umatilla Indian Reservation
Brent Foster	Columbia Riverkeeper
Joni Hammond (Ex-Officio)	DEQ – Eastern Region
Charles Hofmann, M.D.	Citizen
Bruce Hope, PhD (Ex-Officio)	DEQ Headquarters
Mark Riskedahl	Northwest Environmental Defense Center
Carl E. Stiff, M.D.	Baker County Commissioner
Fran Streitman	Ash Grove Cement Plant

Others in attendance and participating included DEQ staff Andy Ginsburg, Uri Papish, Linda Hayes-Gorman, Jerry Ebersole, Doug Welch, Patty Jacobs, and Les Carlough. A meeting sign in sheet is attached to the meeting notes to reflect others in attendance.

IV. Background

Ash Grove owns and operates a cement kiln and associated quarrying operation in Durkee, Oregon. Ash Grove's Durkee kiln processes limestone and other materials removed from the on-site quarry which contains naturally occurring mercury. The thermal process used to manufacture cement liberates the mercury, releasing it to the atmosphere in gaseous and particle-bound form.

The U.S. Environmental Protection Agency (EPA) recently promulgated mercury emission control regulations for new cement kilns. EPA evaluated controls for existing cement kilns but determined that it would not be economically feasible to add controls. Currently, the DEQ is not aware of any cement kilns in the U.S. that are operating with controls specifically to reduce mercury emissions.

Ash Grove conducted comprehensive testing in September and December of 2006 in order to gain a better understanding of the quantity and form of mercury emitted from its cement manufacturing process. That testing and comparison with other mercury sources suggested that Ash Grove is the largest industrial source of mercury in Oregon. The company also performed a risk assessment documenting their belief that operation of the plant does not pose an excessive risk to human health. In the Spring of 2007, the company conducted a pilot project to evaluate the most effective means to control the plant's mercury emissions.

DEQ believes the fastest way to reduce mercury emissions from the Durkee plant is to issue a Mutual Agreement and Order (MAO), signed by both the agency and company. Rules are best suited for source categories with multiple facilities; the Durkee facility is the only cement kiln in the state of Oregon. The MAO process is faster than writing rules and the provisions of the order can become amendments to Ash Grove's Title V operating permit. An MAO is also more readily enforceable than a rule because the MAO has stipulated penalties and the company forfeits its right to appeal the penalties.

The DEQ intends to draft an MAO and collect tribal and public comment prior to finalizing. DEQ will also hold an informational meeting and public hearing in Baker City, and elsewhere if requested by a group of 10 or more.

V. Committee Charge

DEQ will be drafting a Mutual Agreement and Order to control Mercury Emissions at Ash Grove Cement plant.

1. The Committee was charged with evaluating and commenting on the following issues:

    a. The type of mercury control equipment and % reduction of mercury from exhaust gas
    b. The timeline for installation of mercury controls
    c. Requirements for testing, reporting and monitoring

2. This report which summarizes comments, key discussions and recommendations is the product of the Advisory Committee. DEQ staff drafted this report in collaboration with the Committee Chair, and the Committee members reviewed it for completeness and accuracy.

VI. Discussion Background

Part A. Mercury Exposure and Pathways

Mercury is emitted to the air by human activities, such as manufacturing or burning coal for fuel, and from natural sources, such as volcanos and forest fires.

Typically, mercury is released into the atmosphere in one of three forms:

- Elemental mercury which can travel a range of distances, may remain in the atmosphere up to one year and may travel globally before undergoing transformation;
- Particle-bound mercury can fall out of the air over a range of distances;
- Oxidized mercury (sometimes called ionic or reactive gaseous mercury (RGM)), found predominantly in water-soluble forms, which may be deposited at a range of distances from sources depending on a variety of factors including topographic and meteorologic conditions downwind of a source.

What happens to mercury after it is emitted depends on several factors:

- The form of mercury emitted;

- The location of the emission source;
- How high above the landscape the mercury is released (e.g., the height of the stack);
- The surrounding terrain;
- The weather.

Depending on these factors, atmospheric mercury can be transported over a range of distances before it is deposited, potentially resulting in deposition on local, regional, continental and/or global scales. Mercury that remains in the air for prolonged periods of time and travels across continents is said to be in the "global cycle."

Recent emissions estimates of annual global mercury emissions from all sources, natural and anthropogenic (human-generated), which are highly uncertain, are about 4800-8300 tons per year.

U.S. anthropogenic mercury emissions are estimated to account for roughly 3 percent of the total global emissions. EPA has estimated that about one third of U.S. emissions are deposited within the contiguous U.S. and the remainder enters the global cycle.

Current estimates are that less than half of all mercury deposition within the U.S. comes from U.S. sources, although deposition varies by geographic location. For example, because of the direction of the prevailing winds, U.S. sources represent the majority of the total deposition in much of the Northeast and global sources account for over 80% of the total deposition in much of the West.

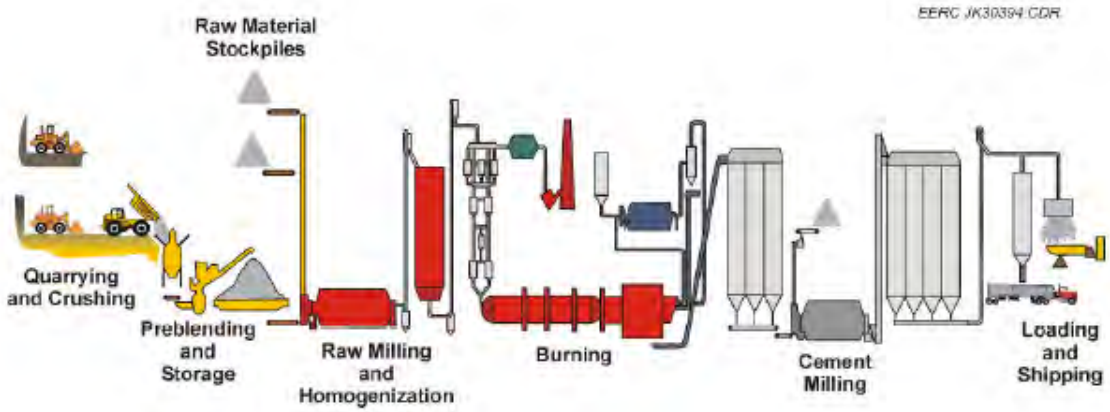
When mercury falls in rain or snow, it may flow into bodies of water such as lakes and streams. When it falls out of the air as dry deposition, it may eventually be washed into those bodies by rain. Bacteria in soils and sediments convert mercury to methylmercury. In this form, it is taken up by tiny aquatic plants and animals. Fish that eat these organisms build up methylmercury in their bodies. As larger fish eat smaller ones, the methylmercury is concentrated up the food chain. This process is called "bioaccumulation".

Methylmercury concentrations in fish depend on many factors, including mercury concentrations, pH, temperature, levels of dissolved solids and organic matter and the presense and type of organism in the water in which the fish live. Methylmercury concentrations in fish may also be affected by the presence of sulfur and other chemicals in the water. Because of these variables, and because food webs are very complex, bioaccumulation is hard to predict and can vary from one water body to another.

However, in a given water body, the highest concentrations of methylmercury are generally found in large fish that eat other fish. The concentrations of methylmercury in large fish can be over a million times larger than in the surrounding water.

Part B. Process Description

The cement-manufacturing process is a large industrial process that includes several processing steps, beginning with quarrying raw materials, preparing material, and pyroprocessing the raw mix in the cement kiln system. The following figure 1 the basic flow diagram for the cement-manufacturing process.



Raw Material Handling

Limestone, shale and clay are mined on-site and iron slag is imported from off-site. These raw materials, necessary for manufacturing cement, are stored in silos until they are withdrawn in proportioned amounts and conveyed to the raw mill system. Typically, the Durkee Plant consumes 1,500,000 tons per year of raw materials and has the capacity to produce 1,000,000 tons of clinker annually.

Raw Mill System

The raw mill grinds and dries the raw material to raw meal. The mill utilizes exhaust gases from the pyroprocess to dry and separate the raw meal. The raw mill operates 80 to 90% of the time the kiln operates. During operating times when the raw mill is off (approximately 15% of the annual operating time frame), the gases bypass the raw mill and are routed directly to the main baghouse. The raw meal is combined with recycled dust from the main baghouse to make kiln feed, which is stored in silos.

Fuel Systems

The plant uses coal, natural gas, used oil, and tire-derived fuels to provide the energy required for the processing of the kiln feed in the pyroprocess. Fuels are delivered to the multi-channel burner pipe in the kiln, to the in-line calciner, and to the separate-line calciner.

Pyroprocess

The heart of the plant is a pyroprocess with a kiln and dual preheater/precalciner system. In this system, combustion off gases from the kiln and dual preheater are utilized for drying and separation of fine raw material and coal in the in-line raw mill and indirect fired coal mill system. The hot off-gases dry and convey finely ground materials which are fed either to the kiln as kiln feed or as fuel. Within the precalciner system, cool raw materials entering the top stages of the preheater tower mix with hot combustion gases from the kiln and calciners. The resulting heat transfer increases the temperature of the raw meal as it proceeds down the preheater tower. When the raw meal temperature reaches approximately 1650°F calcinations begins liberating CO_2 from calcium carbonate ($CaCO_3$) resulting in the formation of CaO, which reacts with alumina, silica, and iron in the kiln to make clinker. Clinker nodules are gray pea to walnut size nodules that contain the materials which, when reacted with water, give concrete its strength. The design of the preheater/precalciner kiln lessens the residence time needed for clinkering versus a conventional dry process kiln. Consequently, preheater/precalciner kilns are shorter and more fuel efficient than conventional wet and dry process kilns.

Cement Mill

The facility operates two cement mill systems that grind the clinker with gypsum to a fine powder producing the various types of cement.

Cement Storage and Shipping

Finished cement is stored in silos or a dome prior to being loaded into trucks or railcars for distribution.

Main Baghouse

The exhaust gases from the pyroprocess and in-line raw mill pass through a conditioning tower and baghouse system which controls particulate matter emissions. The baghouse is a reverse air design. This design isolates one compartment of bag filters from the gas stream and utilizes process gases to dislodge collected particulate matter from the interior of the filter media. The particulate matter loosened from the bags falls into collection hoppers and screw conveyors remove the material for recycling to the process via the kiln feed silos. The de-dusted gases are discharged to the atmosphere through the plant's 290 feet main stack.

Part C. Mercury Emissions

Mercury emission testing was conducted at the facility in September and December of 2006. The utilized testing methods provided full mercury emission speciation (particle-bound, elemental, and oxidized mercury). An understanding of the speciation of the mercury emissions is important in choosing add-on control technology and determining how effective add-on control technology would be in reducing mercury emissions. Testing was also conducted while the Durkee kiln system was being operated in different modes. Testing included periods when the raw mill was on and when the raw mill was off. Mercury emission testing during these two periods improves understanding of the overall mechanism of mercury control in the cement kiln system.

Raw Material Analysis

During the September and December 2006 test periods, process samples were analyzed for mercury. Process samples analyzed for mercury include the raw materials (limestone, shale, clay, iron slag), the kiln feed, the fuel (coal), recycle dust, and the clinker. Tire-derived fuel mercury data has also been analyzed by Ash Grove.

September 2006 Analysis

Input	Mercury Concentration			
	Average (ppm)	**Max (ppm)**	**Min (ppm)**	**St. Dev.**
Limestone	1.1	1.84	0.66	0.374
Shale	0.82	1.06	0.68	0.133
Clay	0.23	0.316	0.128	0.073
Iron Slag	<0.025	<0.025	<0.025	NA
Coal	3.55	7.69	1.42	1.85
Tires	0.13	NA	NA	NA
Clinker	<0.025	<0.025	<0.025	NA

December 2006 Analysis

Input	Mercury Concentration			
	Average (ppm)	**Max (ppm)**	**Min (ppm)**	**St. Dev.**
Limestone	1.43	1.75	1.10	0.25
Shale	0.79	1.19	0.31	0.29
Clay	0.21	0.46	0.02	0.14
Iron Slag	0.02	0.02	0.02	0.00
Coal	0.02	0.02	0.02	0.00
Tires	0.13	NA	NA	NA
Clinker	0.03	0.21	0.02	0.03

Mercury Emissions

The following table presents the Department's findings regarding the mercury emissions testing conducted at Ash Grove Cement in September and December of 2006. Results of the two testing programs were combined to provide a better understanding of the nature and amount of mercury emissions from the facility.

Mercury emissions while the raw mill is on line are an order of magnitude less than when the raw mill is off line. It is believed that the mercury is re-captured (scrubbed) by the materials in the raw mill. When the mill is taken off line, the scrubbing action ceases, and the mercury that has absorbed onto particulate matter is released due to increase in temperature and is emitted through the stack.

ASH GROVE CEMENT, MAIN KILN STACK
COMBINING SEPTEMBER 2006 & DECEMBER 2006 TEST DATA

TESTING PARAMETER	RAW MILL ON	RAW MILL OFF	COMBINED ANNUAL AVERAGE
Exhaust Temperature -°F	219	328	**235**
Exhaust Velocity, fpm	2,760	2,800	**2,760**
Exhaust Flow Rate –dscfm	154,600	136,460	**151,880**
Exhaust Oxygen, % dry vol	8.6	6.5	**8.3**
Kiln Feed Rate, short tons / hr	219	231	**221**
Total Clinker, short tons / hr	132	138	**133**
Particulate Bound Hg:			
-% of total	17	2	**9**
-lbs / hr	0.032	0.027	**0.031**
-lbs / short ton clinker	2.32E-4	1.91E-4	**2.26E-4**
-lbs / yr	185	27	**212**
Oxidized Hg (Vapor Phase):			
-% of total	39	83	**63**
-lbs / hr	0.072	1.122	**0.230**
-lbs / short ton clinker	5.53E-4	8.08E-3	**1.68E-3**
-lbs / yr	442	1140	**1,582**
Elemental Hg (Vapor Phase):			
-% of total	44	15	**28**
-lbs / hr	0.082	0.209	**0.101**
-lbs / short ton clinker	6.27E-4	1.52E-3	**7.61E-4**
-lbs / yr	501	214	**716**
Total Hg:			
-lbs / hr	0.186	1.358	**0.362**
-lbs / short ton clinker	1.41E-3	9.79E-3	**2.67E-3**
-lbs / yr	1,128	1,381	**2,509**

Notes:

- -Appendix K method results used to determine total Hg mass rates
- -Ontario Hydro method results used to characterize vapor phase Hg.
- -September 06 & December 06 results were weighted and combined based on length of sampling run times.
- -Annual Hg emissions based on 15% raw mill off, 85% raw mill on, and 940,000 short tons of clinker per year.

Part D. Mercury Control Testing

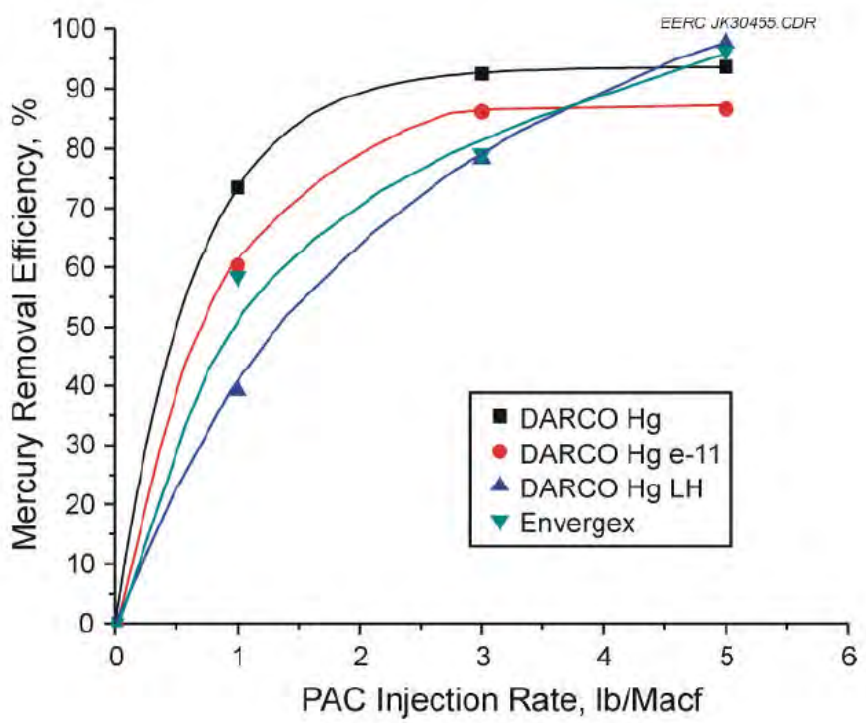
In early 2007, the Energy & Environmental Research Center (EERC) commenced a project to assess and evaluate mercury (Hg) emission controls suitable for use on Ash Grove's cement kiln. The overall goal of the project was to gain an understanding of how various operating and design parameters will impact Hg control for the Durkee cement plant as well as to determine whether a predicted Hg control efficiency could be established.

The EERC identified powdered activated carbon (PAC) injection as the most promising technology for controlling Hg from cement plants. The EERC temporarily installed a slipstream baghouse (SSBH) and PAC injection system at the Durkee Plant. This pilot scale control system received a small slipstream of air off the main stack enabling the EERC to perform a series of tests over 6 weeks under realistic conditions.

Raw Mill On

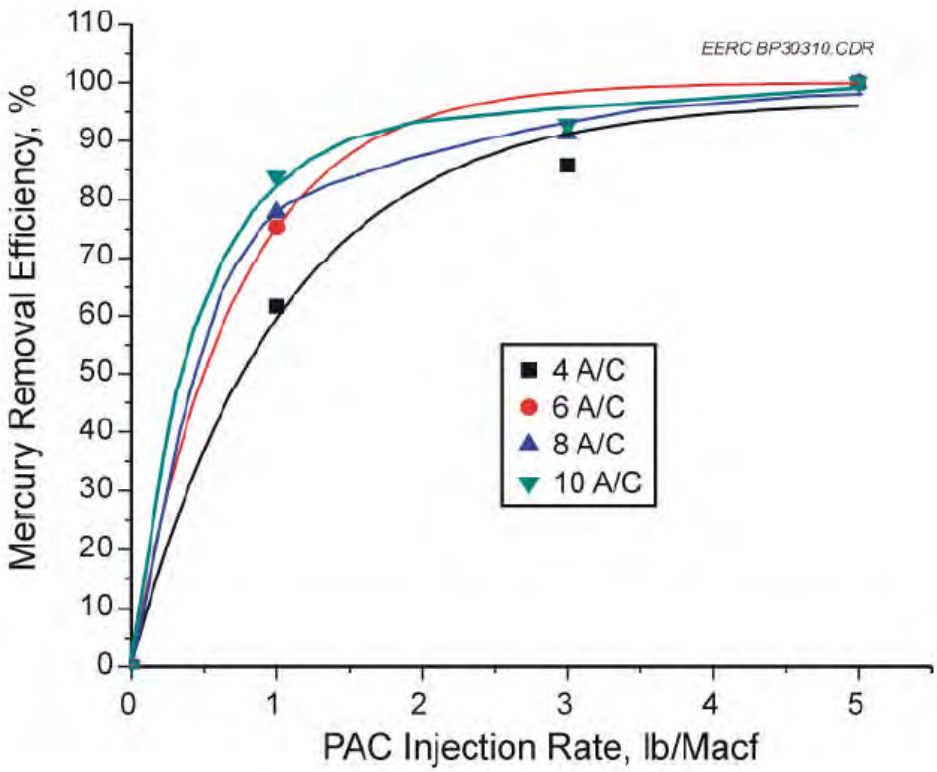
Four parameters were tested during the pilot testing: PAC type, PAC injection rate, bag type and air-to-cloth (A/C) ratio. Each of these parameters was evaluated during periods where the raw mill was operating so as to maintain comparable results. This parametric testing resulted in data for use in designing the full-scale Hg control system.

PAC type: The Hg removal efficiency curves for all PAC types tested are compared in the following figure. Based on the evaluation of the results, the DARCO Hg carbon was determined by EERC to be the best-performing carbon and which, in turn, was then used to evaluate the remaining parameters.



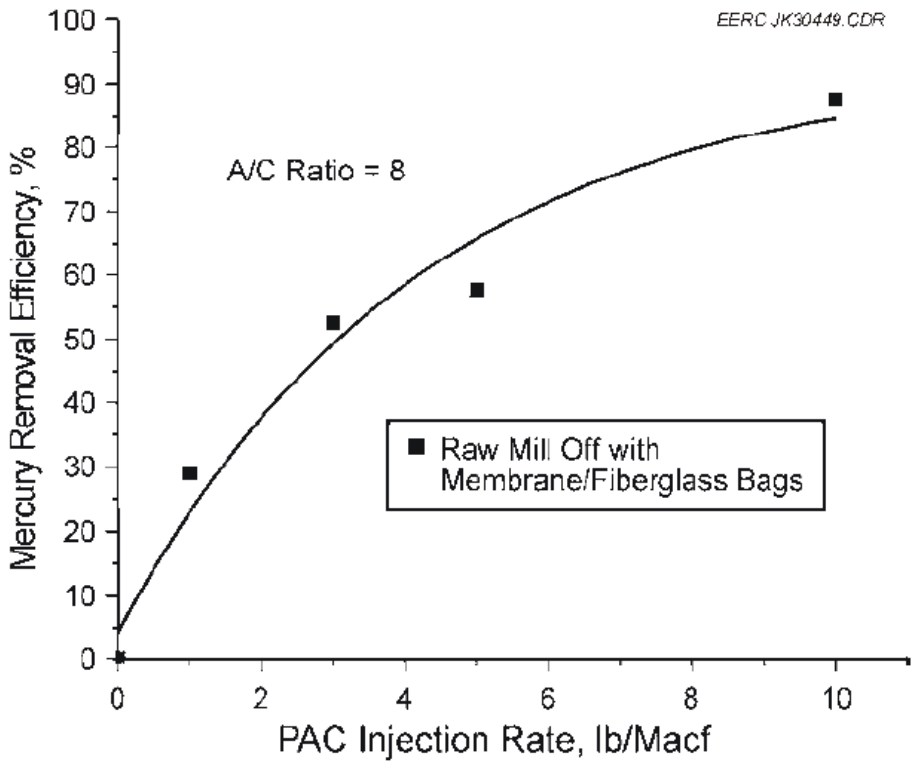
Bag type: The results of testing three the different bag types suggest that at PAC injection rates of 3 lb/Macf or higher the bag type does not play a role in Hg removal. Because of the nature of the process, operating temperatures in the bag filter area of the process can vary as much as 120°F and can exceed 400°F. The membrane/fiberglass bags are the only bags tested that can withstand continuous operating temperatures above 400°F. Therefore, the membrane/fiberglass bags were determined by EERC to be the preferred bag choice.

A/C ratio: The results of testing four different A/C ratios indicate that Hg removal efficiency increased with increasing A/C ratio. Mercury removal efficiencies of approximately 90% were achieved at A/C ratios of 6, 8, and 10 with PAC injection rates of 3 and 5 lb/Macf. The following figure displays the results with respect to PAC injection rate versus Hg removal efficiency.



Raw Mill Off

During the testing of the membrane/fiberglass bags the injection of DARCO Hg was evaluated during a raw-mill-off operating period. This test was performed in order to evaluate the achievable Hg removal efficiency during an operation period when the Hg concentrations were elevated, typical of raw-mill-off conditions. Four PAC injection rates were evaluated: 1, 3, 5, and 10 lb/Macf. The results indicated that only moderate Hg removals (approximately 52% and 58%, respectively) were achievable with injection rates of 3 and 5 lb/Macf. Because of this, the injection rate was increased to 10 lb/Macf to gain an understanding of the level of impact on Hg control efficiency. The results at the injection rate of 10 lb/Macf yielded a Hg removal efficiency of 88%. Results for this testing are summarized in the following figure.



VII. Committee Recommendations and Discussion

Part A. Emission Reduction Goal

The Committee recommended that the MAO include a percent reduction target, not a production-based emission target. The Committee recommended a percent reduction target of 85% with a fallback target of 75% if it is demonstrated that 85% is not achievable despite the best efforts of Ash Grove Cement to achieve 85%. The Committee recommended that the MAO not penalize Ash Grove as long as the plant ultimately achieves a minimum control efficiency of 75%. The Committee recommended the use of alternative limits if 75% is not achievable, similar to those established in the recently adopted Utility Mercury Rule (OAR 340-228-0671(5) and (6)).

Part B. Monitoring, Reporting, and Recordkeeping

The Committee accepted EERC's recommendation that sorbent traps be used to monitor Hg emissions at the facility and to demonstrate the performance of a PAC injection system. The Committee recommended that Ash Grove do some testing to verify the effectiveness and accuracy of the sorbent traps after installation. EERC suggested that the Ontario Hydro Method would be the best test for verification purposes.

The Committee left the details of the monitoring program as well as reporting and recordkeeping to the terms of the MAO.

Part C. Implementation Schedule

The Committee recommends an installation period of 24 months and an additional 18 months for optimization of the PAC injection system. After 42 months, Ash Grove should be required demonstrate achievement of the percent reduction target(s).

VIII. Report Conclusion

The Committee respectfully submits this report and its recommendations are contained in Section VI, Parts A through C, above. Those recommendations are based upon discussions and general consensus of the members at the Committee's second meeting on October 15, 2007. See Appendix E for Notes of meeting.

The Committee expresses appreciation for Ash Grove's willingness on a voluntary basis to invest the resources needed to implement significant reductions of mercury from the Durkee Plant.

IX. Appendices

Appendix A: Ash Grove Mercury Reductions Advisory Committee Meeting 1 Agenda

September 20, 2007
9:00 a.m. – 4:00 p.m.
2020 SW Fourth Ave, Suite 400
Portland, OR 97201 (Room 4 A/B)

DRAFT Agenda

Agenda Item	Time	Topic	Presenter
A	9:00	Introductions	Mark Reeve
B	9:15	Committee Charter	Mark Reeve
C	10:00	Discuss MAO and Process	Les Carlough
D	10:20	Break	
E	10:30	Mercury and Exposure Pathways	Uri Papish
F	11:00	Emissions from Ash Grove	Patty Jacobs
G	11:20	Facility layout and control technology options	Patty Jacobs
H	12:00	Lunch (brought in)	
I	12:45	Public Forum	Open to Public
J	1:00	Ash Grove Mercury Controls Pilot Project Test Results	Fran Streitman
K	2:30	Identify issues not covered	Mark Reeve
L	3:15	Explain Ash Grove Plant Tour Logistics	Fran Streitman
M	3:30	Discuss topics for the next meeting and next steps	Mark Reeve

Appendix B: Emission Test Results

State of Oregon
Department of Environmental Quality Memorandum

Date: Sept. 7, 2007

To: Linda Hayes-Gorman, ER AQ Manager
From: Mark W. Bailey
Subject: Source Test Review Report
Ash Grove Cement Company
Source Testers: AirSource Technologies, Inc.
Process (es): Main Kiln Stack (OA)

Permit Number: 01-0029
Test Date: Sep. 11-14, 2006
Dec. 5-8, 2006
Date Received: May 1, 2007
Observed: Yes, by MWB

Introduction

The purpose of this memo is to present the Department's findings regarding the mercury emissions testing conducted at Ash Grove Cement in December of 2006. Because Ash Grove also conducted a similar test in September 2006, results of the two testing programs were combined to provide a better understanding of the nature and amount of mercury emissions from the facility on a long term basis. Table 1shows the combined source test data, Table 2 shows September 2006 source test data and Table 3 shows December 2006 source test data.

TABLE I:
ASH GROVE CEMENT, MAIN KILN STACK
COMBINING SEPTEMBER 2006 & DECEMBER 2006 TEST DATA

TESTING PARAMETER	RAW MILL ON	RAW MILL OFF	COMBINED ANNUAL AVERAGE
Exhaust Temperature -°F	219	328	**235**
Exhaust Velocity, fpm	2,760	2,800	**2,760**
Exhaust Flow Rate –dscfm	154,600	136,460	**151,880**
Exhaust Oxygen, % dry vol	8.6	6.5	**8.3**
Kiln Feed Rate, short tons / hr	219	231	**221**
Total Clinker, short tons / hr	132	138	**133**
Particulate Bound Hg:			
-% of total	17	2	**9**
-lbs / hr	0.032	0.027	**0.031**
-lbs / short ton clinker	2.32E-4	1.91E-4	**2.26E-4**
-lbs / yr	185	27	**212**
Oxidized Hg (Vapor Phase):			
-% of total	39	83	**63**
-lbs / hr	0.072	1.122	**0.230**
-lbs / short ton clinker	5.53E-4	8.08E-3	**1.68E-3**
-lbs / yr	442	1140	**1,582**
Elemental Hg (Vapor Phase):			
-% of total	44	15	**28**
-lbs / hr	0.082	0.209	**0.101**
-lbs / short ton clinker	6.27E-4	1.52E-3	**7.61E-4**
-lbs / yr	501	214	**716**
Total Hg:			
-lbs / hr	0.186	1.358	**0.362**
-lbs / short ton clinker	1.41E-3	9.79E-3	**2.67E-3**
-lbs / yr	1,128	1,381	**2,509**

Notes:

- -Appendix K method results used to determine total Hg mass rates
- -Ontario Hydro method results used to characterize vapor phase Hg.
- -September 06 & December 06 results were weighted and combined based on length of sampling run times.
- -Annual Hg emissions based on 15% raw mill off, 85% raw mill on, and 940,000 short tons of clinker per year.

TABLE II:
ASH GROVE CEMENT, MAIN KILN STACK
SEPTEMBER 2006 TEST DATA

TESTING PARAMETER	RAW MILL ON	RAW MILL OFF	COMBINED ANNUAL AVERAGE
Exhaust Temperature -°F	233	329	**247**
Exhaust Velocity, fpm	2,790	2,910	**2,800**
Exhaust Flow Rate –dscfm	148,240	138,470	**146,770**
Exhaust Oxygen, % dry vol	8.8	6.8	**8.5**
Kiln Feed Rate, short tons / hr	207	224	**210**
Total Clinker, short tons / hr	127	137	**128**
Particulate Bound Hg:			
-% of total	2	0	**1**
-lbs / hr	0.003	0.005	**0.004**
-lbs / short ton clinker	2.67E-5	3.93E-5	**2.86E-5**
-lbs / yr	21	6	**27**
Oxidized Hg (vapor phase):			
-% of total	47	65	**57**
-lbs / hr	0.074	0.739	**0.174**
-lbs / short ton clinker	5.86E-4	5.40E-3	**1.31E-3**
-lbs / yr	468	762	**1230**
Elemental Hg (vapor phase):			
-% of total	51	35	**42**
-lbs / hr	0.079	0.395	**0.126**
-lbs / short ton clinker	6.34E-4	2.89E-3	**9.72E-4**
-lbs / yr	507	407	**914**
Total Hg:			
-lbs / hr	0.156	1.139	**0.304**
-lbs / short ton clinker	1.25E-3	8.33E-3	**2.31E-3**
-lbs / yr	996	1,174	**2,170**

Notes:

- -Appendix K method results used to determine total Hg mass rates
- -Ontario Hydro method results used to characterize vapor phase Hg.
- -Annual Hg emissions based on 15% raw mill off, 85% raw mill on, and 940,000 short tons of clinker per year.

TABLE III:
ASH GROVE CEMENT, MAIN KILN STACK
DECEMBER 2006 TEST DATA

TESTING PARAMETER	RAW MILL ON	RAW MILL OFF	COMBINED ANNUAL AVERAGE
Exhaust Temperature -°F	206	327	**224**
Exhaust Velocity, fpm	2,730	2,720	**2,730**
Exhaust Flow Rate –dscfm	160,340	134,980	**156,530**
Exhaust Oxygen, % dry vol	8.4	6.3	**8.1**
Kiln Feed Rate, short tons / hr	230	237	**231**
Total Clinker, short tons / hr	136	140	**136**
Particulate Bound Hg:			
-% of total	27	3	**13**
-lbs / hr	0.057	0.042	**0.055**
-lbs / short ton clinker	4.17E-4	3.02E-4	**3.99E-4**
-lbs / yr	333	43	**375**
Oxidized Hg (Vapor Phase):			
-% of total	33	92	**66**
-lbs / hr	0.071	1.404	**0.271**
-lbs / short ton clinker	5.24E-4	1.01E-2	**1.95E-3**
-lbs / yr	419	1,418	**1,836**
Elemental Hg (Vapor Phase):			
-% of total	40	5	**20**
-lbs / hr	0.086	0.072	**0.084**
-lbs / short ton clinker	6.21E-4	5.17E-4	**6.05E-4**
-lbs / yr	496	73	**569**
Total Hg:			
-lbs / hr	0.214	1.519	**0.409**
-lbs / short ton clinker	1.56E-3	1.09E-2	**2.96E-3**
-lbs / yr	1,248	1,533	**2,781**

Notes:
- -Appendix K method results used to determine total Hg mass rates
- -Ontario Hydro method results used to characterize vapor phase Hg.
- -Annual Hg emissions based on 15% raw mill off, 85% raw mill on, and 940,000 short tons of clinker per year.

Test Purpose

The purpose of this project was to quantify the total mercury emissions and to speciate the mercury emissions into its particle bound, oxidized, and elemental components.

Testing Methodology

Total Mercury: 40CFR75 Appendix K (AKM)
Fraction of each Vapor Phase Mercury Species: Ontario Hydro Method (OHM)
Flow Rates: -Used OHM data during September testing.
-Used continuous pitot measurements during December testing.

Testing Location

Testing location was on the main kiln exhaust stack. Physical specifications of the exhaust stack are as follows;

Stack Diameter	130.75"
Stack Height	Approximately 290 feet
Distance A (Mthd 1)	720"
Distance B (Mthd 1)	1920"

Operating Scenarios

During both September and December testing programs the kiln was tested under the following three operating scenarios:

- Raw mill on under normal conditions, representing last 24 hours before the raw mill is shut down;
- Raw mill off under normal conditions;
- Raw mill on under normal conditions, representing first 24 hours after the raw mill was started.

It was presumed the "raw mill on" mercury emissions would be maximized immediately prior to the raw mill being shut down for scheduled maintenance. In addition, it was alleged the "raw mill on" mercury emissions would be at their minimum immediately following the start-up of the raw mill after scheduled maintenance. Raw mill off mercury emissions were expected to represent the largest short-term mercury emissions.

Mercury Mass Rate

Mercury mass rates were determined by the 40CFR75 Appendix K method (AKM). The test data often referred to this method as 324. During the September test project AKM was significantly modified by not extracting a duplicate simultaneous test sample. In addition, flow rates were not measured concurrently during the testing. The impacts of these deviations on the test results are unknown.

Mercury Speciation

Mercury speciation during both September and December testing programs were accomplished utilizing the OHM. The Department used the fractions of the vapor phase mercury species and applied them to the AKM results to obtain speciated mass rates. This was consistent with the December testing program protocol.

During the September test project OHM was not performed simultaneously with the AKM testing. The impact of this testing procedure on the test results is unknown.

Mercury Emissions Calculations

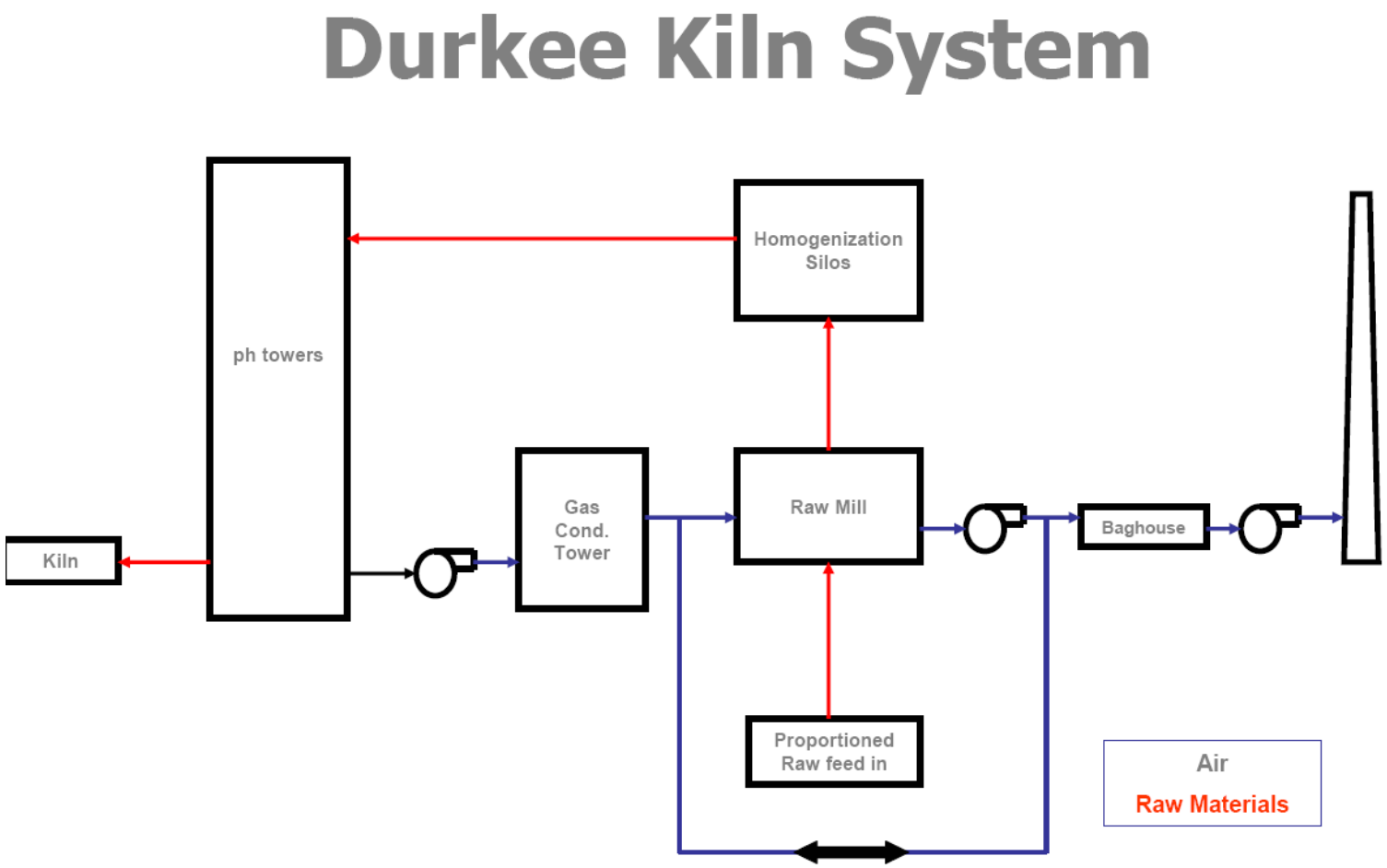
The results presented in Tables I, II, & III were calculated by the Department. The Department considered process rates and the operating time during each sampling period in the mass rate calculations. To account for process rates the mass emissions were calculated on a pounds per short ton of clinker basis. This is not consistent with the contractor's calculations.

Results from each raw mill scenario (on and off) were calculated on a weighted average to account for dissimilar operating times during each sampling period. This is not consistent with the contractor's calculations.

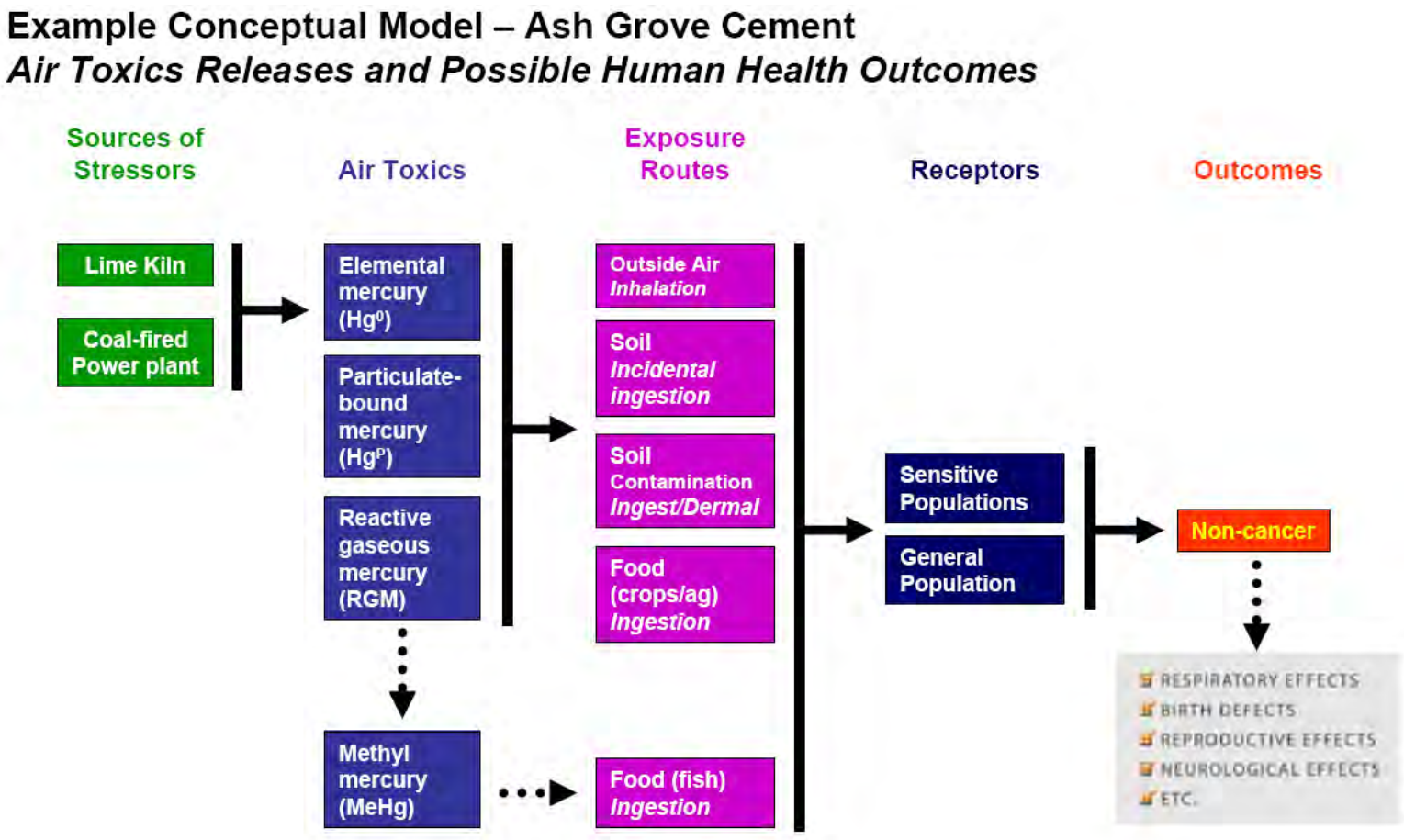
Annual potential to emit calculations were based on an annual process rate of 940,000 short tons clinker per year and assumed the raw mill would operate 85% of the time and the raw mill would not be in operation 15% of the time. The contractor's calculations assumed 7,596 operating hours per year and also assumed the raw mill would be operating 85% of the time and shut-down 15% of the time.

cc: Patty Jacobs, P.E., ODEQ
Doug Welch, P.E., ODEQ

Appendix C: Facility Layout
Ash Grove Cement



Appendix D: Example Conceptual Model
Ash Grove Cement



Appendix E: Mercury Control Study Results

MERCURY CONTROL SLIPSTREAM BAGHOUSE TESTING AT ASH GROVE'S DURKEE CEMENT FACILITY

1.0 INTRODUCTION

Ash Grove Cement Company (Ash Grove) operates a cement-manufacturing plant located in Durkee, Oregon. This plant emits mercury (Hg) that naturally occurs in the plant's raw materials and, to a much lesser extent, fuels. In early 2007, Ash Grove engaged the Energy & Environmental Research Center (EERC) to assist it in assessing and evaluating Hg emission controls suitable for use on a cement kiln. To Ash Grove's knowledge, no cement kiln is known to have installed emission controls intended to remove Hg. Therefore, this research effort has sparked national interest.

The EERC has prepared the following report outlining the evaluative process that it has engaged in over the past 6 months. Because no other cement plant is known to have installed emission controls designed to reduce Hg emissions, this project was highly experimental. The EERC identified powdered activated carbon (PAC) injection as the most promising technology for controlling Hg from cement plants and fixed-bed carbon as a possible alternative technology. The EERC then arranged for the temporary installation of a fabric filter (FF) baghouse and a PAC injection installation at the Durkee Plant as well as a fixed-bed carbon unit. These pilot-scale control installations received a small slipstream of air off the main stack and enabled the EERC to test different PAC types and injection rates under realistic conditions. The information gathered and conclusions drawn from those data are presented in this report.

2.0 BACKGROUND

2.1 Process Overview

The cement-manufacturing process is a large industrial process that includes several processing steps, beginning with quarrying raw materials, preparing material, and pyroprocessing the raw mix in the cement kiln system. Figure 1 shows the basic flow diagram for the cement-manufacturing process. The process uses large quantities of raw materials (rock) to form clinker, the intermediate product of cement. The pyroprocessing step includes heating the raw mix to temperatures in excess of 2750°F in the kiln system, which is fired with large quantities of fuel to provide the energy required for processing the kiln feed. Fuels are delivered to multiple locations in the kiln system in order to deliver the energy at the most effective location for efficient manufacturing. Both the raw materials and the fuel that is used contain minute concentrations of Hg, which can become part of the stack emissions when heated in the kiln system to the high temperatures necessary to produce quality clinker. The Hg is found to be ubiquitous in the raw materials and fuels used to produce cement. As is typical for naturally occurring materials, there is normal variability in the concentrations of Hg found in these materials.

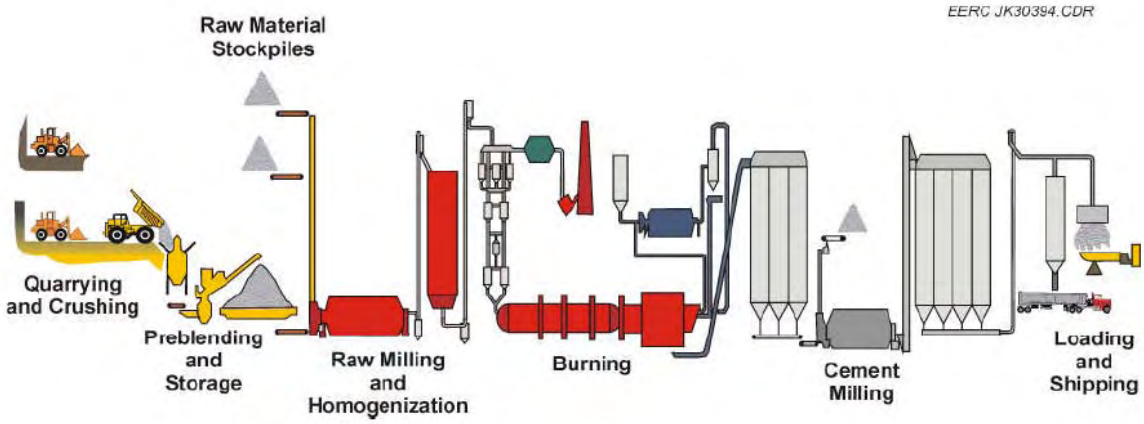


Figure 1. Cement manufacturing process basic flow diagram.

The cement-manufacturing process includes complex physical and chemical reactions that occur during the pyroprocessing in the kiln system. The kiln system at Ash Grove's Durkee facility is a preheater/precalciner system, which includes the rotary kiln, a preheater/precalciner tower, and the associated air pollution control system. The raw materials are mined, ground, and mixed to the appropriate chemical consistency prior to being fed to the kiln system. The materials are heated in the kiln system to temperatures that achieve the appropriate chemical reactions that result in a quality clinker product. The facility is equipped with an in-line raw mill, where the gases from the kiln system are routed directly to the raw mill to provide the heat to dry the raw materials. During operating times when the raw mill is off (approximately 15% of the annual operating time frame), the gases bypass the raw mill and are routed directly to the baghouse. Typically, the Durkee Plant consumes 1,500,000 tons per year of raw materials and has the capacity to produce 1,000,000 tons of clinker annually.

2.2 Mercury

Mercury is found in the environment in one of the four following forms:

- Elemental Hg (Hg^0)
  - "Liquid silver" or Hg vapor
- Inorganic Hg (oxidized)
  - Mercuric compounds – Hg^{2+} (e.g., HgS, $HgCl_2$, HgO, $HgSO_4$)
  - Mercurous compounds – Hg^{2+} (e.g., Hg_2Cl_2)
- Organic Hg
  - Methylmercury species – CH_3Hg or MeHg
- Particulate-bound Hg – Hg_p

All four of these forms of Hg can exist in the environment. Elemental, inorganic, and Hg_p are the types that are emitted from the cement-manufacturing process. Organic Hg is not emitted from the cement-manufacturing process because organic Hg is thermodynamically precluded from forming.

The form of Hg emitted dictates the way in which the Hg will behave in the environment. Mercury that is emitted from a cement kiln stack is deposited in the local environment or is lost to the global Hg cycle. Elemental Hg is not water-soluble and, upon being emitted, has a residence time in the atmosphere of 6 months to 2 years. During this time, Hg^0 can travel thousands of miles before being deposited. Oxidized Hg, by contrast, has a residence time of days once emitted to the atmosphere. Oxidized Hg is water-soluble and has greater potential to enter into rainfall and waterways. Particle-bound Hg, upon being emitted, has a residence time in the atmosphere of between hours and years, depending on the size of the particle. Inhalation of atmospheric Hg species is not a serious health hazard, even at the highest ambient levels. Similarly, ingestion of Hg^0 does not pose a serious hazard. Some of the Hg that is deposited into waterways is converted to MeHg by biological processes. The small percentage of the overall Hg emissions that is deposited in wetlands and converted to MeHg is the Hg that is focused on from an ecological and human health perspective. Recent studies in Clear Lake, California, have indicated that Hg_{total} levels in waterways may not impact MeHg levels. The Oregon Department of Environmental Quality (ODEQ) has estimated that, in the western portion of Oregon, approximately 83% of all Hg being deposited from air originating in Asia.[1]

2.3 Previous Mercury Studies for Cement Kilns

Only limited data are available relating to Hg emissions from cement kilns. Equilibrium calculations suggest that $HgCl_2$ is the dominant Hg species in the flue gases from cement kilns at <480°–590°C.[2] Flue gas Hg speciation measurements and kinetic calculations indicate that Hg^0 chlorination reactions generally do not attain equilibrium because of gas quench rates. Schreiber et al.[3] reviewed the results from previous Hg mass balance studies and comprehensive stack Hg measurement results on cement kiln systems and concluded that cement kiln systems inherently control stack Hg emissions to varying degrees. Likely hosts for Hg in cement kilns are threefold: 1) cement kiln dust, 2) raw materials in the in-line raw mills, and 3) cement clinker.[3]

Schreiber et al.[3] also describes how levels in Hg emissions could change as a result of the raw mill operating or not operating. Data collected during the SSBH testing indicates a higher Hg emission level with the raw mill not operating as compared to that with the mill in operation. One hypothesis given for this release of Hg when the raw mill is shut off and bypassed is explained by the fact that the in-line raw mill has the capability to capture Hg when the raw mill is online. This Hg capture is possible because when the raw mill is online, the kiln gas containing volatilized Hg is used to dry raw materials and sweep the mill of the finely ground and dry raw kiln feed material. Because the mill temperature operates at 90°–120°C, the fine feed particles

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1 Hope, B.; Science of the Total Environment, 2006, p *356.*

2 Senior, C.; Sarofim, A.; Eddings, E. Behavior and Measurement of Mercury in Cement Kilns. Presented at the 2003 IEEE-IAS/PCA Cement Industry Technical Conference, Dallas, TX, May 4–9, 2003.

3 Schreiber, R.J., Jr.; Kellett, C.D.; Joshi, N. *Inherent Mercury Controls Within the Portland Cement Kiln System*; R&D Serial No. 2841, Portland Cement Association, Skokie, IL, 2005; pp 24.

can absorb Hg from the gas stream as the Hg condenses on them. This Hg is then stored in the kiln feed silos, which supply the feed into the kiln system, thereby reintroducing the Hg, which will again volatilize in the higher-temperature zones of the pyroprocess. When the raw mill is shut off, the Hg that has built up in the system through this process is no longer captured in the raw mill, but instead travels through the facility's APCD and out the stack, causing increased levels of Hg.

Mercury control for cement kilns has not been extensively studied. As the U.S. Environmental Protection Agency (EPA) determined in trying to evaluate the availability of Hg controls for the portland cement National Emission Standards for Hazardous Air Pollutants (NESHAP), cement plants have not installed controls for Hg emissions. EPA has stated air pollution control devices (APCDs) such as wet scrubbers may provide Hg control as an unintended benefit, but the level of Hg control has not been adequately studied. EPA recently required the few cement kilns with wet scrubbers to perform inlet and outlet Hg sampling so as to identify Hg control efficiency. Those data have not been collected and assessed. Even when those data are collected and available, there will be significant questions as to the transferability of results from one cement plant to another given the variability in relative proportion of Hg forms encountered in different parts of the country.

2.4 Mercury Control Strategy

Ash Grove has recognized the concerns regarding Hg emissions at its Durkee facility and has voluntarily collaborated with the Oregon DEQ to investigate commercially viable solutions to the issue. In mid-2006, Ash Grove was supplied with data suggesting that the process Hg emissions were greater than previously thought. As noted above, the data concerning cement kiln Hg emissions are limited, and data collected at one cement plant may not be relevant to emissions from another cement plant. Therefore, in order to better quantify its emissions, Ash Grove engaged in extensive Hg testing in September and December 2006. This testing generated detailed information about the form, quantity, and variability of Hg emissions from the Durkee facility. Based on these data, Ash Grove contracted with the EERC to evaluate potential Hg control strategies for the Durkee cement plant. The EERC is a nonprofit branch of the University of North Dakota and is a national leader in the research, development, and commercialization of air pollution control and emission-monitoring equipment. Ash Grove is unaware of any cement plant having installed controls specifically to control Hg. Therefore, the EERC's extensive experience developing Hg controls for the coal-fired electric utility industry made it uniquely qualified to assist Ash Grove in this innovative control technology project.

The EERC's evaluation of potential Hg controls identified PAC injection as the most promising technology for controlling Hg from cement plants. PAC injection, fixed-bed carbon, and wet scrubbing have all been identified as potential Hg control technologies for cement kilns. The scarcity of water in the Durkee Plant vicinity and the limited efficacy of wet scrubbing for controlling Hg^0 make it an inferior control method. Therefore, this study was focused on the feasibility and optimization of PAC injection for cement kilns. A secondary study was performed on fixed-bed carbon, but this technology was not more comprehensively studied because it has not been employed in comparable installations.

The utilization of a PAC injection system at the Durkee Plant would require the installation of a new FF baghouse. PAC is typically injected upstream of a particulate APCD. In the case of a cement facility, an additional APCD is needed downstream of the existing particulate APCD. The Durkee facility recycles the raw material collected in their primary particulate APCD, thus eliminating waste and enhancing the efficiency of the process. At Ash Grove's Durkee Plant, the particulate APCD is a FF baghouse. Injecting PAC upstream of the existing FF baghouse would eliminate the ability to recycle baghouse dust, resulting in large amounts of waste and lower process efficiency. By injecting PAC downstream of the existing FF baghouse and capturing that PAC in a secondary FF baghouse, the plant would be able to continue recycling of the baghouse dust collected in the existing primary baghouse.

The EERC designed this project in order to better understand the site-specific control characteristics of the Durkee Plant. The efficiency of a PAC injection installation is expected to vary with the relative proportions of Hg forms in a particular gas stream as well as the proportion of naturally occurring oxidizing agents such as chlorine. Control efficiency is also expected to vary as the Hg levels vary over time. In order to test these hypotheses and draw meaningful conclusions as to the level of Hg control that can be anticipated from a PAC injection installation, the EERC installed a temporary PAC injection system on a slipstream from the Durkee stack, downstream of the existing particulate APCD. Inlet and outlet emissions were studied over the course of approximately 4 weeks, during which time the types and amounts of PAC were varied. This pilot study provides a basis for predictions as to the anticipated control level that can be achieved and the design parameters for consideration in engineering a full-scale installation. However, it is important to note that this pilot system did not operate under steady-state conditions for an extended period and that the performance documented during this testing may or may not be sustained during long-term, full-scale operation.

3.0 PROJECT OVERVIEW

3.1 Goals and Objectives

The overall goal of this project was to use a small-scale mobile FF baghouse operating in series with an existing Durkee baghouse to perform parametric testing on a slipstream of actual flue gas from Ash Grove's Durkee cement facility to gain an understanding of how various operating and design parameters are likely to impact Hg control at the full scale. The Hg control strategies under consideration involved injection of various sorbents into the second baghouse operating in series with the existing particulate control device.

3.2 Approach/Work Plan

The EERC was on-site at the Durkee facility from April 10 to May 16, 2007. Appendix A contains the resumes of all EERC personnel who participated in this project. Appendix B contains the sample calculations used during testing and the analysis of the data collected. Appendix C contains a daily description of the testing performed at the Durkee facility. Appendix D describes the quality assurance/quality control procedures.

4.0 FACILITIES AND EQUIPMENT DESCRIPTION

4.1 Description of Ash Grove Durkee Facility

4.1.1 Raw Material Handling

Three of the four raw materials are found on-site in the Durkee quarry: limestone, shale, and clay. Iron slag is the only imported raw material for the cement process. Iron slag is imported from off-site sources, unloaded, and utilized as a feed stream supplement. Raw materials are withdrawn from storage silos in proportioned amounts and conveyed to the raw mill system.

4.1.2 Raw Mill

The raw mill grinds and dries the raw materials to raw meal. The mill is referred to as an "in-line" raw mill because it utilizes exhaust gases from the pyroprocess to dry and separate the raw meal. The raw mill operates approximately 85% of the time the kiln operates on an annual basis. The raw meal is combined with recycled material from the main baghouse to make kiln feed, which is stored in silos. The raw mill is shut off once a week for scheduled routine maintenance. Typically, maintenance can be performed over an 8- to 12-hour period. The kiln typically continues in operation while the raw mill is off, utilizing kiln feed stored in the silos.

4.1.3 Fuel Systems

The plant has the capability to use coal, natural gas, used oil, and tire-derived fuel (TDF) to provide the energy required for the processing of the kiln feed in the pyroprocess. Fuels are delivered to the multichannel burner pipe in the kiln, to the in-line calciner, and to the separate-line calciner (SLC). During the time that this test was performed, coal and TDF were the only fuels combusted.

4.1.4 The Pyroprocess

The heart of the plant is a pyroprocess with a kiln and two preheater/precalciner strings; one string is referred to as the in-line calciner (ILC) string and the other as the SLC string. In this system, combustion offgases from the kiln and dual-string preheater are utilized for drying and separation of fine raw material in the in-line raw mill. Within the precalciner system, cool raw materials entering the top stages of the preheater tower mix with hot combustion gases from the kiln and calciners. The resulting heat transfer increases the temperature of the raw meal as it proceeds down the preheater tower. When the raw meal temperature reaches approximately 1650°F, calcination begins liberating carbon dioxide (CO_2) from limestone (calcium carbonate [$CaCO_3$]), resulting in the formation of lime (CaO), which reacts with alumina, silica, and iron in the kiln to make clinker. Clinker nodules are gray pea- to walnut-sized nodules that contain the minerals that, when ground with gypsum, other additives, and reacted with water, give concrete its strength. The design of the preheater/precalciner system results in highly calcined material reaching the rotary kiln; thus the kiln length is shortened (versus a conventional dry process

kiln), and less residence time is needed for clinkering. Consequently, preheater/precalciner kilns are shorter and more fuel-efficient than conventional wet and long-dry process kilns.

4.1.5 Cement Mill

The facility operates two cement mill systems that grind the clinker with gypsum and other additives to a fine powder to produce the various types of cement.

4.1.6 Cement Storage and Shipping

Finished cement is stored in silos or a dome prior to being loaded into trucks or railcars for distribution.

4.1.7 Description of the Main Air Pollution Control Device

The exhaust gases from the pyroprocess and in-line raw mill pass through a conditioning tower and baghouse system that control emissions of particulate matter. The baghouse is a reverse-air design. This design isolates one compartment of bag filters from the gas stream and utilizes process gases to dislodge collected particulate matter from the interior of the filter media. The particulate matter loosened from the bags falls into collection hoppers, and screw conveyors remove the material for recycling to the process via the kiln feed silos.

The dedusted gases are discharged to the atmosphere through the plant's main stack. The stack height is 295 feet. Test ports are available in the main stack at a height of approximately 230 feet.

4.2 Description of the EERC Slipstream Baghouse

Shown in Figure 2 is the EERC's trailer-mounted baghouse that was transported to the Durkee cement facility and connected in a slipstream fashion to enable the testing on "real" flue gases under actual operating conditions. The slipstream baghouse (SSBH) chamber accommodates twelve 6-inch FFs, with bag lengths up to 12 feet. This equates to approximately 226 ft^2 of filtration area. To connect the SSBH to the flue gas of the plant, two separate 10-inch flanges were required: one at the exit of the cement facility's FF and the other downstream of this location. The plant provided these connections.

Figure 2. SSBH, trailer, and control room.

A variable-speed fan is used to draw between 450 and 2700 actual cubic foot per minute (acfm) of flue gas (≈300°F) through the slipstream device to vary FF face velocity between 2 and 12 ft/min. The fan speed is controlled at a rate sufficient to draw gases at or near the maximum system flow of 2700 acfm for all test conditions. In comparison to the full-scale unit, the SSBH would be treating only approximately 1.0%–1.1% of the total facility's flue gas. An 8-inch baghouse bypass line was utilized as a flow control mechanism. Flow control was provided by an orifice meter on the baghouse effluent stream, with a flow control valve inserted in the 8-inch bypass line. Utilization of the bypass line enabled a constant draw of flue gas and isokinetic flow at the inlet nozzle for all test conditions. In addition, pipe velocities were maintained near 75 ft/sec for all test conditions, preventing dropout of particulate matter. The baghouse chamber utilized between one and three inlet ports (5-inch diameter), depending on test conditions. Gases were drawn from an 8-inch header at the baghouse inlet. The baghouse chamber and inlet piping were insulated, with heat-traced lines used to maintain temperatures above a specified minimum, assumed to be 280°F.

The following was provided for testing purposes:

- Access to the Durkee cement facility
- Assistance and cooperation from plant personnel during planning and while on-site
- Assistance from plant personnel to adjust valve positions, if required, and change out SSBH catch collection barrels between tests

- A site location with level grade to place trailer and mobile unit
- A 10-inch duct connected after the facility's baghouse (SSBH inlet)
- A 10-inch return duct connected at the base of the stack (SSBH outlet)
- An adequate source of low-voltage (480-V) 3-phase electricity (≈60 amp)
- Approximately 120 amp of 3-phase (120-V) electricity
- An adequate source of compressed air (3/8- to 1/2-inch line)

Approximately 1 week was used to install and shake down the slipstream equipment before testing was initiated. Several operating parameters, such as gas flow, air to cloth (A/C) ratio, injection rate, etc., were varied during shakedown testing.

4.3 Mercury Monitoring

4.3.1 Main Stack Mercury Monitor

Mercury monitoring was performed at the main stack using a Tekran Model 3300 atomic fluorescence-based Hg vapor analyzer. The mercury monitor (MM) was used in conjunction with a Tekran dry pretreatment/conversion unit to rapidly monitor Hg^0 and Hg_{total} concentrations. Samples of flue gas were extracted from the main stack and drawn through an inertial gas separation (IGS) filter to remove particulate matter. The IGS filter consists of a heated stainless steel tube lined with sintered material.

The Tekran instrument, which was located 230 feet above ground along the main kiln stack, traps the Hg vapor from the conditioned sample onto a cartridge containing an ultrapure gold sorbent. The amalgamated Hg is then thermally desorbed and detected using atomic fluorescence spectrometry. A dual-cartridge design enables alternate sampling and desorption, resulting in a nearly continuous measurement of the sample stream. An automatic Hg^0 permeation source was used to calibrate the instrument daily. Manual Hg^0 injection calibration on both cartridges was also performed for verification. The Tekran instrument measures either Hg_{total} or Hg^0, with an analysis occurring approximately every 2.5 minutes. To prevent the saturation of the unit's conditioner, the flue gas stream was diluted at a ratio of 180:1. At this dilution rate, the system could measure concentrations exceeding 20,000 $\mu g/m^3$.

4.3.2 Slipstream Fabric Filter Baghouse Mercury Monitor

Mercury measurements were made at the slipstream FF baghouse inlet and outlet using a Horiba/Nippon Instruments Corporation DM-6B. The DM-6B uses dual individual channel atomic absorption spectroscopy to measure Hg^0 and Hg_{total} concurrently every 10 seconds. The DM-6B uses a dry thermal catalytic pretreatment/conversion system to transform all Hg compounds to Hg^0 for analysis so that Hg_{total} concentrations can be determined. A dilution system was also utilized with the Horiba to prevent saturation. A dilution ratio of 10:1 allowed

this system to measure concentrations above 10,000 μg/m^3. The Horiba MM is not considered to be a robust system but is a very good research tool. Figure 3 is a schematic showing the connection of the Horiba system to the SSBH.

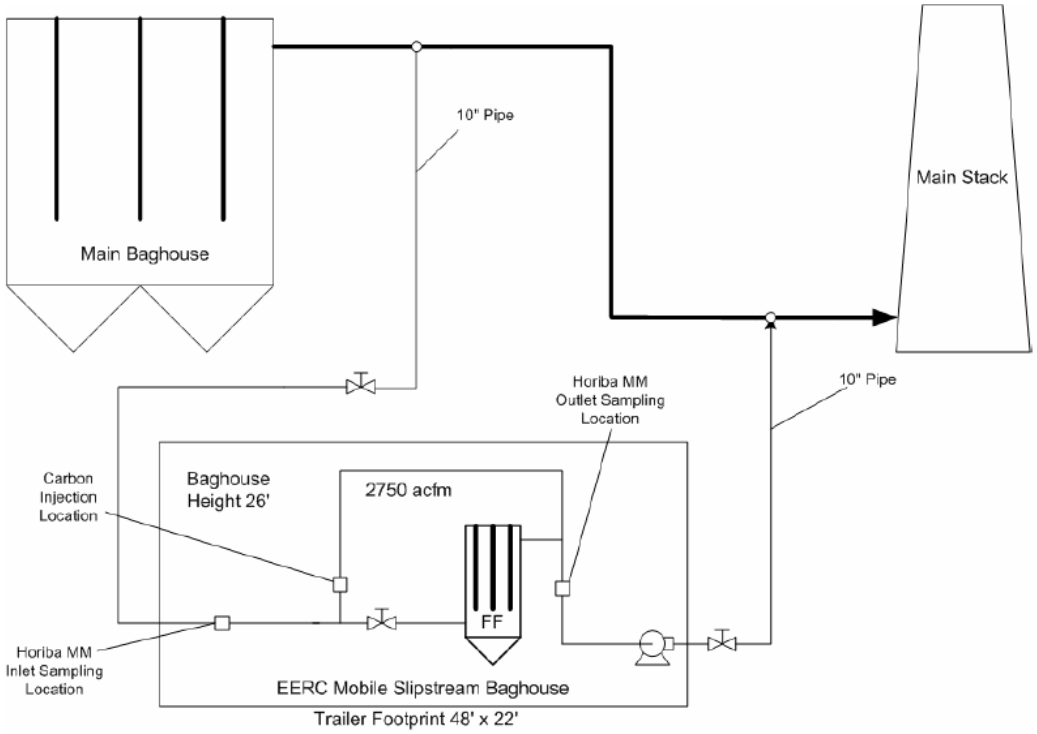

Figure 3. Schematic of the SSBH showing the locations of MM sampling and carbon injection.

4.4 OH Method Flue Gas Mercury Measurements

For verifying the MM measurements in the flue gas, ASTM International (ASTM) Method D6784-02 (Standard Test Method for Elemental, Oxidized, Particle-Bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources – Ontario Hydro Method) was used. OH method samples were withdrawn from the flue gas stream isokinetically through a probe/filter system, maintained at 120°C or the flue gas temperature, whichever was greater, followed by a series of impinger solutions in an ice bath. Particle-bound Hg, Hg_p, was collected on a quartz filter in the front half of the sampling train. Hg^{2+} was collected in impingers containing a chilled aqueous potassium chloride solution. Hg^0 was collected in subsequent impingers (an impinger containing a chilled aqueous acidic solution of hydrogen peroxide and three impingers containing chilled aqueous acidic solutions of potassium permanganate). Samples were recovered and analyzed on-site by cold-vapor atomic absorption spectroscopy (CVAAS) using a CETAC M6000A automated Hg analyzer. The OH method samples were typically prepared and analyzed the same day of collection or the following day.

4.5 Carbon Trap (EPA Method 30B) Mercury Measurements

In addition to using the OH reference method, the U.S. Environmental Protection Agency's (EPA's) draft reference Method 30B (Determination of Total Vapor-Phase Mercury Emissions from Coal-Fired Combustion Sources Using Carbon Sorbent Traps) was used. Proposed Method 30B is a procedure for measuring Hg_{total} emissions from coal-fired combustion sources using sorbent sampling and an extractive or thermal analytical technique. The method is intended for flue gases that are not particulate-laden (e.g., sampling downstream from particulate control devices).

4.6 Powdered Activated Carbons

The sorbents used for this project were PACs obtained from vendors that had a product on the market readily available for use. Many experimental carbons do exist but were not considered for this project because they are not widely available commercially. The selected activated carbons were NORIT DARCO Hg and NORIT e-11. The selected treated activated carbons were NORIT DARCO Hg LH and Envergex e-Sorb e-11. NORIT DARCO Hg is a multipurpose activated carbon created from lignite coal. The NORIT e-11 is a coarser version of the DARCO product line. A coarser carbon was selected to determine if any significant differences, such as bag blinding, could be found with the SSBH operation with this product over the more generic DARCO Hg. The treated carbons were both treated with a proprietary process, adding the benefit of increased reaction with the material with the gas stream through halogenation. The carbons chosen represent the available carbons on the market today. Different carbon vendors do exist, but their products fall under the carbon types tested (halogen-treated and untreated). Table 1 contains information about each carbon chosen for evaluation in this study, including a brief description of the carbon material.

Table 1. Brief Description of the Carbons Tested During Parametric Testing Through the SSBH

Carbon Name	Manufacturer	Availability	Description
DARCO Hg	NORIT Americas	Commercially available	Lignite coal-based
DARCO Hg e-11	NORIT Americas	Commercially available	Lignite coal-based, larger particle size than DARCO Hg
DARCO Hg LH	NORIT Americas	Commercially available	Lignite coal-based, halogen-treated
Envergex e-Sorb e-11	Envergex	Readily available	Proprietary treated carbon

4.7 Stack RATA Testing

A relative accuracy test audit (RATA) was conducted at the conclusion of sorbent testing to aid in the identification of the challenges that would be encountered in certifying a MM for regulatory purposes. Dates of testing are listed in Appendix C. Sampling at the stack with

15 paired OH method trains was conducted over a 4-day period for the RATA. Analyses of the OH method trains were performed on-site immediately after being sampled. The results of the paired OH method samples were then compared to the averaged stack MM data from the same time period. A traverse was not conducted before OH method sampling began. Examination of previous testing performed at the facility's stack did not indicate that stratification of gas flow or stratification of Hg was occurring.[4]

4.8 Fixed-Bed Testing

The EERC built a small fixed-bed apparatus with the capability to provide a slipstream of flue gas to a fixed-bed contactor to investigate this technology for applicability to this system as a Hg reduction strategy. The intent was to determine the life of a typical granular activated carbon when exposed to the Durkee process gas. Several attempts were made at running the apparatus. Because of the low flow rate and limited time line of the project, the apparatus failed to achieve normal baseline conditions (no carbon in the bed) because the metal in the system was absorbing Hg. Therefore, no results were obtained, and the carbon life was not determined.

5.0 RESULTS AND DISCUSSION

5.1 Slipstream Baghouse Operation

Mercury control testing occurred across the SSBH over a 4-week period. During this time, the EERC evaluated several parameters, including bag type, A/C ratio, activated carbon type, activated carbon injection rate, and baghouse operation. The first week of testing involved a setup and shakedown period of the SSBH; during this time, baseline data were gathered to evaluate the normal Hg concentrations through the baghouse with a standard polyphenylene sulfide (PPS) bag. Testing then continued with the evaluation of several carbon types, which included treated and untreated carbons.

After results from parametric testing with the four sorbents, identified in Table 1, were evaluated, comparative results were analyzed to determine the best-performing carbon, which was then used to conduct the remaining tests. This was done to control the number of variables in the system when other parameters such as differential pressure, bag type, and A/C ratio were evaluated. The remaining baghouse testing involved the evaluation of two other bag types, membrane and membrane/fiberglass, with varying injection rates and A/C ratios. Pressure change values were used in determining the baghouse operability and bag type performance.

During the injection of PAC, the differential pressure was measured to determine if bag blinding was a concern. After several injection periods, it was determined that the differential pressure was not an issue for this test. The highest differential pressure that occurred during testing with the PPS bags was 1.11 inches of water during the highest injection rate of Envergex e-11. During injection into the membrane bags, the highest differential pressure was 0.04 inches of water. This is a very low differential pressure, but during the use of the membrane bags, small

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[4] Cobb, G. *Mercury Emissions Test Report*; Prepared for Ash Grove Cement Company Dec 5 through 8, 2006, AirSource Technologies, Inc., Shawnee, KS, 2006; p 6.

quantities of fine carbon were determined to have bled through the bags. The highest differential pressures for the membrane/fiberglass bags was 2.42 inches of water. Appendix C contains the differential pressure data in table form for all injection periods.

5.2 SSBH Baseline Testing

Two days of baseline testing occurred on April 16 and 17, 2007. During these 2 days, baseline data were gathered that demonstrated the two main operating cycles: raw mill on and raw mill off. The primary goal of collecting baseline data was to demonstrate the typical Hg concentrations throughout the SSBH system.

5.2.1 Raw-Mill-On Baseline Period

Baseline results during the raw-mill-on period were variable, with an average daily Hg concentration at the inlet of the SSBH equal to 485 ± 64 $\mu g/Nm^3$ and at the outlet equal to 461 ± 79 $\mu g/Nm^3$ to one standard deviation. Since it was not expected that the SSBH would remove Hg without the aid of a Hg control technology (such as the injection of PAC into the system), the Hg removal efficiency during baseline conditions (the native capture) was expected to be zero. This means that the average Hg concentrations during a baseline period should be the same at the inlet and outlet locations of the SSBH. Based on the experience of EERC and the statistical evaluation presented in Appendix G, it can be said that the native capture is, in fact, zero and the Hg concentration at the inlet and the exit of the SSBH during the baseline raw-mill-on period are essentially the same.

To compare methods, modified carbon traps and OH method sampling were used in conjunction with the Horiba MM located at the inlet and outlet of the SSBH. These methods were performed as a set, with each method being performed at both the inlet and outlet side of the SSBH.

In order to allow a comparison between data collected by the Horiba MM, carbon traps, and OH method testing, all three methods were employed during this baseline period. The Horiba MM was collecting and analyzing samples from the inlet and outlet of the SSBH. For approximately 15 minutes, data were simultaneously collected at the inlet and the outlet via carbon traps. The difference between the carbon trap inlet and carbon trap outlet data is 12.2%, indicating good correlation. Inlet MM data correlated very closely with inlet carbon trap data. Outlet MM data differed by 21.8% from outlet carbon trap data with the carbon trap appearing to be biased high. For approximately 30 minutes, data were simultaneously collected at the inlet and the outlet via the OH method. The difference between the OH method inlet and the OH method outlet data is 29.0%. The inlet OH method results indicate a percent difference of 28.6% from the MM average at the inlet. This suggests that there may have been an error with the inlet OH method test as the inlet MM data correlates well with the outlet MM data as well as the outlet OH method data. The outlet MM monitor data correlated well with the outlet OH method data. Table 2 shows the results from this testing. Figure 4 shows the real-time Hg monitor data compared to carbon trap and OH method results.

Table 2. Results from Carbon Trap and OH Method Testing During Raw-Mill-On Baseline Testing

Test Method	Inlet MM Hg Concentration	Test Method Hg Concentration	Inlet Difference	Outlet MM Hg Concentration	Test Method Hg Concentration	Outlet Difference	MM Difference
	$\mu g/Nm^3$		%	$\mu g/Nm^3$		%	%
Carbon Trap	422	423	0.2%	384	478	21.8%	9.4%
Ontario Hydro	512	384	28.6%	442	514	15.1%	14.7%

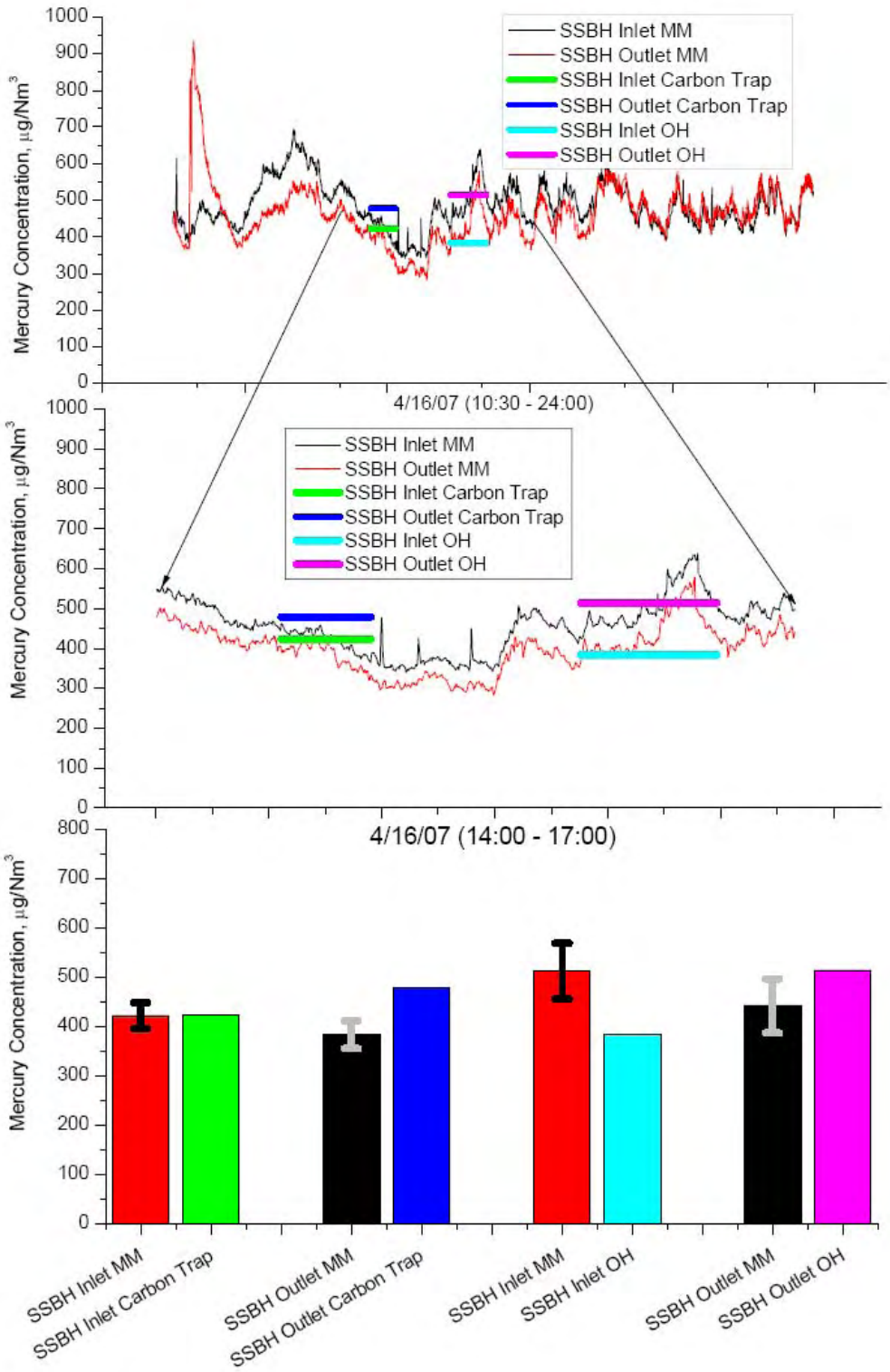

Figure 4. Raw-mill-on baseline results comparing MM, carbon traps, and OH method.

5.2.2 Raw-Mill-Off Baseline Period

On the second day of baseline testing, the cement facility's in-line raw mill was shut off for planned routine maintenance. During this period, measurements of typical raw-mill-off Hg concentrations were obtained through the SSBH. The results of this testing indicated an initial spike in the Hg concentration for a brief period of time followed by a period of Hg concentrations at a somewhat steady state condition. This level of Hg concentration slowly decreased throughout the testing period. The spike observed during this raw-mill-off condition reached Hg concentrations close to 5000 $\mu g/Nm^3$ for a short period of time before stabilizing to a concentration of approximately 2700 $\mu g/Nm^3$. The baseline Hg concentration at the inlet of the SSBH before the raw mill was shut off was 484 ± 95 $\mu g/Nm^3$, and the Hg concentration at the outlet of the SSBH before the raw mill was shut off was 505 ± 94 $\mu g/Nm^3$. The average raw-mill-off baseline Hg concentrations for the inlet and outlet of the SSBH were 2570 ± 260 $\mu g/Nm^3$ and 2980 ± 483 $\mu g/Nm^3$, respectively. This yields a 14.8% difference between the inlet and outlet MM. Again, based on the statistical analysis of the native capture results and the experience of the EERC, we assume that these are essentially the same, indicating a zero native capture.

During the raw-mill-off baseline testing, carbon traps were used and compared with the MM. Three carbon trap tests were performed: two at the inlet and one at the outlet of the baghouse. The results of carbon trap testing for the first set of traps indicate a percent difference of 12.4% between the carbon trap and MM data at the inlet of the SSBH and an 11.0% difference between carbon trap and MM data at the outlet of the SSBH. The difference between the inlet and outlet Hg concentrations measured by the MM at the SSBH during this set of traps indicated 34.8%, and because of this, a second carbon trap test was performed at the SSBH inlet. The results of this test yielded a percent difference of 17.9% from the SSBH inlet MM to the inlet carbon trap, these results can be seen in Table 3. During this second test, the SSBH inlet MM agreed with the outlet MM with a percent difference of 8.6%. These results can also be seen in Figure 5.

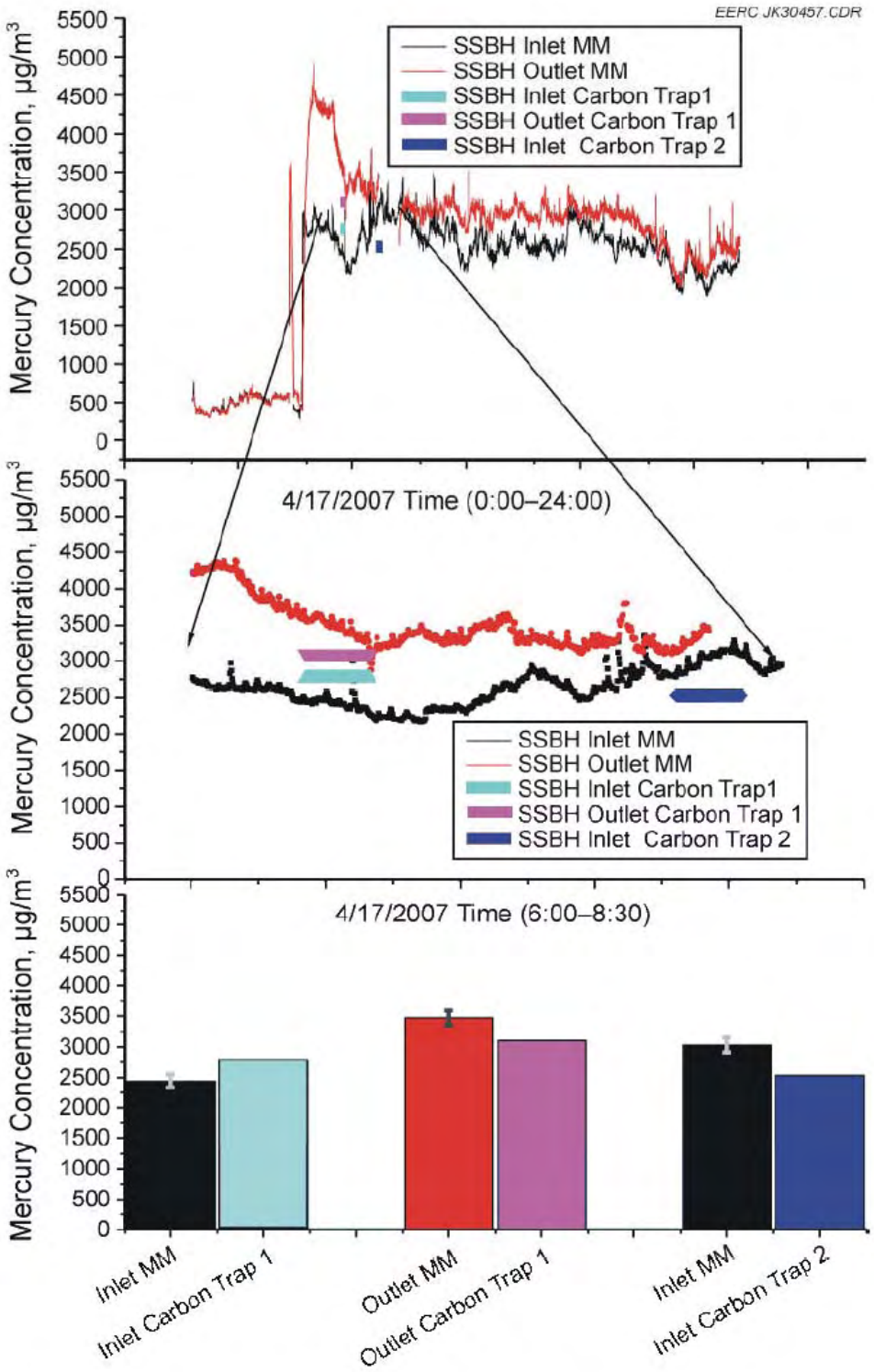

Figure 5. Raw-mill-off baseline results comparing the MM to the carbon trap results.

Table 3. Results of Carbon Trap Testing During Raw-Mill-Off Baseline Testing

Test Method	Inlet MM Hg Concentration	Test Method Hg Concentration	Inlet Difference	Outlet MM Hg Concentration	Test Method Hg Concentration	Outlet Difference	MM Difference
	μg/Nm^3		%	μg/Nm^3		%	%
Carbon Trap	2439	2762	12.4%	3468	3106	11.0%	34.8%
Carbon Trap	3031	2533	17.9%	3302	–	–	8.6%

5.3 Parametric Testing

Four parameters were tested during the pilot test: PAC type, PAC injection rate, bag type and A/C ratio. Each of these parameters were evaluated during periods where the raw mill was operating so as to maintain comparable results. This parametric testing resulted in recommendations for use in designing the full-scale Hg control system.

Parametric testing began on April 18, 2007, with the evaluation of PAC type. DARCO Hg was the first PAC to be tested. Because of the Hg concentrations observed in the system, three injection rates (1, 3, and 5 lb/Macf) were chosen for evaluation. Before carbon injection began, the Hg concentration at the inlet of the SSBH was 594 ± 70 μg/Nm^3, and the Hg concentration at the outlet of the SSBH was 629 ± 76 μg/Nm^3. The PAC injection began with a feed rate of 1 lb/Macf. When the feeder was turned on, the Hg concentration at the outlet of the SSBH trended downward quickly. After a couple of hours of injection, the outlet Hg concentration reached a steady state, or a period of time where the data appear to have leveled off during the injection testing, with an average calculated to be 136 ± 45 μg/Nm^3, a 73.4% reduction in Hg. This average is based on the data that correspond to the time when the system reached a steady state, as defined above, during injection. The percent removal is based on the calculated average Hg concentration from the inlet MM compared to the calculated average Hg concentration from the outlet MM during the steady state condition.

Results of this injection test can be seen in Figure 6. Several blanks in the data are observed during PAC injection and SSBH recovery. These blanks correspond to times when MM maintenance (e.g., filter changes) was occurring. When injection stopped, the SSBH was cleaned and allowed to return to baseline conditions before further testing was initiated. The SSBH

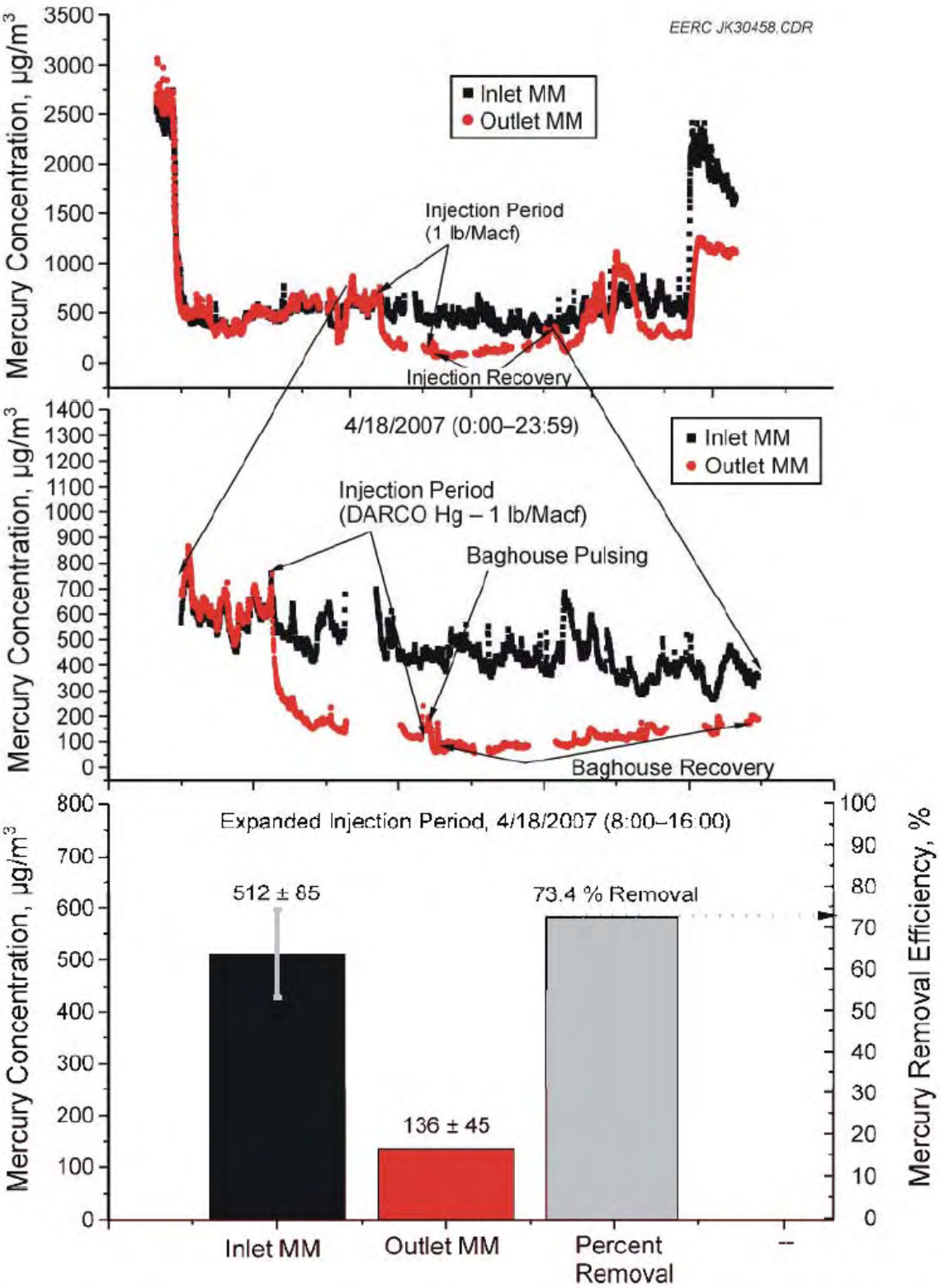

Figure 6. PAC injection results for the injection of DARCO Hg at 1 lb/Macf.

recovery took longer than expected based on what is typically seen in a coal-fired utility system. This was, in part, due to the relatively clean (particulate-free) gas stream seen in the cement facility versus a coal-fired power plant system. It was observed that after the SSBH went through a system-pulsing sequence for bag cleaning, the Hg concentration in the SSBH outlet gas dropped slightly. One possible reason this occurred is that the pulse air created a situation where mixing occurred in the system, exposing fresh carbon surface sites for the Hg to be adsorbed.

The additional two rates, 3 and 5 lb/Macf, for the DARCO Hg PAC were tested on the second day (April 19, 2007) of PAC injection testing. Results showed similar trends noted at an injection rate of 1 lb/Macf in that, upon the start of PAC injection, the Hg concentrations decreased steadily until a steady state was reached. When the PAC injection was increased from 3 to 5 lb/Macf, the Hg levels actually increased slightly, but during this period, so did the inlet Hg concentrations. As a method for comparison, a Hg removal efficiency is calculated based on the inlet and outlet Hg concentrations measured at the time of injection. For the two rates tested on this day, the Hg removal efficiencies were 92.4% and 91.9% for 3 and 5 lb/Macf, respectively. It appears that no additional benefit is gained by increasing the PAC injection above 3 lb/Macf. The results from testing the additional two rates for DARCO Hg can be seen in Figure 7.

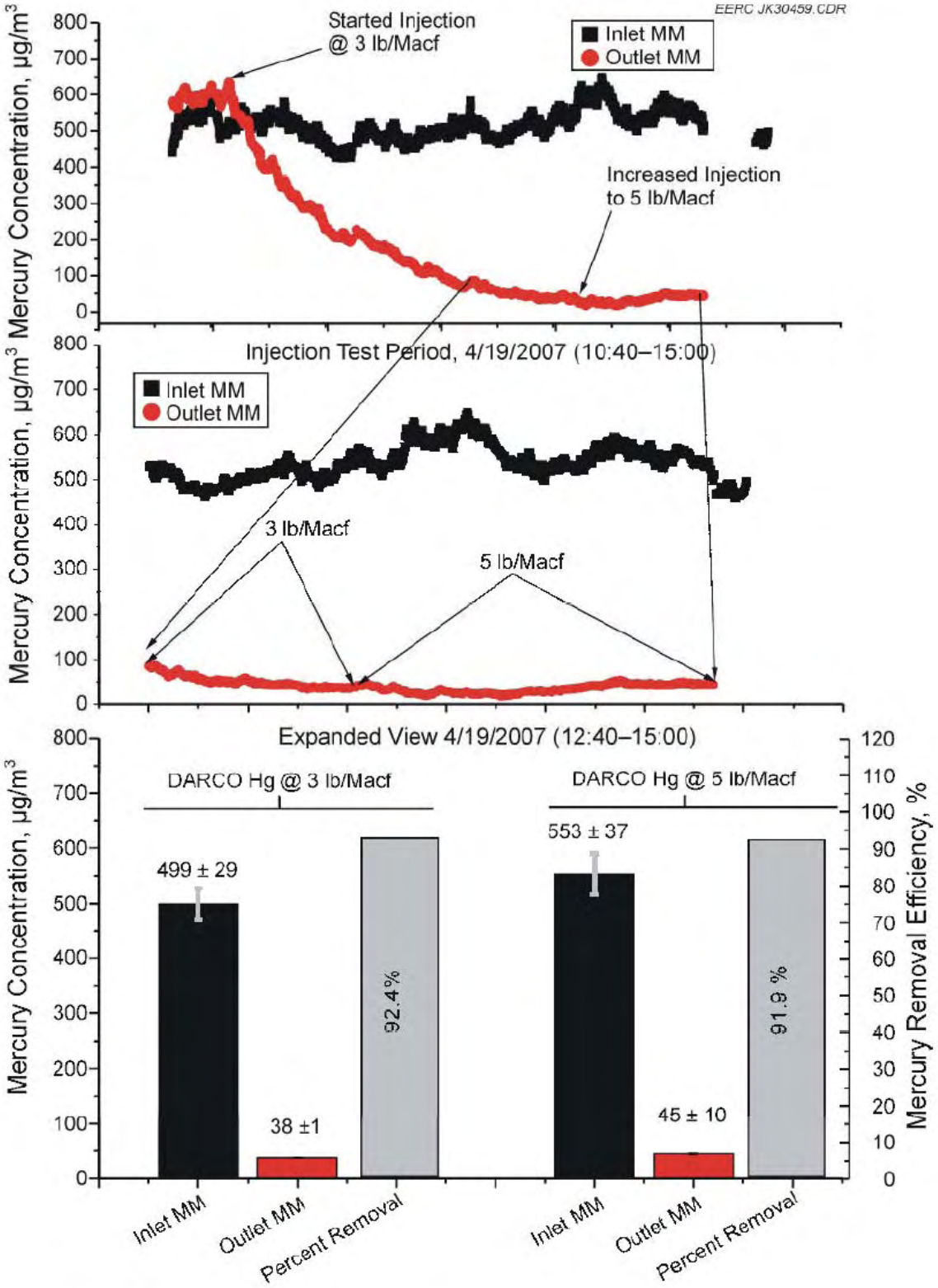

Figure 7. PAC injection results for DARCO Hg for the injection of 3 and 5 lb/Macf.

The remaining PAC injection testing occurred in the same manner as it did for the DARCO Hg injection testing. When testing for all PAC types and injection rates was complete, a Hg removal efficiency curve was generated in order to create a means of comparison among the other carbon types. The Hg removal efficiency curves for all PACs tested are compared in Figure 8. The results indicate that each carbon tested performs differently in the SSBH system, with the untreated carbons performing better than the treated carbons.

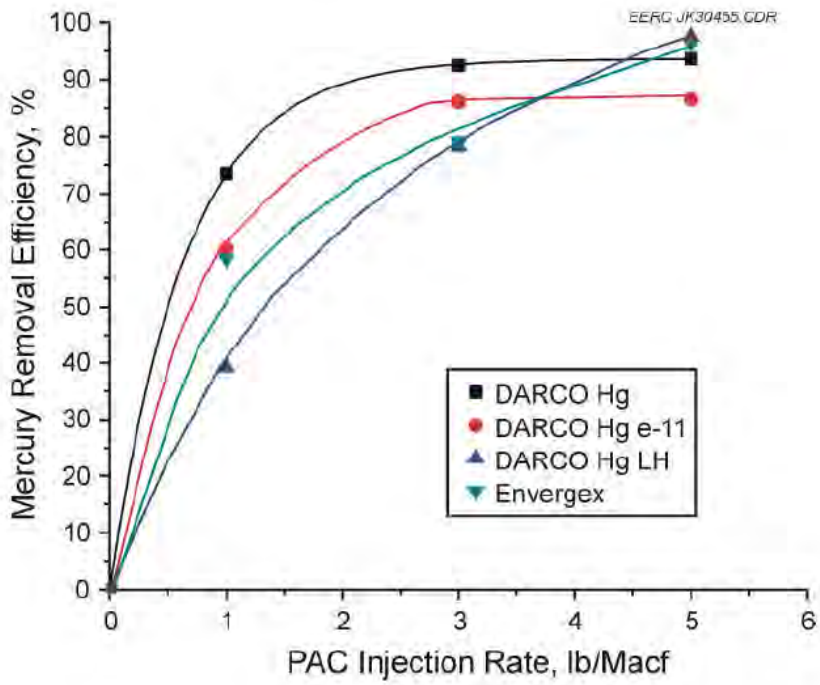

Figure 8. PAC parametric testing results performed at an A/C ratio of 4 with standard PPS bags.

One possible explanation for the untreated carbon (DARCO Hg) performing better at this site takes into consideration the carbon's adsorption capacity and system reaction time. Treated carbons (DARCO Hg LH and Envergex) have been shown to perform better than untreated carbons in coal-fired boilers, especially when reaction times are short (electrostatic precipitator [ESP] systems). Thus the halogens used to treat the carbon act like a catalyst, oxidizing the Hg in the system and allowing for faster adsorption onto the carbon. This is critical in systems with higher SO_x concentrations, because SO_x species have been shown to compete for active sites on the carbon surface; therefore, the halogens on the treated carbon allow the oxidized Hg to bind to the carbon surface before the SO_x species consume the active sites.

At the Durkee facility, in the SSBH, the SO_x concentrations are very low compared to a coal-fired utility system. The high calcium concentration in the cement manufacturing pyroprocess enables the removal of SO_x species from the gas phase by forming calcium sulfate. In cases such as this, the halogens may still increase reactivity, but one would expect a decrease in sorbent adsorption capacity as the halogens reduce the amount of active surface area available on the carbon surface. In addition, it is reasonable to assume that Hg^0 would be physisorbed on

the surface of the sorbent along with NO_2, which could facilitate oxidation of the Hg and subsequent chemisorption of the oxidized species and, therefore, removal in the baghouse. This is reflected in the trends shown in Figure 8.

At low injection rates, the untreated carbon performed better because of its additional sorbent capacity. At the higher rate of 5 lb/Macf, the treated carbons appear to perform as well as the untreated carbons, possibly because the large amount of carbon injected into the system provided for ample active surface area, allowing the halogens to improve reactivity without jeopardizing active sites. However, injection of the treated carbons at 5 lb/Macf does not result in a significant difference in Hg control efficiency as compared to untreated carbon injected at 3 lb/Macf. There is no reason to choose halogenated carbon over untreated carbon, particularly in light of potential concerns associated with the use and disposal of halogen-treated materials.

A small carbon particle size was initially thought to be a concern because of the possibility of bag blinding. It was thought that the fine particle size and small particle distribution may blind the bags, causing a high pressure drop in the system. Because of this, a fourth carbon, DARCO Hg e-11, was tested that had larger particles and a larger particle-size distribution. The injection of DARCO Hg e-11 yielded a trend similar to the finer DARCO Hg, but the Hg removal results were lower by 10%–15%. This was most likely caused by the larger particle sizes not having as much exposed active surface area as the finer carbon.

At the start of testing, a baseline A/C ratio of 4 was chosen because, at the time of the sorbent injection parametric testing, an optimal A/C ratio was unknown. Typically, in a coal-fired utility that has carbon injection into a baghouse, the A/C ratio is chosen to be anywhere between 4 and 8. Because of the fine-particle baghouse-blinding concern, a lower A/C ratio of 4 was chosen for the initial evaluation of sorbent effectiveness. Based on the evaluation of the results presented in Figure 8, the DARCO Hg carbon was chosen as the best-performing carbon tested which, in turn, was then used to evaluate the remaining parameters.

Once the PAC-type parametric testing was complete, bag type and A/C ratio parametric testing began. The tests were conducted in a similar manner as the PAC-type evaluation testing. The results from testing the three different bag types suggest that at PAC injection rates of 3 lb/Macf or higher the bag type does not play a role in Hg removal. Shown in Figure 9 is a comparison of the three bag types at an A/C ratio of 4. It can be seen that at 3 lb/Macf of PAC, all three bag types perform similarly with the largest percent difference being 10% when the PPS and membrane bags are compared. Based on the variability discussed previously between the inlet and the outlet MM measurements, it is likely that the bags are performing essentially the same at these conditions. A comparison showing the calculated percent differences of the three bag types can be seen in Table 4. Because of the nature of the process, operating temperatures in the bag filter area of the process can vary as much as 120°F and can exceed 400°F. Based on information provided by GE Energy, the membrane/fiberglass bags were the only bags tested that can withstand continuous operating temperatures above 400°F. This is a similar material to the bag material currently used in the facility's main APCD. Therefore, based on the results seen

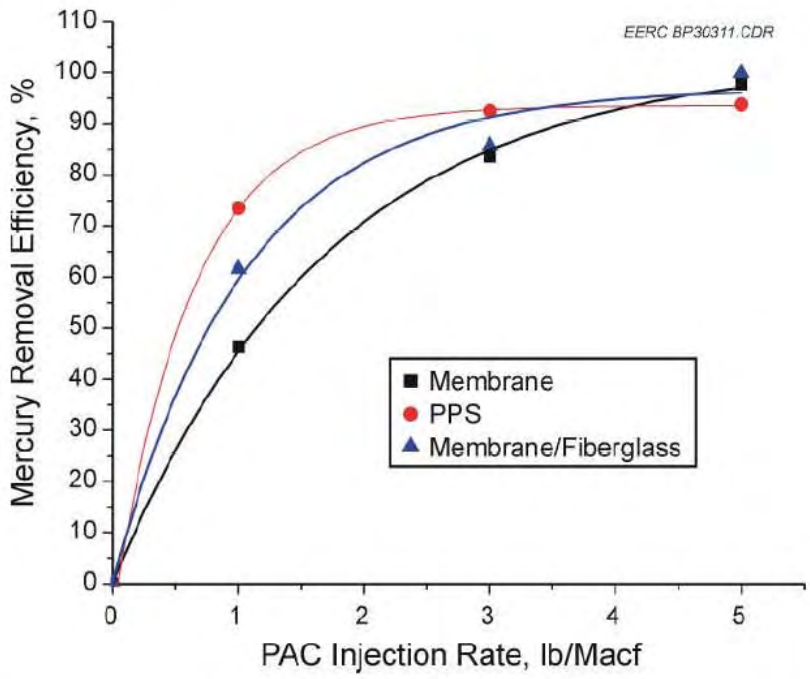

Figure 9. Bag type comparison showing their effectiveness with regard to Hg removal efficiencies.

in Table 4 and Figure 9, the membrane/fiberglass bags appear to be the preferred bag choice as they performed similarly to the other two bags and are the only bag type that is recommended for continuous operation when experiencing temperatures above 400°F.

Table 4. Comparison of Bag Type Results

	Mercury Removal Efficiency, %		
Bag Type	1 lb/Macf	3 lb/Macf	5 lb/Macf
PPS	73	93	92
Membrane	46	84	98
Percent Difference	**45%**	**10%**	**6%**
PPS	73	93	92
Membrane + Fiberglass	62	86	100
Percent Difference	**16%**	**8%**	**8%**
Membrane	46	84	98
Membrane + Fiberglass	62	86	100
Percent Difference	**30%**	**2%**	**2%**

In order to evaluate A/C ratios, DARCO Hg was injected at the same three PAC injection rates (1, 3, and 5 lb/Macf) and at four A/C ratios (4, 6, 8, and 10). The results for the

membrane/fiberglass bags indicated that at the lowest injection rate, 1 lb/Macf, the Hg removal efficiency increased with increasing A/C ratio. This could be caused by the greater flow rates causing more mixing in the system. These results can be seen in Figure 10. With this type of bag, it appears that A/C ratios above 6 have little effect on the Hg removal efficiency. Mercury

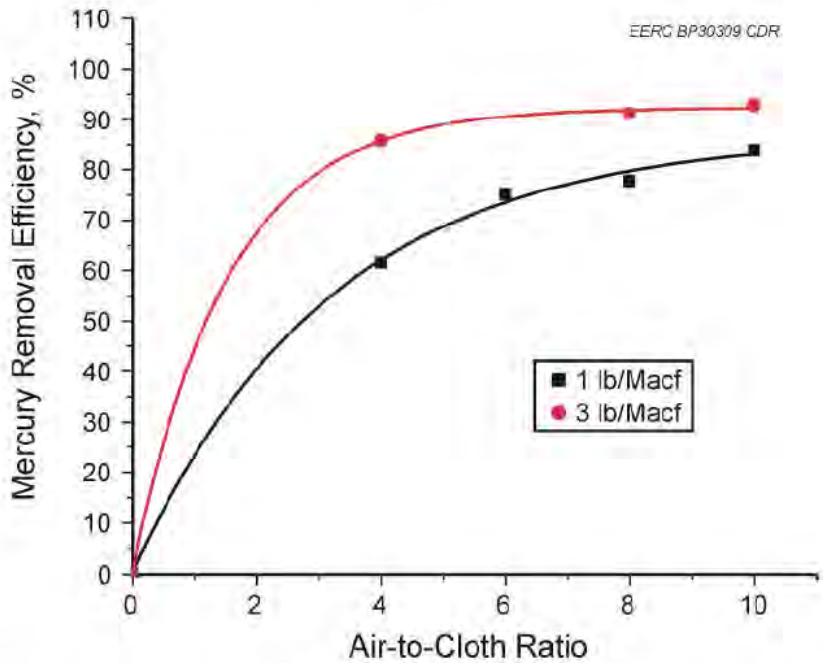

Figure 10. Membrane/fiberglass bags parametric testing results showing effects of varying A/C ratio. Tests at 5 lb/Macf were not performed.

removal efficiencies of approximately 90% were achieved at A/C ratios of 6, 8, and 10 with PAC injection rates of 3 and 5 lb/Macf. Figure 11 displays the results with respect to PAC injection rate versus Hg removal efficiency. The results indicate that injection rates higher than 3 lb/Macf give insignificant increases in Hg removal efficiencies at an A/C ratio of 6. Similarly, there is essentially no material difference in control efficiency achieved by increasing the PAC injection rate above 3 lb/Macf. Increased PAC injection rates raise concerns regarding greater solid waste generation rates, and so absent any material increase in control efficiency, there is no reason to operate at a higher PAC injection rate for a system designed for an A/C ratio of 6.

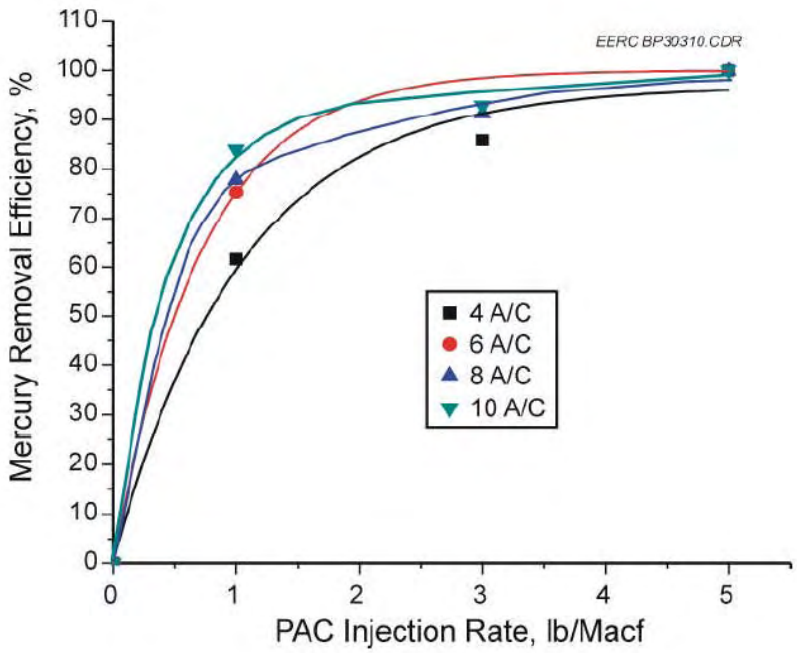

Figure 11. Membrane/fiberglass bag parametric testing results showing effects of varying PAC injection rate.

During the testing of the membrane/fiberglass bags the injection of DARCO Hg was evaluated during a raw-mill-off operating period. This test was performed in order to evaluate the achievable Hg removal efficiency during an operation period when the Hg concentrations were elevated, typical of raw-mill-off conditions. Four PAC injection rates were evaluated: 1, 3, 5, and 10 lb/Macf. The results indicated that only moderate Hg removals (approximately 52% and 58%, respectively) were achievable with injection rates of 3 and 5 lb/Macf. Because of this, the injection rate was increased to 10 lb/Macf to gain an understanding of the level of impact on Hg control efficiency. The results at the injection rate of 10 lb/Macf yielded a Hg removal efficiency of 88%. Results for this testing are summarized in Figure 12.

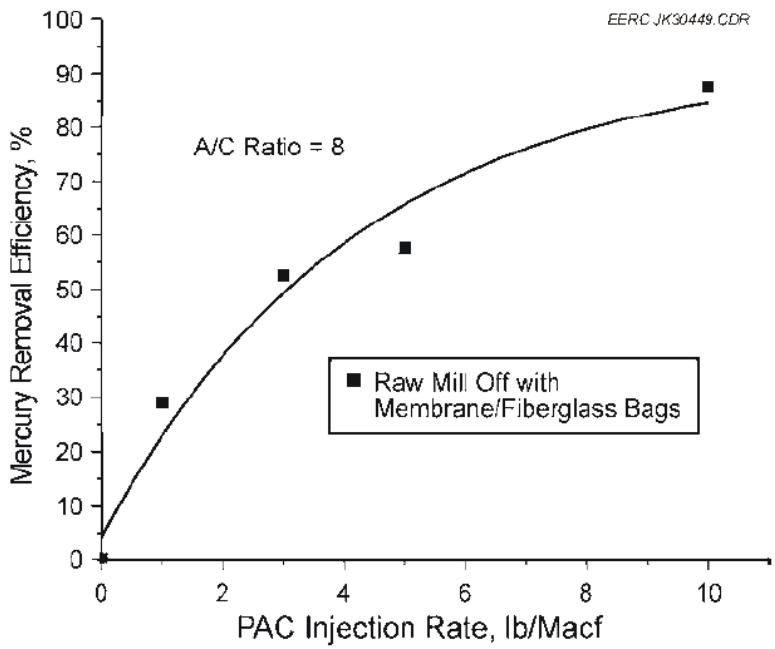

Figure 12. Raw-mill-off injection testing with membrane/fiberglass bags at an A/C ratio of 8.

Carbon injection at full scale prior to the main baghouse was conducted on three different days (April 26, May 3, and May 10) with the raw mill off, coinciding with planned routine maintenance. For purposes of this test the Darco Hg LH carbon was utilized. Injection rates were changed on each of the three days from 1, 3, and 5 lb/Macf. The effect of carbon injection was measured with the Tekran MM located at the main stack. The result of full-scale carbon injection is shown in Figure 13. A more significant reduction is seen with 5 versus 3 lb/Macf due to the high Hg emission levels during raw-mill-off conditions as compared to the raw-mill-on conditions during the other parametric testing. The difference is significant enough to suggest the higher injection rate during this condition. The level of Hg reduction measured was very similar with that of testing conducted on the SSBH during raw-mill-off conditions. Using the average value between the full-scale and SSBH injection tests at a rate of 5 lb/Macf yields an approximation of the Hg removal during raw mill off of 63%.

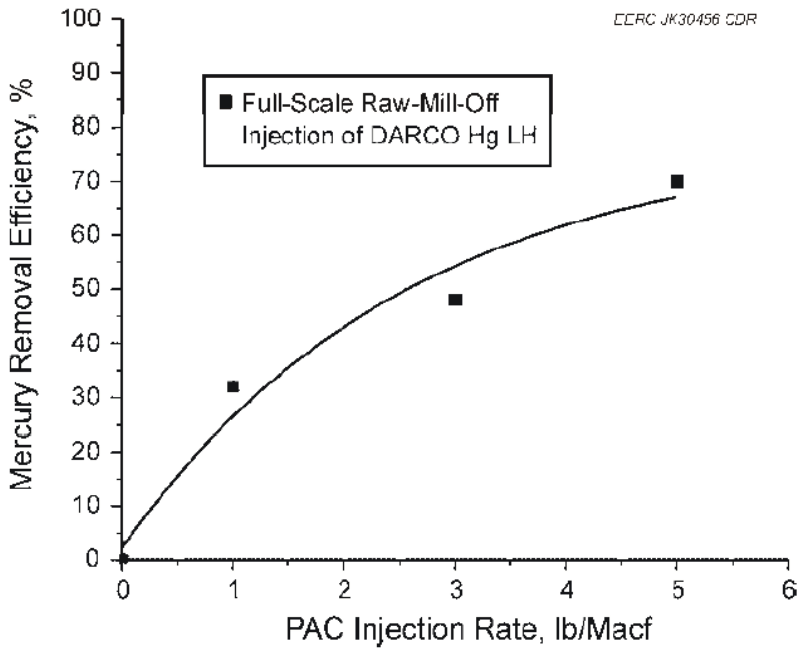

Figure 13. Full-scale carbon injection results.

Based on the parametric testing, the EERC recommends that a full-scale Hg control installation should be designed based on the following parameters:

Parameter	**Design Criteria**	**Comments**
PAC Type	Untreated carbon	Untreated PAC performs comparably to halogen-treated PAC, while avoiding potential environmental issues associated with use of halogens.
Bag Type	Fiberglass with membrane	All bags performed comparably, but fiberglass with membrane withstands higher temperatures.
A/C Ratio	6 to 8	Lower A/C ratios resulted in lower control efficiency. Increasing A/C ratio over this range results in higher energy consumption without increased control efficiency.

Injection Rate	3 lb/Macf (raw mill on) 5 lb/Macf (raw mill off)	Elevated PAC injection rate during raw-mill-off conditions may not be necessary after first hour.

Based on the pilot-scale testing, there is a reasonable likelihood that a full-scale installation designed using these parameters would be expected to perform as follows:

- Approximately 90% Hg control during raw-mill-on conditions (annual average).
- Approximately 60% Hg control during raw-mill-off conditions (annual average).
- A weighted average of approximately 77% control (annual average).

Calculations used to determine the above parameters can be found in Appendix H.

5.4 Stack Hg Measurement

A Tekran Model 3300 MM was installed in the main stack to measure Hg^0 and Hg_{total}. This was done with the intention of determining the potential for future use as a continuous monitoring device rather than determining the ability to certify the instrument for compliance purposes. The MM located in the stack began logging data on April 13, 2007. The instrument logged data 24 hours a day until May 13. One technician was dedicated to monitor the operation of the instrument each day. The typical day ran from 6:30 a.m. to the end of scheduled testing, which varied from 4:00 p.m. to 6:00 p.m. Each day the zero and span of the analyzer was checked along with the gas dilution factor. All connections, umbilical temperature, system pressure, and gas flow rate were also checked. Daily spikes to the analyzer and also the probe were conducted using a calibration source. The previous night's data were also reviewed daily for any indications of machine malfunction.

The mechanical operation of the analyzer allows for a single data point to be logged approximately every 2.5 minutes. The theoretical number of data points that could be logged in a day would be 576. While calibration, zero and span checks, and spiking are being performed, the measurement of the gas stream is interrupted; thus the theoretical maximum was never reached. On average, 505 ± 24 data points at one standard deviation were logged per day, which is 88% of theoretical maximum.

During April 15 through 17, a daily OH method test and a draft method carbon trap were conducted to verify that the MM was measuring Hg levels accurately. A graphical example of the correlation for April 15 is shown in Figure 14. Sampling occurred during raw-mill-on conditions. A numerical comparison for all 3 days is shown in Table 5. The correlation was

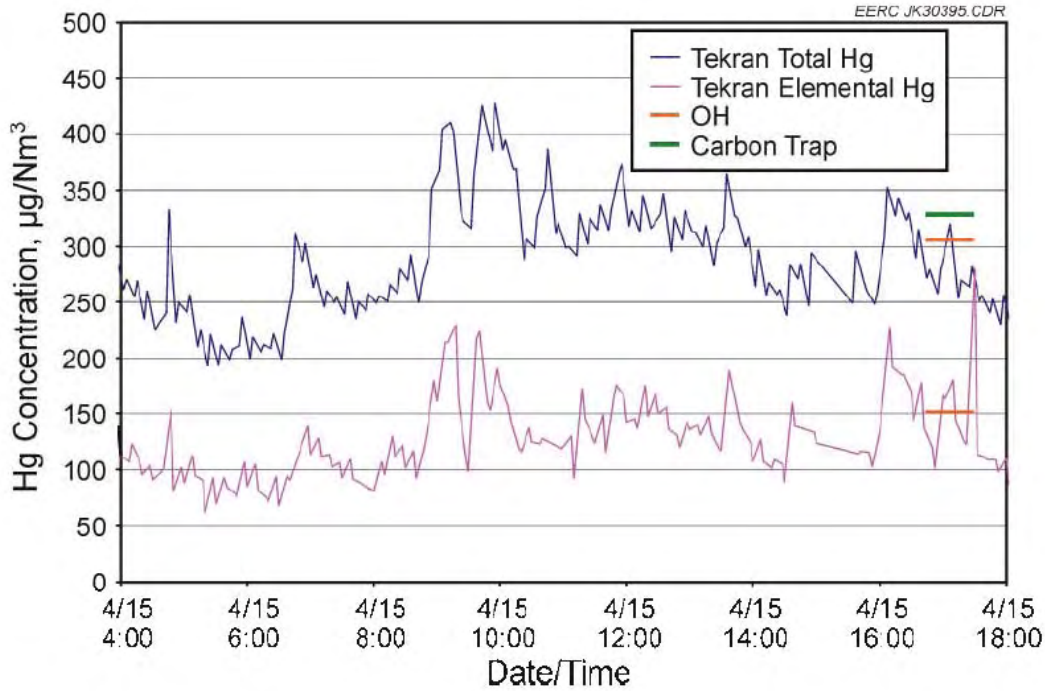

Figure 14. Graphical comparison of MM, carbon trap, and OH method for April 15, 2007.

Table 5. Comparison of Sampling Methods Showing Difference of MM with Carbon Trap and OH Method

Date	MM, µg/Nm^3	Carbon Trap, µg/Nm^3	MM to Carbon Trap Absolute Difference, %	OH Method, µg/m^3	MM to OH Method Absolute Difference, %	Trap to OH Method Absolute Difference, %
April 15	279	299	6.9	306	9.2	2.3
April 16	374	388	3.7	329	12.8	16.5
April 17	2046	2039	0.3	2460	18.4	18.7

sufficient enough to allow the use of modified carbon traps as a check for the stack Hg monitoring. The modified carbon trap results are shown in Table 6. Appendix E contains daily plots of the MM data.

Table 6. Stack Emission Carbon Trap Data

Sample Date	MM, µg/Nm^3	Carbon Trap, µg/Nm^3	Absolute Difference, %
4/15/07	279	299	6.9
4/16/07	374	388	3.7
4/17/07	2046	2039	0.3
4/19/07	527	514	2.5
4/20/07	443	375	16.6
4/22/07	371	381	2.7
4/23/07	363	364	0.3
4/24/07	480	528	9.5
4/25/07	435	446	2.5
4/26/07	1375	1607	15.6
4/27/07	227	205	10.2
4/28/07	411	344	17.7
4/29/07	345	395	13.5
4/30/07	459	416	9.8
5/1/07	691	626	9.9
5/1/07	611	533	13.6
5/2/07	527	505	4.3
5/3/07	2570	2458	4.5
5/4/07	373	403	7.7
5/4/07	393	380	3.4
5/5/07	227	253	10.8
5/5/07	332	371	11.1
5/6/07	277	304	9.3
5/11/2007	154	148	4.0
5/11/2007	124	112	10.2

Mercury concentration at the stack was observed to be variable on a daily, even an hourly, basis. Figure 15 shows graphs for the Hg_{total} and Hg^0 stack output for April 23 and May 1. The

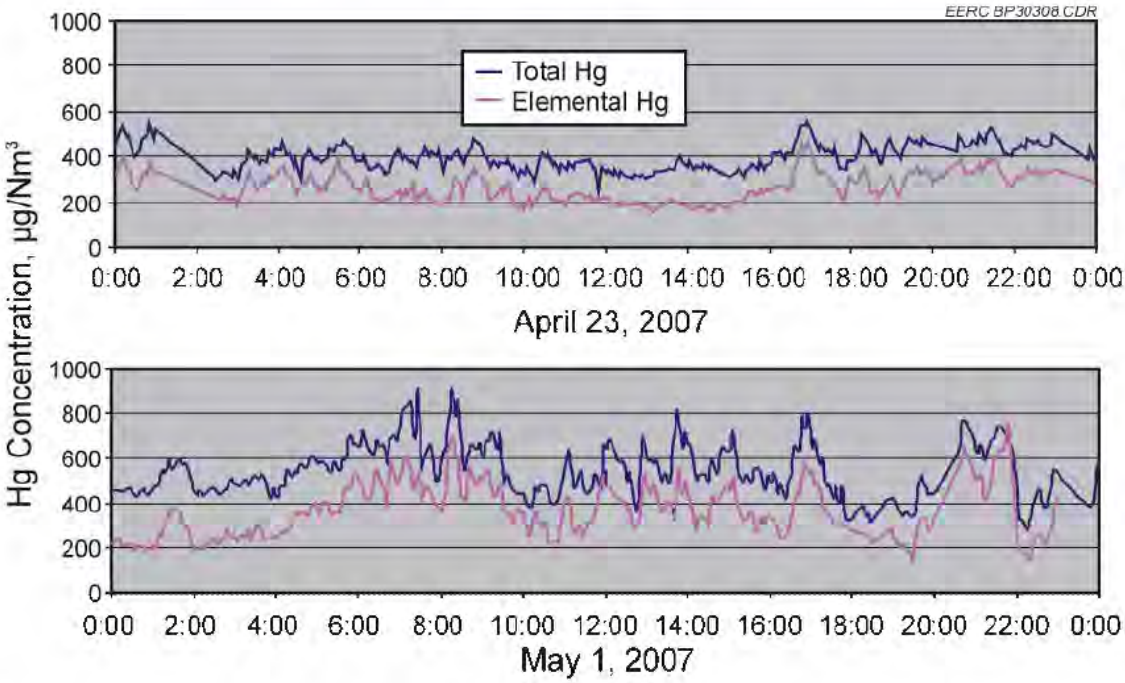

Figure 15. Comparison MM graphs for April 23 and May 1 showing the variability of Hg_{total} and Hg^0 output.

variability between these 2 days is high. Also of note is that the ratio of Hg^0 to Hg_{total} is highly variable as well. The analysis of process data collected on these 2 days shows the pyroprocess and raw grinding systems were operated under similar conditions. Table 7 illustrates the similarities. The data indicate kiln and raw mill feed rates and kiln fuel rates are similar. The daily average of critical temperatures in the system also shows that the temperature profile of the pyroprocess and raw milling system on each of the 2 days were similar. Stack conditions as well show that the gas flow, temperatures, and oxygen levels at that location were similar over the 2 days.

Table 7. Comparison of Process Data for April 23, 2007, and May 1, 2007

		April 23, 2007		May 1, 2007	
Description	Units	Average	Std. Dev.	Average	Std. Dev.
Kiln Feed Rate	Mtph	235	2.36	236	4.13
Stack Gas Flow Rate	Dry scfm	138,437	5812	144,595	7815
Stack O_2	%	6.5	0.72	6.6	0.70
Stack Temperature	°C	101	2.3	103	3.30
Main FF Inlet Temp.	°C	111	9.00	117	12.70
ILC Stage 1E Exit Temp.	°C	392	5.90	397	5.20
ILC Stage 1W Exit Temp.	°C	408	7.40	415	7.60
SLC Stage 1 Exit Temp.	°C	339	3.50	338	5.40
SLC Coal Feed	Mtph	6.3	0.18	6.2	0.32
Kiln Coal Feed	Mtph	7.2	0.32	7	0.28
TDF Feed	Lb/hr	2000	NA	2000	Na
Raw Mill Feed	Mtph	200	NA	201	Na
Raw Mill Exit Temp.	°C	97	0.92	97	1.30
Raw Mill Motor Power	kWh	1007	41.30	989	46.60

Figure 15 helps to explain the lack of comparability of previous OH method tests conducted for Ash Grove. It is clear to see that two sampling tests conducted on even the same day will most certainly not yield similar results. The variability of past OH method tests along with this day-to-day variability provides an approximation of the variability of the Hg in the limestone from the on-site mine and its impact on emissions.

To further illustrate the variability, Figure 16 charts the overall average stack Hg output alongside the daily averages of some selected days for the period when the raw mill was on. Error bars display one standard deviation of the average value. The average raw-mill-on value was 408 ± 118 μg/Nm^3 for Hg_{total} and 215 ± 113 μg/Nm^3 for Hg^0. During raw-mill-off periods measured during the testing period, the average value was 2254 ± 981 μg/Nm^3 for Hg_{total} and 305 ± 182 μg/Nm^3 for Hg^0. A weighted average combining the relative times of raw-mill-on with raw-mill-off periods yielded an average Hg_{total} output of 685 ± 408 μg/Nm^3 and an average Hg^0 output of 229 ± 127 μg/Nm^3. The error for the weighted averages is calculated using a pooled standard deviation based on the combined data sets of raw mill on and raw mill off. Graphs of daily average Hg concentration at the main stack can be found in Appendix F. A statistical discussion of the variability is given in Appendix G.

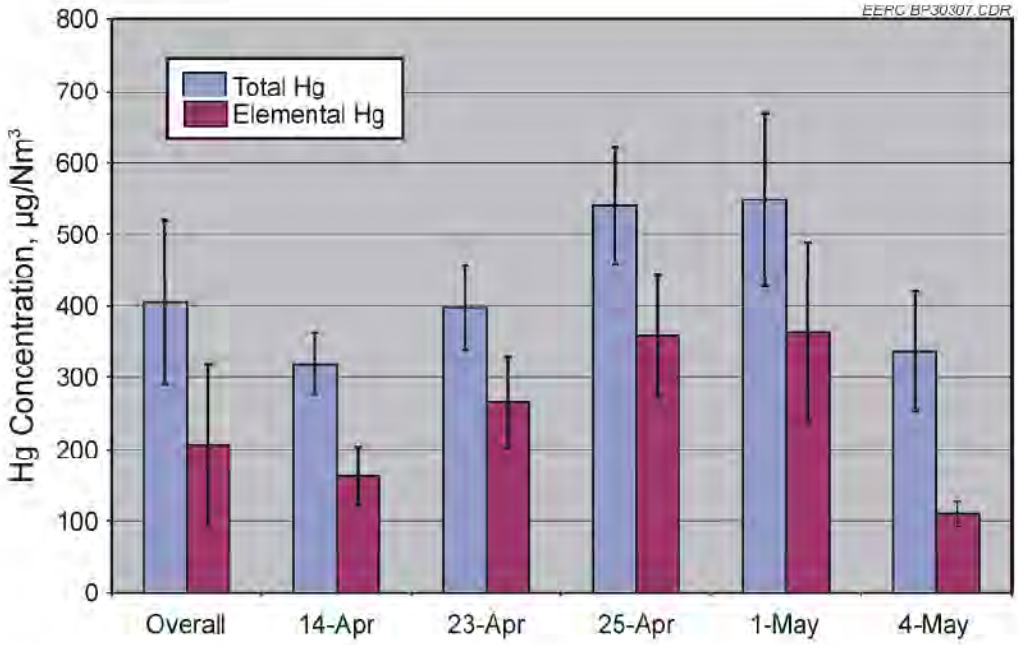

Figure 16. Average Hg concentration during raw-mill-on conditions over the entire test period compared to various specific days.

When the raw mill shuts off, the Hg emissions increase. Figure 17 shows the MM data during a typical raw-mill-off period. The increase is shown to affect the oxidized portion much more than the elemental portion. Oxidized Hg levels rose over 400%, whereas the elemental portion increased by roughly one-third. Reaction of the system to the mill outage was fairly quick, as the rise of Hg at the beginning of the outage and the reduction back to typical levels when the mill is turned back on occur within the span of approximately 30 minutes. The increase in emission during raw-mill-off conditions is discussed in detail in Section 2.3.

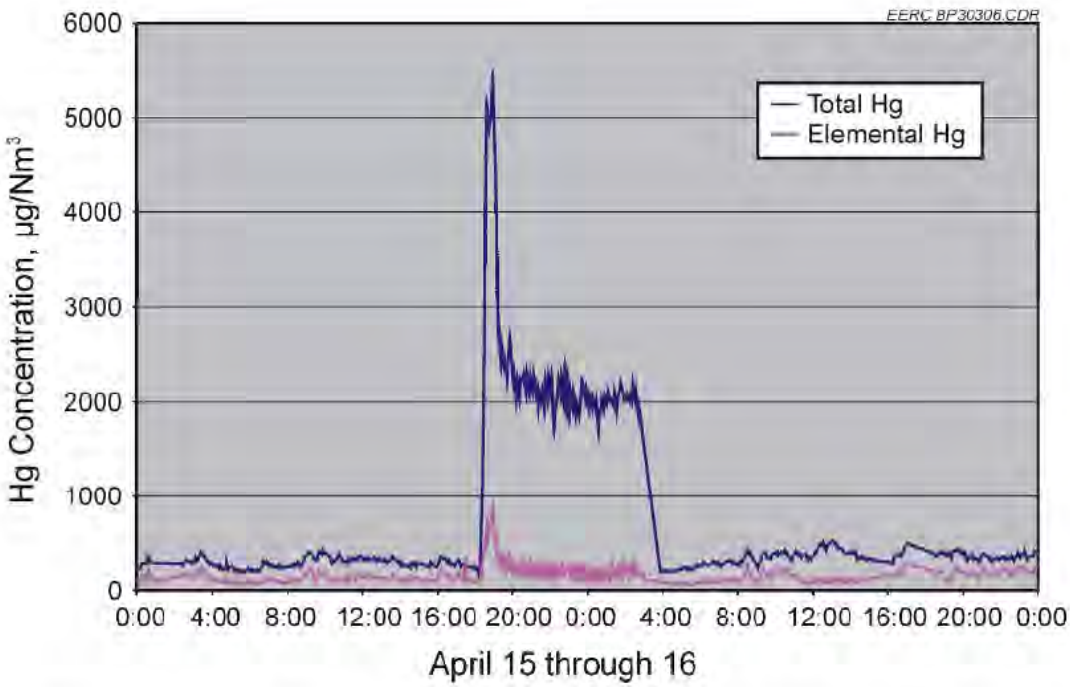

Figure 17. Stack MM data of raw-mill-outage overnight April 15 through 16.

5.5 Analytical Methods and Procedures – Their Applicability at the Durkee Facility

The temporary installation of the stack MM did not follow EPA Method PS-12a for several reasons. PS-12a is intended to assess the MM performance for minimum maintenance requirements for a permanent installation. This project was intended to attempt the measurement of the Hg levels at the Durkee facility under many conditions, with the expectation to evaluate the performance of sorbent additions and how they affect Hg reduction. To achieve this, the MM was scrutinized much more closely than would be desired or contemplated for routine measurement.

Further, the method requires the use of National Institute of Standards and Technology (NIST)-traceable standards for both Hg^0 and Hg^+. An elemental source was used for calibration purposes. Oxidized sources are a new commodity, and the EERC does not yet have access to them. None of these is NIST-traceable. NIST-traceable standards for Hg simply do not yet exist.

Parameters such as the maximum potential concentration and high span were not determined because of limited information about the nature of the Hg levels at this facility. Stratification was not checked but was deemed not necessary based on previous testing conducted at Durkee. Drift tests were not conducted because the systems were being evaluated daily by a technician.

It is important to mention that the operation of the MM during this project was not simply plugging in the instrument and turning it on. The Hg levels encountered at this facility were much higher than intended for routine MMs. The sampled gas stream had to be diluted before the

instrument conducted its measurements to prevent saturation of the detection cells. Also, factors such as the difference of the Hg output between raw mill off and raw mill on, temperature changes in the room in which the instrument was housed, and inherent instrument drift required that a dedicated technician carefully check the instrument daily.

The use of draft method carbon traps as a replacement for the modified OH method worked very well at this facility. Values obtained were comparable to the OH method and MM measurements. The benefits of this method are that the training and investment to use the needed equipment are small, and the method is easy to perform, making it inherently more reliable in a plant setting. Analyses of the samples can be completed in under an hour, so this method generates timely results. The exact length of time a trap can sample before being saturated has not been determined. However, carbon traps provide an excellent means of routinely checking Hg APCD performance.

5.6 Main Stack RATA Testing

The Tekran MM installed on the main stack did not pass a RATA. A summary of the results can be seen in Table 8. Only five of the 12 paired OH method samples were within the passing 20% difference limits. Three additional paired trains were conducted and passed within limits. Even with the additional three tests, the RATA failed, with only eight of the needed nine passing pairs. Agreement between the two OH method pairs was very good, but two of the pairs had to be thrown out because they differed by more than 10%.

Table 8. RATA Test Results

RATA Run No.	OH Method Probe Side, $\mu g/m^3$ A	OH Method Probe Side, $\mu g/m^3$ B	OH Method Relative Difference, %	OH Method Value, $\mu g/m^3$	MM Value, $\mu g/m^3$	OH Method-to-MM Difference, %	Pass/Fail
1	5220	5397	1.7	4438	3673	18.9	Pass
2	351	312	5.9	276	467	53.2	Fail
3	410	395	1.9	337	516	42.0	Fail
4	191	220	7.1	170	540	104.2	Fail
5	379	349	4.1	305	324	6.0	Pass
6	393	338	7.5	306	315	2.9	Pass
7	474	408	7.5	369	328	11.8	Pass
8	933	797	7.9	732	766	4.5	Pass
9	6624	6519	0.8	5573	3318	50.7	Fail
10	6499	9431	18.4	6762	3632	60.2	Fail
11	6416	6805	2.9	5652	3775	39.8	Fail
12	577	460	11.3	430	459	6.5	Fail
13	449	390	7.0	349	366	4.8	Pass
14	394	348	6.2	311	342	9.5	Pass
15	359	335	3.5	294	286	2.8	Pass

No approved method exists to perform a RATA for a MM operating at Hg levels above 150 $\mu g/m^3$. Concentrations during the testing were 2 to 45 times that level. When measuring at

these levels, both the MM analyzer and the reference method lab bench analyzer require that the sample undergo significant dilutions. This increases the opportunity for significant error. If a MM is ever intended to be permanently installed at the Durkee facility and be required to pass a RATA, then a procedure would need to be written.

5.7 Fixed-Bed Testing

The work at Durkee to evaluate the fixed-bed option for Hg control was not successful, as stated earlier in Section 4.8.

The EERC is, however, involved in ongoing research evaluating fixed beds for use in removing Hg for process gas streams. The results to date indicate that it is possible to capture a high level of Hg while maintaining a low differential pressure through the fixed bed, but several parameters are unknown and are site-specific. The main unknown at this time is the carbon life. Several gas components can potentially lead to decreased carbon life and are currently being evaluated. The technology itself has not gone through the rigorous testing that PAC injection into APCDs has. As a result, EERC cannot recommend the technology at this time.

6.0 CONCLUSIONS

6.1 SSBH Testing

The EERC performed extensive SSBH testing at Ash Grove's Durkee Plant from April 17, 2007, through May 8, 2007. The main focus of the SSBH testing was to evaluate whether the injection of PAC into a secondary baghouse is a viable option for Hg removal from the Durkee facility and what design parameters should be utilized in order to design a robust, high-performance control installation. Significant variability was identified in Hg mass and form at the SSBH inlet. Nonetheless, by comparing inlet Hg concentrations to outlet Hg concentrations, the EERC was able to identify clear design choices for a full-scale Hg control installation appropriate for the Durkee cement kiln.

The following parameters were tested during the pilot project: PAC type, FF bag type, A/C ratio, and PAC injection rate. Based on this testing, the EERC is able to make recommendations as to the predicted optimal design and operating parameters for the full-scale PAC injection installation.

<u>PAC Type</u>: Results indicated that for the variety of PACs tested (halogen-treated and untreated), the untreated carbon, DARCO Hg, performed as well or better than the halogen-treated carbons. Use of the untreated carbon avoids the potential for secondary environmental impacts associated with the use of halogenated products. Therefore, the untreated carbon, DARCO Hg, was chosen to evaluate the other parameters.

<u>Bag Type</u>: Of the three bags tested (PPS, membrane, and membrane/fiberglass), all three performed well. However, dust found downstream of the membrane bags indicated that a small amount of PAC was able to penetrate the bags. As this could lead to higher particulate loading in

the main stack exhaust gas, the membrane bags were dropped from consideration. The fiberglass with membrane bags are rated for a maximum continuous operating temperature of 500°F, while the PPS bags are only rated for a maximum continuous operating temperature of 375°F. Because of concerns over bag failure due to elevated temperatures as a result of process upsets, the fiberglass with membrane bags were identified as the best bags for use in a full-scale system.

A/C Ratio: Four A/C ratios were evaluated: 4, 6, 8, and 10. The one common trend existing between testing the A/C ratios with the three different bags was that when the A/C ratio was increased, the Hg removal efficiency also increased. However, the results indicated that an A/C ratio greater than between 6 and 8 did not provide a material additional benefit in terms of Hg removal efficiency. Performance was not significantly different between the 6 and 8 A/C ratios, and so the choice of A/C ratio within this range should be left to the FF baghouse manufacturer. In summary, the EERC recommends that the secondary baghouse serving the full-scale PAC injection installation be designed with an A/C ratio of between 6 and 8.

PAC Injection Rate: Three PAC injection rates were evaluated during raw-mill-on conditions: 1, 3, and 5 lb/Macf. The data showed that at an A/C ratio of between 6 and 8, there is not a significant additional Hg removal efficiency gained by increasing the injection rate above 3 lb/Macf during raw-mill-on conditions. Testing was performed during raw-mill-off conditions using four PAC injection rates: 1, 3, 5, and 10 lb/Macf. These tests showed that Hg control increased with increased PAC injection. The highest control efficiencies were reached during the time when 10 lb/Macf were injected. Based on the expense and system wear of injecting at a rate of 10 lb/Macf and the uncertainty whether a baghouse system would maintain the control levels seen in the short term injection test, an increased injection rate of 5 lb/Macf during raw-mill-off conditions is warranted. Therefore, we recommend that the full-scale installation be designed for a PAC injection rate of 3 lb/Macf during raw-mill-on conditions and 5 lb/Macf during raw-mill-off conditions. As testing suggested that the highest Hg emissions occur during approximately the first hour of a raw-mill-off period, the elevated PAC injection rate may not be necessary for the full duration of the raw-mill-off event.

Control Efficiency and Optimization Period: The results gathered from testing the SSBH are only an indication of the relative differences between the different parameters tested. While the data indicate that a 90% Hg control efficiency can be reached on a long-term average basis during raw-mill-on conditions, we caution Ash Grove against assuming that the SSBH results will match the performance on the full-scale unit, particularly in the first 12 to 18 months of operation. It is our expectation that a PAC injection unit designed and operated consistent with the parameter choices outlined above has a reasonable likelihood of reaching the 90% control level on an annual average basis during raw-mill-on conditions. Likewise, it is our expectation that that a PAC injection unit designed and operated consistent with the parameter choices outlined above has a reasonable likelihood of reaching a 77% Hg control level on an annual average and mass-weighted basis. However, the differences between what occurs when controlling 1% of the exhaust gas over short periods and controlling 100% of the exhaust over long periods could result in a lower control efficiency. In addition, our experience suggests that Ash Grove will require at least 12 and more likely 18 months to optimize a full-scale installation where, as here, the installation would be the first of its kind in the industry. At the end of that

period, Ash Grove should have adequate data to determine whether a 77% weighted control efficiency (annual average) is a realistic target.

6.2 Performance Monitoring

In order to demonstrate the performance of a PAC injection system, Ash Grove will need to implement some sort of periodic Hg-monitoring program. Such programs can rely upon continuous monitoring or periodic monitoring. Although two types of continuous MMs were used during this study, neither of these monitor types, nor any other that we are aware of, is robust enough to withstand a cement kiln stack environment nor analyzes Hg at the concentrations found in the Durkee exhaust gases. Each MM used in the pilot study required a dedicated technician. Such an allocation of resources is simply not realistic in an operating plant. In addition, there is no approved method for performing a RATA should a continuous MM be installed on the Durkee main stack. Therefore, at this time, we do not recommend the use of continuous MMs for monitoring the performance of the PAC injection installation.

The EERC recommends that carbon sorbent traps would be the best method to allow Ash Grove to monitor Hg emissions at the Durkee facility. Carbon sorbent traps present numerous advantages over MMs in the workplace, including their inherent reliability. Results from carbon sorbent traps compared favorably with results obtained from OH method testing and the MMs during the pilot study. The periodic testing of Hg emissions using carbon sorbent traps will enable Ash Grove to confirm the performance of the PAC injection installation while avoiding the significant issues currently posed by MMs.

6.3 Fixed-Bed Option

The work at Durkee to evaluate the fixed-bed option for Hg control was not successful because of problems with the test equipment. Although fixed-bed technologies appropriate for cement kiln exhaust gases may be developed in the future, the current lack of system performance data make it difficult at best to design a full-scale fixed-bed system for use at Durkee. Based on the research to date, the EERC cannot recommend the fixed-bed technology for application at the Durkee Plant.

Appendix F: Ash Grove Mercury Reductions Advisory Committee Meeting 1 Notes

Committee Members Present
Mark Reeve (Chair)
Carl Stiff
Chuck Hofmann
Bruce Hope
Fran Streitman
Dean Atkinson
Deanna Conners
John Cox
Joni Hammond
Brent Foster
Mark Riskedahl

Others in attendance (per sign-in attendance sheet):
Andy Ginsburg
Les Carlough
Uri Papish
Linda Hayes-Gorman
Patty Jacobs
Jerry Ebersole
Doug Welch
Margaret Oliphant
Thomas Wood

Notes: Mike Nelson, originally appointed to the committee, had to excuse himself from committee due to family obligations.

Andy Ginsburg kicked off the meeting, stating how appreciative he and the Department are of the committee dedicating time to the process and this issue.

Committee Charter
Mark Reeve reviewed the Charter with the group. He noted that 2 DEQ employees are on the committee as ex-officio members. They are here to represent the Department and interact with the committee.

Purpose of committee is to make recommendations to DEQ regarding the issue of mercury reduction at Ash Grove. The issues are listed on 2nd page. This is not an exclusive list – we will see if these are appropriate as we move on.

The report will be written by DEQ staff. Mark Reeve will edit and make sure the committee's views are represented. Report will be a summary of what was presented and discussed in committee meetings. The report will be not be definitive on conclusions because there will be a public process phase after the report is written. The Committee is not charged with the final decision. The final resolution will be between DEQ and Ash Grove.

We'll try to reach consensus. If we don't, we'll note that in the report and try to be faithful to the various opinions of the committee in the report.

This is a public process. Members of public may come and listen to the meeting, if they wish. We have set aside time for public comment (note: no members of public commented or attended the meeting).

Materials will be sent to members by our point person Linda from DEQ. A test report on the pilot project was just available this Monday and there was not enough time to read it. It can be read for next meeting. If there are additional materials DEQ will send them out before our next meeting.

There will be a summary of this meeting and the next. Committee members can comment on these and they will be publicly available. All materials here are public records; the communications we have in the advisory committee meetings are not confidential.

Mark stated his job is to keep the committee focused on moving forward and he has no stake either way in the outcome. He apologizes if he steps on toes in the interest of keeping the process moving forward. He is focused on working towards the end product, and in seeing that the committee process is an open and fair process.

Linda and Uri will handle media inquiries, and Mark Reeve will represent the group to the media. If members of the committee are contacted by media, please make clear that your comments are your own and are not made on behalf of the committee.

Mark stated that he has committed to go on the tour of Ash Grove and he believes it is really important for others to go where possible.

Speaker Les Carlough, DEQ

In rulemaking DEQ convenes an advisory committee, drafts rules, and uses a public notice and comment process to involve the public. The rules are adopted by the EQC and entered with secretary of state. Rules are "generally applicable" to anyone conducting that activity in the state. It could turn out in practice that only one facility is subject to a rule, but they are written for general applicability. To enforce the rules DEQ initiates a formal enforcement contested case process.

The other way is through an Order. DEQ drafts the Order and gives notice to specific persons to whom the order is directed. They can appeal by requesting a contested case hearing involving an administrative law judge who drafts a proposed final order for the EQC. If appealed that proposed order goes to EQC which may accept or amend the proposed order. However, DEQ can resolve contested cases in advance through pre-hearing settlements called Mutual Agreement and Orders (MAOs). The MAO typically includes a stipulation of facts between DEQ and the party, an agreement to the entry of a final order of the commission, a settling or withdraw of rights, and a final order with specific steps to comply. The MAO also includes stipulated penalties for violations of the order and a description of the abbreviated enforcement process.

We are proposing a bit of hybrid in this case – better qualities of the two processes to reach a MAO – we have an advisory committee, we will have public notice and comment, but we will be able to proceed quicker and more flexibly through a negotiated MAO.

Riskedahl: Does DEQ have any rules that apply to just one facility?

Oregon rules may in practice apply to a single facility, but they are written for general applicability. The MAO process does not commit obligations for any other facility, just the one identified in the MAO.

Hofmann: Is there background information of other mercury regulations?

Reeve: The committee's work is more specific to Ash Grove and not broad – it isn't charged with looking at mercury. This committee's work is looking at facilities. To work effectively it is important to understand background policy of mercury emissions.

Riskedahl: the company has agreed to set into this process. Is there a way that the agency can translate that into application to other facilities?

Ginsburg: after the order is issued, it will have a compliance schedule and at some point will be rolled into the permit. If another facility is constructed in the state in the future it will be subject to federal rules that apply to new mercury emission kilns. It may or may not be necessary to adopt a state rule. We may have a better rule and can adopt that at some point. What we have here is an existing facility and there are currently no federal requirements specific to mercury emissions for existing cement kilns.

Hofmann: are we leading the country in this effort? What are other states doing?

Ginsburg: other states are trying to get their programs going but it's across the board. He describes the 3 time look at federal law for existing plants and how it was appealed but they are still excluded from the new regulations for cement kilns.

Carlough: My point is that this process is a bit of an Order and rulemaking hybrid because it includes public notice. It's easier to amend an order than a rule. We'll get emission controls much faster that a protracted rule process. They give up appeal rights, it fits in this situation. This facility is interested in taking actions to control emissions. One of the things this order can do is move us to emission controls more quickly than a rulemaking.

Cox: Have we used this MAO system before for air emissions controls?

Carlough: yes we used this instrument in the 90's quite a bit. It's sometimes used for unilateral settlement cases.

Cox: Warns that a quick process can be flawed.

Carlough: you can create in an order a step-wise fashion to get to the ultimate goal. It's a bit more adaptive than a rule.

Speaker, Uri Papish, DEQ:

A basic presentation about Hg and its forms, sources, exposure pathways, and a little about health effects.

A number of different Oregon industrial sources with mercury emissions: Ash grove, steel mills, PGE, municipal waste combustors, and crematories are the main industrial sources.

Forest fires emit mercury too. When trees burn Hg is reemitted from previously deposited mercury.

When emissions come out of the plant they are in three different forms: elemental, particulate bound, reactive-gaseous (oxidized). Depending on the type of mercury, it will stay in atmosphere different lengths of time and travel different distances.

Elemental mercury is the simplest form it is persistent in atmosphere for 6 months to a year and travels thousands of miles. China's coal fire power plants mercury is deposited in Oregon. If you do not live by a mercury source, over 80% of elemental mercury that lands in your area comes from overseas sources because it can travel so far.

Particulate bound mercury, depending on particle size, will travel different distances and fall-out at different rates. It can stay in atmosphere 1-2 weeks.

Reactive gaseous mercury, the oxidized form of mercury, is very reactive and water soluble. It will get scrubbed out of the atmosphere and fall down with rain. It also falls out as dry deposition, and it can also combine with particulate. It is the shortest-lived form of mercury. Fall out is in less than a week's time and has the most local and regional effects.

These are inorganic forms of mercury and are deposited on the ground. Once deposited, if conditions are right, if the right kind of bacteria exists which is generally present in water bodies, microbes can convert the inorganic Hg to organic Hg, called methyl mercury, and it is the most toxic form of Hg.

Exposure Pathways.
Once Hg reaches ground level, it can be inhaled or accidentally ingested with contaminated soil particles, food, and fish. It accumulates in fish. Exposure to mercury can affect the general population and sensitive populations differently. General population may be able to consume a certain amount of mercury with no problems, but then sensitive populations may eat only a little and be affected. Tribal populations may eat higher quantities of fish and Hg accumulates.

Quite a few chemicals reactions occur in the atmosphere. Hg converts to different forms, falls out through dry or wet deposition. Inorganic form fallout can be consumed by animals and get into crops. Inorganic Hg is not as toxic as the organic form. You can eat a higher concentration without adverse health effects, but with fish it is methyl mercury and it bio accumulates.

Another way is through inhalation, enclosed indoors extremely toxic. Once mercury gets into your system – methyl mercury will cause birth defects; interfere with cognitive development, motor skills in newborns, in higher concentration will affect neurological and cardiovascular and immune and reproductive systems of adults.

Atkinson: These affects are listed as non-cancer endpoints.

Hope: methyl binds to proteins. Hg is treated as a non-cancer entity. It can be persistent and not cause cancer. Non-cancer affects are rapid and more devastating. Inorganic form has a shorter half life – accumulates rapidly at very high levels.

Conners: Will particulate mercury readily turn into the vapor form at typical outdoor temperatures? Hope: With warmer temperatures you will get more vapors.

Cox: Made an observation – all the science about Hg isn't known. We are still studying it and trying to learn.

Papish: Studies may or may not be valid about autism; still a lot of study needs to be done regarding significant health affects.

Slide: Bioaccumulation of mercury in the aquatic food chain.
Water: 10% of mercury in water is in methyl form.
Algae: 15% of mercury in algae is in methyl form
Zooplankton: 30% of mercury in zooplankton is in methyl form.
Fish: 95% of mercury in fish is in methyl form.
Generally predatory fish have higher Hg concentrations. They eat other fish. Shell fish eat algae – not as concentrated.

Foster: There are USGS studies on the health of fish – do we have studies on mercury effect on fish? There are reports of secondary effects on immune system of fish leading to lesions.

Hofmann: From a public health standpoint the target tissue is the nervous system. It's bad enough to cause neurological deficits in the tissue in the fetus. Understand, we don't know everything, but from a pubic health standpoint, neurological deficits are bad enough.

Papish: USGS did a study on mercury in Brownlee Reservoir. Ash Grove did study on human impacts. But keep in mind that this is a historic mining area. Lots of metals in the ground.

Hope: I have a CD with the USGS study on it if anyone would like a copy. The levels are higher than we would like to see in Brownlee. It is a difficult question – is the mercury due to Ash Grove or is it some other reason, like naturally occurring?

Foster: I have been asking DEQ to get mercury data. We don't have data only because DEQ doesn't ask for it. He has asked DEQ to get data for 10 years for the Willamette River.

Hope: Questions come well ahead of data.

Papish: The point of this slide is that very small concentrations in environment can become large concentration in a food source.

Papish then showed a Google Earth satellite image slide of a big area around the plant.

Foster: What about $45 hair sampling for mercury in the local area? If we are comfortable with the knowledge that there is no impact then maybe we could be less aggressive in controls.

Hope: DEQ typically doesn't sample hair – that's the public health division's area.

Hofmann: We do know there is not an epidemic of neurological disease in the area. Let's get mercury emissions reduced whether impact now or future.

Patty Jacobs, DEQ, Mercury Testing

Original Hg testing conducted in 2001. Ash Grove took it upon themselves to do separate testing in September and December 2006. This was quite extensive testing and it was voluntary. The December testing was observed by Mark Bailey (DEQ source test coordinator) and Patty.

Continuous Emissions Monitor (CEM) – tested in the pilot.

Quite a bit different Hg emissions when the raw mill was on vs. off. The raw mill is taken off once a week. When this occurs, the exhaust gas goes straight to bag house and out the stack. We see higher emissions.

Streitman: We shut raw mill off once a week (15% of time) for maintenance, but keep the kiln going. Why? It is not efficient or productive to shut kilns down during raw mill off. For every hour down, you have to preheat the kiln and you lose a lot of energy. It's best to keep the heat stable.

Welch: Once a week they shut the raw-mill down for about 8 hours and it is a complicated process. Most emissions occur during start up/shut down phases. The goal is to run the raw mill as much as we can. They run the raw mill about 85% of the time. You would probably increase emissions if you were shutting down more often.

Jacobs: she refers to reactive gaseous mercury as oxidized, same thing. If you can get Hg in oxidized form, it is easiest form of Hg to remove.

The 2 Hg emission sampling test methods used were "Appendix K Method" (particulate trap filter) and "Ontario Hydro Method". With Appendix K method, there is no differentiation between the elemental and oxidized forms of Hg. The Ontario Hydro Method can distinguish between oxidized and elemental forms. Those are the two test methods specific to mercury.

September 2006 test data:
When the raw mill was on we saw an even split (volume of mercury being emitted) between oxidized and elemental Hg. When the raw mill was off, we primarily saw oxidized and some elemental. They were close to even for an annualized amount. This calculation was done with 85 % of time when raw mill was on, 15% when raw mill off.

December 2006 test data:
The speciation when the raw mill was on was just about evenly split between the three forms of mercury and when the raw mill was off it was primarily oxidized Hg being emitted. The thing about source testing is that it is a "snap shot" in time (whatever you have at that moment coming out of the stack).

Combined testing: In the combined data the majority of Hg is still oxidized. This is all post-control testing.

Atkinson: Why is the % of Hg so different in September and December for oxidized Hg? 65 vs. 92.
Jacobs: Some variability has to do with variability of mercury in raw materials and in the system. Not sure why oxidized is different.

Conners: We do need to have a discussion on the variability.

Cox: What other things are generated on site?

Streitman: Most waste is shipped off site. Storm water collected on site.

Riskedahl: What other Hg emissions are there at the site? Are there fugitive emissions from the quarry?

Jacobs: We looked at that and determined that there are less than 1 lb/year Hg emissions from quarry. It's because it is not being heated. Otherwise, there is very little opportunity for mercury to escape elsewhere at the plant. Everything leading to the stack is pretty button-tight. There is just one stack.

Mercury sources at the plant: Mostly from the limestone, clay and shale. Most is from raw material, there is also a little Hg from Coal.

Riskedahl: Is there any combustion of Municipal Solid Waste?

Jacobs: There is no combusting of municipal waste.

Enormously high temperatures at a cement kiln will drive up releases of mercury.

Mercury Control Technologies:

- Flue gas desulphurization systems – it's about 230 degrees when raw mill runs, 300 some degrees when off.

- Conventional wet scrubbers Systems on power plants.

Streitman: There are 5 U.S. plants with wet scrubbers. Testing of wet scrubbers is in process (primarily for SO2 removal) results would be available at end of year. Hard to do at Durkee, no water source.

Stiff: Is mercury in all limestone?
Streitman: yes – even at non-detect levels, it is likely in all limestone. High variability.

Jacobs:

- Spray dryer and dry injection type absorption systems. Limited mercury testing suggests only 20% removal.

- Oxidation pretreatment systems, they have been looked at but only at lab-scale level. Not any where ready for consumption at plant scale.

- Avoidance techniques. Kiln cleaning primarily for ash reduction. Mostly used in Cement Kilns. Fuel modification or fuel switch. Tire Derived Fuel, natural gas firing. Raw material substitution.

- Adsorption processes.
  -Raw mill on
  -Cement kiln dust bleed
  -Activated Carbon Injection and dedicated fabric filter. Subject to testing.
  -Polvetic (Activated carbon/coke packed beds)

Of all the technologies out there, adsorption processes seem the most promising.

Ginsburg: Is oxidized Hg more readily adsorbed than elemental?

Streitman: carbon will not adsorb elemental.

Atkinson: how will you dispose of waste carbon/mercury?

Streitman: the waste will be characterized using TCLP (toxicity leaching characteristic procedure) and disposed of in an appropriate way – either subtitle D or haz waste landfill. So far, TCLP has had variable results.

Riskedahl: how much carbon will you use? Streitman: between 400-1000 tons per year of activated carbon.

Reeve: what other industry is using ACI? Is there a track record of this use. Is a carbon bed seen as an alternative?

Streitman: If using a carbon bed system, you need two beds – one gets full of mercury then you have to shut down to remove it. It's in a research stage there is not a lot of big facilities out there to use carbon beds.

Ginsburg: Is there is a different surface volume available with ACI vs. a packed bed?
Streitman: I don't really know.

Cox: This is a lot different scale. The configuration would have to be huge for this facility. Have all of the technology options for Ash Grove really been surveyed and reviewed nationally? Is this is what is available to them? Has that homework been done. This seems critical to our discussion. We have a list of technologies but do we know their success rates?

Riskedahl: Can we invite a person from EERC (Energy & Environmental Research Center) to the next meeting?

Streitman: EERC has long resume. They used to be part of Dept. of Energy. They do contract work for EPA and private companies. They have worked a lot with power plants. Mercury testing, mercury CEMs. They seemed to be the right people for this job. They could pull into facility and do the testing. They have the expertise and high quality people.

Hofmann: Do you anticipate using EERC as you go forward? Are they going to be around for implementation phase? Are there other technical providers to help implement the technology? Who is going to help you do this?

Streitman: We will continue to use EERC. They will help us with a monitoring plan. They are also looking at companies to help with the equipment.

Cox: EERC is recognized as the gurus of mercury removal.

Streitman: This would be the first carbon injection control system in the country on a cement kiln.

Lunch break. No public forum as no members of public were present

Plant Overview, Fran Streitman, Ash Grove

Ash Grove Company is the largest American owned cement company. Pioneers in limestone use in cement industry. 6th largest manufacturer of concrete in the country.

Durkee Plant overview:
Opened limestone quarry in 1953, constructed plant in 1977, in 1996, plant was expanded.

Chemistry of Cement: the chemistry complies with ASTM standards and is closely monitored. What is concrete? One shovel powder, two shovels of sand, three shovels of rock. With water, cement binds those together like glue.

Reeve: Are these ASTM standards for the % of materials in cement? Do you make only one product?

Streitman: We make 2 types of clinkers. Both sulfate resistant.

Reeve: Are you generally running at the same temperature, etc…

Streitman: our emissions are variable all the time. Doesn't see mercury emissions changing because they use same volume input.

Ginsburg: Why do plants use fly ash?

Streitman: It would be used as the clay and some of the shale component. If we use fly ash, we use less shale. But we don't use fly ash from coal plants at Durkee. Why choose not to use it? There are only a few coal fire plants around. Fly ash has mercury in it. They don't use fly ash at Ash Grove and our mercury is coming from naturally occurring raw materials. It doesn't make any difference in the emissions and we are not really in control of that because we need to use materials that are around the site.

Process: Shale and clay and limestone are quarried and crushed. We blast and haul it in 100 ton dump trucks. Blended and put in piles. Then put it into raw mill vertical, then goes into a silo, blends material for consistent chemistry. Material then goes into pre-heater tower then into kiln. Burn it, then cool the clinker and put it into a silo. Then put it in the raw mill, and then add gypsum and some other additives. Store and ship product.

In old days Kilns were 500 feet long then they learned how to make it more efficient. The old wet kilns used about twice as much energy than we use today. Fire in front end of kiln, 3500 degrees, all the chemicals combine. Raw material goes into top of pre-heater tower at 200 degrees, in less than 30 seconds its up to 2000 degrees. Second burning place is called a calciner. Changes calcium carbonate into calcium oxide.

Mercury cycle: fuel is mostly coal, little natural gas, little used oil. A little mercury comes from the fuel.

About 2 lbs of mercury per million pounds of clinker which is a very small amount. Hg is insoluble in clinker. When temperatures cool in raw mill, mercury will condense and be collected in the bag house. What isn't collected while its running goes out the stack.

Hg in Limestone Ore body. Shows mercury ranges vary from a low of 1 ppm up to a high 20 ppm. Of all samples it is an average of about 1 ppm.

Mercury emissions testing at Ash Grove – Durkee.

Testing done in the middle 1990's showed very low Hg emissions. In 2001, testing showed 62 micrograms when the raw mill was on, and 2000 when raw mill was off. In September 2006, they had 245 micrograms when mill was on and 2360 with the mill off. In December 2006, they had 440 micrograms when mill was on, and 2917 when off. Emissions were different in all three test periods.

Durkee Hg Mass Balance - about 2700 lbs. mass balance. Therefore, they believe emissions are about 2700 lbs. /yr.

They are trying to assess best way to address mercury emissions. Found EERC to help out. Looked at the various promising technologies. Wet controls were eliminated because no water on site. Dry controls were found to be the most advanced, in particular, ACI (activated carbon injection).

The pilot consisted of a truck-mounted bag house system. Lasted 6 weeks in April/May 2007. Included mercury monitors. This has been the most advanced testing on a cement kiln in US.

They used a slipstream bag house, 2000 cfm slip stream. ACI injected right before the bag house. Also brought in a full-sized carbon injection system. 3 times while mill was down they injected carbon into the bag house.

ACI Capture Mechanism. Carbon is the promoter for oxidization of elemental hg.

Parameters to test:

- Powdered Activated Carbon (PAC) type
- Bag Filter type – 3 kinds of bags tested
- Air to Cloth (A/C) ratio, amount of air that goes through square foot of cloth
- PAC injection rate.

PAC types of carbon assessed. Untreated, fine, coarse, halogenated treated. Initial tests. 1 lb. ACI – 74% efficiency mill on. Even when stopped injecting carbon, the system continued to capture mercury.

Darko 3 lb. injection – 92%, 85% - 92% with raw mill on. Inlet variability has to do with what the kiln system was emitting.

Untreated carbon got most levels of reduction. These numbers are almost the same.

Bag testing. Three types tested. Used A/C ratio of 4 Macf. Bags to use are the membrane plus fiber glass. They do seem to leak a wee bit.

Tested variety of A/C ratios: 4, 6, 8, 10 to 1 trials. EERC recommends an A/C ratio of 6-8.

PAC injection rates raw mill on and off.

Atkinson: Would there normally be a difference between the inlet and the carbon.

Streitman: This slide shows that there is not much difference. Adding 2 more pounds of carbon did not affect the control efficiency all that much.

Raw mill on ideal A/C ratio 6 and 3 lbs. PAC injection rate. Raw mill off injection rate from 1-10 lbs. EERC picked 8.

Hope: Wouldn't you get more than 80 % reduction most of the time when 10 lbs. PAC injection rate was used?

Streitman: The EERC was trying to figure out why the untreated carbon was equal or better than the treated carbon. Almost all the carbon injection work is done at power plants. Some have coal; some have halogens and have different characteristics. Coal is different. Part of it they think has to do with sulfur, it helps oxidize the mercury.

Main bag house PAC injection raw mill off. Injected PAC into main stack bag house on 3 separate days. Results similar to slip stream bag house. Average Hg control efficiency for raw mill off tests (5 lb/Macf) was 63% (58% ssbh and 68% main bag house).

Hofmann: Because emissions so much greater with raw mill off, and because you have to do maintenance, is having two raw mills is not practical? Fran - You emit Hg now or you eventually emit it later.

Conners: Can you be flexible in what you inject?

Streitman: this is what EERC recommends:

- Untreated carbon (Darko)
- Fiber glass bags
- a/c 6 to 8
- 3 lb raw mill on
- 5 lb raw mill off

Hope: Figure 12 – 5 lb versus 10 lb mercury. Is there some significant reason for not using 10 lbs.? Is it because there is more cost for carbon, is it a waste issue, doubling the amount of mass going into bag house? Destabilizing the system? Could that much material overwhelm the system?

Streitman: This is experimental and the next step is experimental too. EERC is taking best educated guess.

Atkinson: Maybe a 10 lb. surge up front and then scaling back would be more effective?

Streitman: It could be. Getting back to EERC's predictions:

- Predicted Control efficiency: annual average 77% removal
- Raw mill on 90%, Raw mill off 60%
- Removal of 2000 lbs. of hg reduction per year
- Full-scale installation may not match pilot scale results. Guessing 18 months optimization period.

Reeve: Can any other variables be tweaked? Is the amount of mercury carbon can absorb a function of mercury and length of time and completeness so that all that can be absorbed will be absorbed? Are there variables in the location where you inject carbon? Can they be tweaked to get greater efficiency for amount of carbon being used so that all the mercury that can be absorbed is absorbed?

Streitman: We would have to look at some models and do some engineering evaluations.

We try to get a uniform distribution in air stream before it gets to bag house. We consider length of time. Also, the cake build-up of carbon on bags. How often do you clean the bags? Still have to determine this. We may clean the bags one at a time and each bag would get cleaned every four to six hours.

Conners: Were the bag tests conducted at same time as other tests?

Streitman: No, each focus area was tested separately. There is a bed-effect of continuing to capture mercury. The bags eventually get so caked they don't work.

Measure/Monitoring methods used: 2 types of monitors out there: the Tekran and the Horiba. Used Ontario Hydro test method and carbon traps for testing.

Tekran Model 3300 – all the monitors on market do not work for them because their mercury levels are too high. They had a technician on the monitor all day for the pilot testing, but cannot afford to do this otherwise during normal operations. Did not pass RATA (relative accuracy testing audit). Passed 8 out of 15 runs, but you have to pass 9 out of 12. EERC does not recommend using a CEM for full scale implementation. It's because of the high mercury concentration.

Horiba Slip stream monitor: had a technical person there all the time. But they stopped making that monitor.

EERC is not recommending continuous emission monitors at this time. Carbon trap technology is more versatile and robust. Not as responsive as CEM, but it is reasonable and relatively accurate. You can use these carbon traps on a continuous basis.

Next steps for Ash Grove:

- MAO completed & signed by end of year (2007)
- Bid & contract equipment supply procedure through summer 2008
- Fabricate summer 2009
- Construct end 2009
- Tie – in kiln start early 2010

Recommending to Ash Grove Board of Directors to approve the installation & operation of system as recommended. Cost at least 15 million, 2-4 million to operate including carbon.

Target is 77% efficiency removal by end of 18 month period.
Operate PAC consistently whenever possible.
Minimize to not shut down and not have PAC system and raw mill down at same time.
Submit compliance status report to DEQ.

<u>Points of consideration:</u>
AG is proceeding voluntarily and expeditiously. Already spent over $1 million – they have made a big investment in this. A lot of focus from industry. This puts them at risk because of competition with other cement providers, China in particular. They are the only cement plant in Oregon. The control strategy is still highly experimental. Durkee facility is a critical component of Baker County's economy.

Stiff: If this is successful and cost possible, do we see this stretching across US as the standard?

Streitman: EPA plans to come out with standards for new or existing plants next summer. It depends on the plant – all emit various amounts.

Hofmann: This plant is the highest Hg producer in Oregon. Are you anticipating adding this technology to your other plants? Are there proprietary characteristics?

Streitman: We'll probably submit a patent application to protect the work. If there is a niche, they'd like to get it. They have a couple plants in the 2-300 lb range.

Atkinson: Does the ACI and bag house go between your process and stack, or will it be part of the process? Why not make it part of the cycle back through?

Streitman: We will take the outlet of the main bag house and dump that to the carbon bag house.

Riskedahl - Other than altruistic reasons, why go though this process? Are there any other economic incentives, like cap and trade, or the potential value of Hg?

Streitman: There is no cap and trade program. There is for power plants under the CAMR rule. But nothing for cement kilns.

Stiff: Is there any market for the mercury that you can take out?

Streitman: Doesn't think he can sell it. There is excess mercury being stored that cannot be sold. Also, looking at no exporting requirements by legislature. Best solution is stabilization in a MSW or HW landfill.

Hope: What about storing their waste on site and not transporting it?

Streitman: If it tests as non-hazardous wastes maybe, but he won't recommend a HW landfill on-site.

Riskedahl: What is range of forces driving this analysis? This is a serious endeavor.

Streitman: We are committed to control emissions, it's the highest force. Also, we know its better to work voluntarily with a group like this, and we don't want to get forced into something more expensive down the road. This is stuff has never done before. We are sticking our neck out. We want a fair and achievable target. We're willing to take a risk. Part of being a good company and to work with DEQ and the community is to help out. Management's goal is to control mercury emissions and keep going in a profitable business. This is AG's turn on the block to do something. Hope the economics work out and we are all happy.

Reeve: What recovery efficiency are the wet scrubbers getting?

Streitman: More mercury is coming out. Look at page 14 of the report. Other sources were showing oxidized mercury captured with raw mill down. But what do you do with the contaminated water when you are done?

Cox: The power industry has power institute, natural gas has American gas association, what does cement industry have for R & D?

Streitman: the Portland Cement Association. We do work together on a lot of these issues. But in the area of control technologies, we don't share that research burden. A lot of research is done on the product, but not on control technologies. Research lab is Chicago and Office in DC.

Hope: I put the report on the CD.

Tom Woods: What drives the reporting on mercury is the TRI reporting.

Streitman: His guess is that when EPA goes through this process, some people will be surprised. A lot of companies are using AP 42 emission factors. The bottom line is that some people will be surprised when they see the mercury in their limestone. Another surprise is on page 34 (chart). The chart shows variability over 5 days. Most people don't realize how variable limestone can be.

Discussion and Questions including issues not covered

Hofmann: Does the group think an EERC representative should come out and explain the study? Technical answers? Hope seconds.

Atkinson: It would be good to talk about elemental and oxidized controls. Are we going to ask about follow up of activated carbon disposal?

Reeve: it is the purview of the committee to make recommendations about what's in charter. It is open for discussion. If its an area we want to learn more about, then we can. Looking for more information from Ash Grove or EERC about disposal of activated carbon.

Streitman: TCLP – if its determined to be non-hazardous, they'll stabilize the carbon waste in MSW. If it is hazardous, they'll stabilize it and send to a hazardous waste landfill. He can come back with information. Somewhere 400- to 1000 tons of carbon will be used each year.

Ginsburg: If we are looking at two different control options it would be important. If we are really looking into just this one technology, the MAO could include a requirement for follow up studies in evaluating the waste issue.

Reeve: Wouldn't want to recommend something where we haven't explored safe disposal of activated carbon.

Cox: What's the driver here in the control technology – what's best available technology? Or is it the reduction ability of the mercury?

Reeve asked Papish: Do we want to get individual recommendations from each committee member on what control technology is appropriate?

Papish: We want to get the feedback on what is a prudent level to put in the MAO. Working with whatever numbers we can get.

Cox: The limits should be identified that we want to get to. We need the toxicologists to weigh in on this. What's impact of emissions here? Tribal impact on fish is more of an impact to Native Americans because of their consumption rate. We should be thinking about it. It impacts our community more than others. It is an important consideration.

Conners: I think this brings in one of our other charges, the monitoring. I know we don't have an answer on that right now, what sort of options are there for monitoring. Make recommendations on this. Did I hear you right in that EERC is in the process of developing monitoring plans for the next couple of months?

Streitman: Yes that is right. It is stack monitoring. One of the things that DEQ sketched out early on is the monitoring. Stack monitoring results will be available from EPA soon.

Hope: There has been a risk assessment by ash grove. What we don't have is empirical evidence to confirm the results of the risk assessment. We might want to think about ambient monitoring in addition to stack testing.

Reeve: What is an accurate measure for ambient monitoring? Are there other atmospheric monitoring methods?

Hope: We can look at soil layers. Look at fish. Looking at an ambient measurement that shows an impact over time. Soil test and fish tests are relatively cheap.

Papish: Originally, we were thinking about looking at ambient monitoring for mercury. If we found a problem, we would ask Ash Grove put on controls. The facility came forward and offered to put on the best controls possible, so we backed off.

Atkinson: He is optimistic. Thinks that 77% is a conservative number. Question is, how much removal is enough reduction?

Ginsburg: When you go from pilot scale to commercial scale a lot of things can change, for the better or worse. Look in terms of the process. Use the MAO for optimizing what happens in practice. There will be some time period for that, and a way to determine final % reduction. How to structure the MAO to end up with a limit they can achieve that is most protective we can get.

Hofmann: Available technology is the driver. Set what you hope for then adjust that tighter if the numbers look better than the pilot. From the ambient monitoring perspective, he's where Uri is at. At the end of the day, what will you do with the numbers of more ambient monitoring? He is struggling with that aspect. Hoping the numbers show a 77% overall reduction. He's looking for a continual improvement process. Set up for what you hope for and is reasonable with the science. As technology improves, then pursue the higher reduction goal.

Stiff: How far out will you have to go if you want to know if the fish in Brownlee are healthier than before? Natural arsenic, mercury, etc. from mines. Is reducing mercury from Ash Grove going to make it any healthier for the fish? Will we ever really see a difference? I know what the miners have spilled up above Sumpter.

Papish: There is a benefit to the health of the people if there is testing fish for mercury.

Conners: We do that (Public Health Division). That should continue.

Hope: Ambient air and background levels change a lot. Much more difficult thing to measure. Surface soils and fish give us a better measure of what is happening over time.

Reeve: We'll hear from EERC a little more about different mercury control equipment and get consensus to help present to committee next time.

So far, we've heard about the proposed technology that is available and most appropriate. There has been an evaluation of what is out there and nothing is viable. But we'd have better confidence about what is out there if we heard more evaluation of the other technologies.

Phase 2 of charter identifies a % reduction of mercury from exhaust gas. We heard some discussion about both total amount (lbs) or percentage amount reduction of mercury. There are no clear goal posts. No regulatory requirements for either of those, therefore, some judgment needs to be made in terms of what needs to be the goal, what is possible, doable, etc. lbs vs. %. We may not be in agreement on the reduction goal types. What do people expect? We should have some discussion of that. We may not be agreement, but committee needs to talk about it and weigh in on goals here.

Hofmann: So what does that goal post mean? What does that get us? That's another part of the discussion.

Papish: There area a couple of ways to do it. You could put in MAO the technology gets the best % reduction. If they can't reach that control level identified, then ratchet it down.

Atkinson: Is there room to come back and re-evaluate?

Reeve: Not sure much that the committee would add a lot to the discussion of equipment on the timeline but leave it in. We may need additional information.

Hofmann: Thought 2010 is an aggressive schedule.

Papish: We still want to hear committee input.

Reeve: I'm interested in this process for optimizing results - adaptive management. Committee should discuss and make recommendations on the adaptive management process in the order. We recognize this is a new thing with lots of uncertainties. To get the biggest bang for effort, there will need to be additional changes made as we go along. It might not be possible to find the optimal solution at first, we need mileposts, off-ramps, and changes. Lets think about these.

Hammond: The language would go something like: "By this date they should submit X" and set future dates that we can add and subtract from the MAO as it progresses.

Ginsburg: There will be a shakedown period. We'll have the added issue of scaling up to a size that is different than the pilot. The company may want to try different rates of carbon injection. We can build flexibility and milestones into the MAO.

<u>Ash Grove Tour</u>
Need at least 3 hours total for tour (from pick up to drop back off).

Group discussed touring plant morning of 15th then afternoon meeting in Baker City, possibly at Geiser Grand Hotel. Chuck was going to check with the hotel. This is a change from the original plan to meet in Pendleton and for there to be a tour of the plant on the 28th.

Appendix G: Ash Grove Mercury Reductions Advisory Committee Meeting 2 Agenda

Meeting #2 - October 15, 2007
Geiser Grand Hotel
1996 Main Street
Baker City, OR 97814
tel: 541-525-1889

DRAFT Agenda

Agenda Item	Time	Topic	Presenter
A	7:30	Meet in front of Geiser Grand for bus to Ash Grove	Ash Grove Hosts
B	8:00	Tour	All
C	10:00	Bus to Geiser Grand w/sack lunch provided by Ash Grove	All
D	10:30	Arrive back to hotel, break, meeting set-up, check out from hotel	All
E	11:00	Agenda review; corrections to 9/20/07 meeting summary	Mark Reeve, Chair
F	11:15	Presentation: Comparison of Mercury Control technologies for cement kilns	Mike Jones, EERC
G	11:45	Presentation: Emission Reduction Goal Options/scenarios	Uri Papish, DEQ
H	11:55	Discussion & Recommendation: Emission Reduction Goal	All
I	12:55	Break	All
J	1:10	Public Forum	Open to Public
K	1:30	Presentation: Monitoring, Reporting, Record Keeping (typical conditions)	Doug Welch, Permit Writer DEQ
L	1:40	Discussion & Recommendation: Monitoring, Reporting, Recordkeeping	All
M	2:10	Discussion & Recommendation: Implementation Schedule	All
N	2:45	next steps	Mark Reeve, Chair
	3:00	Adjourn	

Appendix H: Ash Grove Mercury Reductions Advisory Committee Meeting 2 Notes

Committee members Present:
Mark Reeve (Chair)
Carl Stiff
Chuck Hofmann
Bruce Hope
Fran Streitman
Dean Atkinson
Deanna Conners
John Cox
Joni Hammond
Mark Riskedahl

DEQ Staff & Others in attendance:
Mike Jones
Uri Papish
Linda Hayes-Gorman
Jerry Ebersole (via telephone)
Doug Welch
Thomas Wood
Mike Hrizuk
Terry Kirby
Norma Job
Pat Nair
Madonna Narvaez

The Committee met at 7:30 AM at the Geiser Grand Hotel and took a bus to the Ash Grove Facility for a tour of the quarry and plant. The facility was not operating. Bagged lunches were provided and the group bussed back to the hotel for the meeting.

The Meeting started at roughly 11:15 AM.

Reeve: Thank you to Fran & Terry and the Ash Grove group for tour. It was helpful to get an idea of the layout and a feel for how things run first hand. Another thank you to the committee members for making the trip and the extra effort to make it to Baker City and for losing part of their weekend to travel.

The agenda is ambitious. I'd like to finish the main work of committee today, but no running rough-shod over any of the issues. I'd like to reach consensus, but if we don't, there is an opportunity to layout this in the report. Intent is to assist DEQ and Ash Grove in this MAO process. This is preceding a public comment process and before any final actions take place.

Presentation from Mike Jones from EERC (Energy & Environment Research Center)
"Mercury control Demonstration Activities at the Durkee Cement Kiln"
(Credits on title slide: Michael Jones, John Kay, Brandon Pavlish and Dennis Laudal)

EERC is affiliated with the University of North Dakota. It is strictly a research and development group. EERC was de-federalized in 1983 and now there are over 300 employees.

Presentation focuses on Mercury Monitoring Options & Mercury Control Options
Mercury is the current metal of interest. Most mercury research dedicated to coal-fired energy plants because there is the immediate issue of them having to deal with meeting new standards (clean air mercury rule – CAMR). EERC's been to 50 different coal plants across continent.

Mercury Monitoring Options. 3 options to consider:

1. Classic stack testing with wet chemistry for Hg analysis (a snap-shot in time). Ontario Hydro method.
2. Installation of continuous mercury monitors (CMM).
3. Sample continuously using sorbent traps following EPA's Appendix K procedures (used for determining compliance with CAMR)

1. Stack testing: not accepted under CAMR except for low-Hg emitters (under 25 lbs. year) and to conduct relative accuracy test audits (RATA).

- Expensive and time consuming.
- Long lead time to get results.
- No real-time data.

2. Continuous Mercury Monitoring.

- Offers real time data.
- Excellent R & D tool.
- Many utilities still consider them to be in the development stage.
- Requires substantial maintenance.
- National institute of standards and technology (NIST)-traceable Hg standards are not yet available as required under CAMR.

3. Sorbent traps

- The EPA has approved Appendix K methodologies for compliance purposes under CAMR.
- Based on recommendations from Frontier Geosciences, 7-day sampling period is appropriate.
- Evaluate Hg spike recoveries to verify performance.
- Simple, robust and trustworthy.

EERC Recommendation to Ash Grove for Monitoring

- Use sorbent traps with 7-day exposure
- Analysis to be done by Ash Grove's personnel
- Periodic quality assurance/quality control to be done by third party to verify validity.

Reeve: Question: Anything that is a 7-day test means that you would necessarily be operating at times during both the raw mill on and off periods. Does this mean that you won't be able to track the affect of different carbon feed rates or other tweaks to the system?

Jones: Feels Appendix k would do a good job overall running for this period of time. It won't give an instant number, but it will give total emissions over a period of time. That's the trade-off.

Riskedahl: What's the status in Europe of continuous mercury monitoring?

Jones: They are behind the US significantly. We are the largest marketplace. We have 1150 power plants that need monitoring now. We are starting to hear more about mercury emissions in the E.U.

Conners: Why do we see so much variability of mercury emissions over time?

Jones: Each monitoring method has its own strengths and is best used for different conditions. You'll see different results. Ontario Hydro has many steps, you can get good results provided the group performing the measurement is skilled we caution that there are groups doing the procedure that may not have the experience necessary to provide "good" data. This is the state of the technology right now.

Mercury Control Options

- Sorbent injection
- Sorbent enhancement additives (SEAs)
- Fixed Bed
- Oxidized agents
- Wet scrubbers

Sorbent injection: Carbon is the most widely used and commercially successful sorbent on the market today. Mercury sorbs onto the surface. 3 forms of mercury. Oxidized form is easier to work with in terms of takeout. We are looking for things to take out mercury but also for something that will deal with all forms of mercury.

Sorbent Enhancement Additives: trying to change the chemistry of the sorbent material to be more efficient. More able to facilitate sorption of mercury. Also looking at non-carbon sorbents. Haven't seen very high levels of control out of this. Not aware of any commercial facilities using non-carbon sorbent for control.

Fixed bed: granular bed of material where gas is drawn through system made up of a bed of the sorbent material. Used in a number of systems in Europe and in US at smaller scale facilities.

Oxidized agents: try to force mercury from the elemental to the oxidized state; you'll have a greater chance to remove mercury if it is in the oxidized form.

Wet scrubber: Oxidized mercury is water soluble; this is another chance to remove mercury from the system.

Mercury control option selection criteria:

- commercially available
- proven track record in industrial applications 24/7/365
- robust
- reasonable expectation of no "unintended consequences"
- potential to control high levels of Hg emissions

Sorbent Injection

- Carbon injection
- Non-carbon sorbents (not being used commercially today)
- Use of enhancing agents (SEAs)

Fixed Beds

- Limited commercial applications, mainly in Europe with incineration systems
- Has not been used for Hg control for large systems
- Requires two full-sized beds
- No data generated with bench-scale system.
- Unable to assess applicability to Durkee.

Oxidizing Agents

- Oxidizes Hg^0 to Hg^{+2}
- Can act on many other elements
- Halides are effective but can have other consequences in the system. Fairly corrosive – can lead to bag failure.

Wet Scrubbers

- Oxidized Hg is water soluble.
- Up to ~90% of oxidized Hg can be removed.
- Only removes oxidized Hg
- Re-emission has been noted (with elemental Hg leaving at higher levels than its level at the inlet to the scrubber, its an observation, not sure why its happening).
- Not enough water on site.

EERC Recommendation for Control Options:

- Carbon injection with a dedicated bag house
- Optimize injection starting with a rate of 3 lb. /Macf.

This was a 6-week short test. We don't know how much we can put in the system long-term, but when you have a bag house, you have a fixed-bed of sorts. Bag tends to even-out with carbon cake on the bag acting as a fixed bed.

Hope: I remember reading that you achieved a 90% recovery rate with a 10 lb. feed rate, if those bag houses became carbon-coated would you have failure?

Jones: We never saw a break through of mercury where the carbon on the bag becomes saturated with Hg. As we build up a better cake, you would clean the bag, thus taking out carbon and replacing it with fresh material. We are looking for trend lines. I suggest running 3 weeks at a time before you increase the carbon to next rate.

Conners: Are you going to test the optimal change out time for the bags?

Jones: We hope the bags are there for years. We'd set out the various parameters: A/C ratio, cleaning cycles as cake builds up, carbon rate, etc. It's a matter of balancing these things. The pilot system is great because it helps us understand how a variable affects what we are trying to do but it isn't the final solution and doesn't give us good information on bag life.

Hofmann: I'm confused about changing bag time versus conditioning bag time. There is a cleaning time too?

Jones: I apologize. I assume everyone has seen one of these systems. Think of it as a vacuum bag. If it gets too full you cannot run it. In this situation, they run the bag. Then they send a back-pulse of high pressure air, snaps the bag out to clean it, material falls out into a hopper, and you take it away.

Hofmann: When you pulse the bag, does that not affect the condition?

Jones: Good question. Generally, when you start out with a new bag, once a bag has been in there for a while, they tend to come back to a baseline. I call that conditioned.

Cox: I'm surprised that fixed beds are not used more. Can you say some more about that?

Jones: Main issue is that it does not make as efficient use of the carbon, due to the large granular materials. A bag house is like a fixed bed, with smaller materials. We are getting some of the advantage of a bed with bag houses. It's our bias, that's what we have worked with. Also, we couldn't get a back-up guarantee from any manufacturer with fixed beds, but we can with bag houses. That is a critical thing, to have a manufacturer stand behind the product.

Cox: Between the two technologies, which is more expensive – fixed bed or bag house?

Jones: Not sure, there are a lot of variables, a whole series of issues to evaluate. We couldn't get past the first two – you need a lot of space and there is a lot of waste to be disposed. Not saying fixed beds won't work, I just do not have the data to make recommendations today, and am not willing to guess that.

Atkinson: Seems to me that there will be a period of about a year to 18 months where there will be testing and tweaking. Strongly suggests during this time using a continuous mercury monitor. You would get a lot more information during this period.

Jones: That certainly is a consideration. There is a significant challenge to keeping CMM online. You'd have to have someone dedicated to working on it all the time. They are not that reliable yet.

Riskedahl: How many power plants are using CMM?

Jones: Permanently installed? Not sure. Everyone is trying to make the 2009 deadline. Of the 50 plants I've visited only 2 or 3 have them installed.

Stiff: Are these power plants installing the activated carbon injection bag houses?

Jones: Yes, most are using 1 lb. Macf. Most are using carbon, not all though. Some have scrubbers. Some scrubbers back east are being upgraded. It is really plant-specific.

Cox: Is there a shortage of activated carbon?

Jones: Chinese are really stepping it up and providing a supply. There is quite a demand for carbon. Maybe you've heard that there are a number of pyrolysis facilities starting up and they

may provide a new source of carbon in the country. Standard carbon today is called “Darco,” Provided by the NORIT company. There are more groups looking at developing/building activated carbon plants right now.

Cox: Do you feel if you keep increasing ACI and adjusting air to cloth ratio, that you can get just about any level of mercury recovery?

Jones: The graphs show there is clearly a leveling off and diminishing return. Maybe you can get another percent increase but that would come at quite a cost.

Cox: Can we re-engineer the raw-mill on raw-mill off ratio?

Streitman: We try to run the raw mill as much as we can. Usually, the raw mill is off about 15% of time because of maintenance. Fact of the matter is, whether that raw mill runs 100% of the time or not, the mercury that is in the system is going to come out of the stack. If raw mill ran all the time, the mercury still comes out. It is the annual emissions that are critical to the impact in the environment.

Reeve: Aren’t you less efficient from your emissions reductions when the raw mill is off? Hypothetically, if the raw mill is off half the time your total annual emissions would be much higher because you’d have less emissions control in those circumstances.

Streitman: It may turn out that way, but there is now way we can run 100% of the time.

Jones: You cannot deviate it too much.

Streitman: We try to run it as much as we can. If we don’t shut the raw mill down for maintenance, it could break and then we’d have the kiln down as well.

Reeve: It also seems that in your report you are recommending a higher carbon feed rate as a way to mitigate essentially the rise in mercury when raw mill off?

Jones: What I was trying to say with that is that those recommendations are based on what we are seeing in the pilot. We need to look at this long-term. The system needs to be flexible. But the simpler you make it, the more robust it is, it will keep it running, as opposed to being all over the place. This mitigates spikes, etc.

Streitman: And they had recommended jump from 3 to 5 as soon as the raw mill goes down. So in the transition time when injecting the carbon to when it gets deposited on the bag you have more carbon in the air as well as in the bag.

Atkinson: (could not hear question completely) Can adding more carbon when raw mill is down get more mercury recovery?

Jones: Trying to optimize the system based on what we see.

Wood: Depending on how much carbon you are injecting. Start adding too much carbon and you will have to shut down and this could actually hurt you then by having to pulse.

Jones: Pressure drops will affect bags, more stress to the bags. Be careful, the last thing we want is to have catastrophic failure of bag.

Conners: Do you have plans to monitor for bag house leaks? I'm aware that there are fluorescent dyes for doing this.

Streitman: We do have bag house leak detectors on each compartment. So that if one compartment decides to leak a little we can find it. Second thing we have is the opacity monitor on the stack. Opacity by itself will not tell you exactly what you want to know, but as part of that machine, it measures optical density, and you can use optical density to see a leak. I'm pretty sure when we are done with the carbon bag house that we'll have leak detectors, plus we are putting in some PM detectors to meet the hazardous waste combustor MACT at some other locations (plants). We'll learn about that and be able to better use the opacity monitor to let us know if there is an increase in emissions.

Stiff: Are these systems built so you don't have to shut down the bag system when you clean, so that you can just switch bags?

Jones: It depends upon the vendor and the design used. I've seen both types of operations – shut down (go offline) & switch out. We are looking at membrane bag which has a lot of advantages.

Cox: How much particulate matter comes out of the stack in the normal course of operation?

Streitman: We have a very efficient dust collector and I think the maximum we emit out of there is in the range of 0.008 per dry standard cubic foot.

Cox: Is that PM that goes out the stack analyzed for Hg?

Streitman: Yes, in the one report we did analyze the particulate bound mercury coming out the stack.

Cox: What did you find?

Streitman: I don't recall. Out of the total mercury emissions its pretty small, less than 10 or 5%. It's not a significant part of the mercury emissions.

Conners: How similar was the temperature in the bag house during the pilot test to how it will be when up and running?

Jones: We tried to mimic the same temperatures in the test bag house as in the full scale system. We looked at key issues, such as cooling and condensation. We added heaters on the sides of the bag house to maintain temperatures. Its part of what we had to do to simulate conditions in a full-scale system.

Reeve: A question came up in the first meeting that we'd like some information about the lifecycle of mercury. Essentially, you are capturing it with carbon and the carbon has to be changed out. What is your experience in working with power plants, does a lot of the carbon end up being hazardous waste? What is the TCLP showing?

Jones: One site (using a technology called Toxicon) used an e.s.p (electro static precipitator), and their ash does pass TCLP. It depends on the system and type of ash. We've done a comprehensive study through D.O.E. They've looked at the various waste streams depending on how they treat mercury. Generally speaking, not a problem, but need to look at each case to make sure it is stabilized. Mercury is chemically bound on the surface of the carbon. Depending on the environmental conditions, the mercury can come off the carbon. We have not done definitive studies. That wasn't the main focus of what we've done.

Streitman: We will have a little bit different experience, when we put the full scale system in because the carbon is going to be in the system a little longer – we are going to have to take a look at it. If it passes TCLP, it will be sent to a subtitle D landfill. If it fails and is hazardous, we'll stabilize it and send it to a subtitle C landfill. I don't think we really won't know what we have until we test it.

Hofmann: This question has bothered me since our last meeting. When raw mill is off, emissions go up so dramatically (oxidized form), it seems that if you scrub the stack when the raw mill was off, you could end up being about the same as ACI all the time. Am I missing something?

Jones: You would have a chance to take out a significant portion. Not aware of anyone able to do that.

Cox: What is the coal power industry doing for regulations, what percent?

Jones: Their regs are phased in over a period of about 10 years. Starting in at about 60% moving into 85%.

Wood: Point of clarification. There is no federal limit for power plants for mercury. There is a level of allocation that you get. It's a total cap & trade program. There is no requirement under federal program for any particular plant to meet any level of control.

Papish: We have a state rule that has a specific limitation.

Reeve: Good introduction to Uri's presentation.

Papish Presentation: Mercury Emissions & Control Levels
I'm going to talk about what control levels are required for different mercury sources in Oregon and what regulations are out there. We went to 2002 data for estimates for mercury emissions.

Oregon's Large industrial mercury emitters

Source	Source Type	Estimated 2002 Hg Emissions (lbs) Pre-control	Post-Control
Ash Grove	Cement Plant	2,510	? (?%)
Covanta	Municipal Waste Incinerator	564	32 (94%)
PGE Boardman	Coal-Fired Power Plant	217	22 (90%)
Cascade Steel	Steel Mill (Using Vehicle Scrap)	144	72 (50%)
Oregon Steel	Steel Mill (Not Using Vehicle Scrap)	81	81 (0%)

We say what level of control and the source can decide how to get there.
Covanta is achieving 94% but law says 85%
Boardman – 1 year extension if cannot reach 90% by 2012.
Cascade Steel will have to reduce mercury based on the NESHAP because they are using vehicle scrap.
Virtually all sources are using the carbon injection system.

Large industrial sources, their regulation, and type of control:

Source	Regulation	Required	Date	Control Type
Ash Grove	MAO	?	?	Fabric Filter & Carbon Injection?
Covanta	Federal Emission Guidelines (OAR 340-230-0310)	85%	Current	Fabric Filter & Carbon Injection
PGE Boardman	Oregon Utility Mercury Rule (OAR 340-228-0671)	90%	2012-2013	Fabric Filter & Carbon Injection
Cascade Steel	National Emission Standards for HAPs (40 CFR Part 63 Subpart YYYYY)	50%	2008	Fabric Filter & Hg Switch Removal
Oregon Steel	National Emission Standards for HAPs (40 CFR Part 63 Subpart YYYYY)	0%	N/A	Fabric Filter

Papish: There are a couple ways we can set up a regulatory standard for an emission. One way to do it, if you have control efficiency, like with PGE they have a 90% control rate, they have to measure the mercury content of the coal coming in and then the amount of mercury going out of the plant to calculate that 90% removal. The other way to do it is a production-based limit. In this case they monitor the amount of production they have which is clinker (at the power plant it was the amount of energy) and that way there's less testing of what's coming into the plant and they

are focusing on the emissions coming out. For the control efficiency rate we would do take the *average* mercury concentration of the materials going in and then figure out what that 90% would be. We would set a production-based limit for the amount of mercury coming out per ton of clinker production.

Hofmann: Does DEQ have thoughts on which form is preferable? Are there advantages or disadvantages to either?

Papish: Less burdensome on the plant to do a production-based measure. For PGE-Boardman we had both, we had a 90% control and a production based limit so the company could select either.

<u>Emission Limit for Ash Grove</u>
Form of emission limit:

- Control efficiency (i.e., _% hg control) and/or
- Production-based limit (i.e., _ lbs per ton of clinker production)

Setting emission limit:

- Set a less aggressive limit that is clearly achievable, or
- Set an aggressive limit that is potentially achievable, adjust if not achievable (PGE example). Have a mechanism to adjust if not achievable.

<u>Example from the Boardman Plant Emission Limit:</u>
Goal was set high: 90% or 0.6 lbs., Hg per TBtu.
Adjusts down if 90% or 0.6/TBtu not achievable:

- <u>Temporary alternative emission limit (TAEL)</u>
  - If controls fail to achieve 90% or 0.60, PGE must:
    - Notify DEQ within 30 days
    - File for a permit modification to establish a TAEL
    - Include a control strategy to achieve at least 90% or 0.60 TBtu
    - Requires public notice

- <u>Permanent alternative emission limit (PAEL)</u>
  - If controls fail to achieve at least 90% or 0.6 TBtu, despite properly implementing the control strategy in TAEL, PGE must file for a permit mod to establish a PAEL that comes as near as technically possible to achieve 90% or 0.6 TBtu.
  - Requires public notice.

Reeve: I think there is a gray area between tweaking and areas of modification. Has to be some judgment in this area as to putting some parameters on expenditures, etc….

Papish: It's a little gray, that's why they have a Control Strategy Report in the language. We would approve it.

Stiff: Considering these are experimental methods that we will be using, wherein do we consider the total cost of doing this? It could literally bring it to the point that it is not productive to run the plant.

Papish: That language was not put into the rule for PGE.

Wood: I would point out that PGE is a utility, a monopoly, not a private holder. If Ash Grove's cement becomes too expensive, cement will come from China. It's that simple, can't bring in the kilowatts from China.

Reeve: Forgot to do this. We received the summary from the first meeting. I am giving Linda comments, please give Linda your comments, grammar, typos, etc.

Break come back at 1:00.

No Public in attendance to provide comments

Discussion & Recommendation: Emission Reduction Goals
Reeve: Our time as a committee to discuss goals. These would be incorporated into the MAO as a goal. Uri – anything you want to add?

Papish: The options would be a production-based limit or a % reduction, or both. And whether we want to limit with some off-ramps or some options for a temporary alternative level or we just set a fixed level that is less aggressive.

Hammond: Let's focus on context and not exact language.

Atkinson: What are production plans for Ash Grove in the next 10 years? Increasing?

Streitman: We have a production limit. It's not a direct production limit, but one based on pollution caps known as a PSEL (plant site emission limit) for about 10 pollutants. This caps our production, somewhere around a million tons – we've been making 940,000, our best year was 966,000 tons. We could get to a million tons under the right market – so that's 30K-50K tons we could grow. There will not be any drastic production increase that we have planned at this time.

Conners: Are there limits set on mercury in the permit?

Wood: Oregon DEQ rules do not allow for a PSEL for hazardous air pollutants. The ones we have for the plant now are established PSELs for criteria pollutants, NOx, SOx, etc..

Conners: Will this new technology reduce NOx emissions?

Streitman: It's not designed to reduce NOx, but it may likely reduce PM emissions from the kiln because of a second bag house there.

Reeve: Plant site emissions limits are written as a lbs/year limit. One of the disadvantages from an environmental standpoint, if you have a PSEL at 100, and you run the plant at half capacity, you can get rid of your emission controls for a while and still be below your PSEL. You would be less efficient in your emissions controls, instead of adopting an emission control or a limit that has a % reduction, or a pounds per unit of reduction. It sounds to me that Uri and Tom are on the same page that any kind of limit would be expressed as either % control from raw material or as a unit per unit of produced material. Are we on the same page?

Papish/Wood together: Yes.

Stiff: Is the plant capable of producing more than a million tons a year? Is there any way you can make it run more than what you are already running it?

Streitman: Probably not. PSEL for lead is the limiting factor.

Conners: Would mercury reduction reduce lead?

Streitman: No. We expect it only to reduce particulate but maybe a little lead might come out.

Hofmann: Is a pound of clinker a pound of cement?

Streitman: No. We take clinker and mix it with gypsum and grind it. Whatever we do, we'd like to stick with the clinker unit.

Reeve: Question about setting the limit. Is going to that type of measurement – unit of production, rather than what's coming in and going out, better for the company?

Streitman: Taking into consideration that we are in early stages of this and it hasn't been done before on a large scale. Mercury concentrations will vary in raw material. In the past year the mercury in limestone has varied from 0.8 up to 1.5 ppm. To get to a precise hourly limit, that will be difficult. We do not have a lot of control of what comes out of the mountain. A straight lb/hour unit will be difficult. Range changes day to day. Does that answer your question?

Reeve: Not exactly, but it does bring to mind a follow up. Can you take that variability and tell yourself that it is an average over a month or year? Especially when you establish averages that are fairly consistent year to year.

Wood: I think the answer is you could though, with as much certainty as you have today over 77% control over the course of a year and divide that through with a particular amount of clinker and come up with a lbs/ton clinker. Anything other than at that gross level is not possible. Not enough information to come up with any more specific number.

Riskedahl: What criteria have other states used in determining the type of limit, whether it be lbs/unit of production or percent reduction?

Papish: The burden of the sampling would be on the company if they chose to do % reduction. The decision was on the company (PGE), to chose which standard they wanted to do (% reduction or % of production).

Wood: Uri – with Oregon coal plants, unlike cement plants, some of the mercury goes out with the ash. Ash Grove has virtually nothing that goes out with the product. So if you are going to do a mass balance with the coal-fired plants you have to look at the coal as it comes into the door and then the look at the amount of mercury going out the stack. That is a much more difficult exercise. At least in Oregon, we decided to put that as an option. I think with the other states I worked with they almost all ended up being thermal input or power output. That's a lot easier to measure what comes out the stack.

Streitman: I'm sure the mercury in the coal is a lot less variable than the limestone variability we are looking at. I sense you guys/gals are asking what does Ash Grove want to do. We haven't

really sat down and hammered out what it ought to be, except if you look at common sense. If you look at lb/hr emission limit or lb/ton clinker, it could potentially be difficult to achieve all the time, even on a year to year basis. Because we aren't sure what's in that mountain, it's so variable. We get different emissions. There is low stuff there but we don't know when we are going to get it, today or tomorrow.

Hope: That speaks to choosing an appropriate averaging time if we want to use mass balance and lbs/ton clinker.

Streitman: We've got some ideas of what that % reduction could be, we've done some testing. It's a little more monitoring, as far as cost goes. That's something that we could do, give us a target and it's probably achievable.

Wood: It works here in a way it doesn't work in the power industry. They can do it but it's much more difficult to do and I toss out that as the mercury content goes up and down as you work your way through that mountain, the % reduction works both ways. It can go up and down. As the mercury level goes down, the control requirement is going to stick with it as a percent, lbs. per ton clinker. As the mercury content in limestone goes down, then you have a less stringent requirement. So there are benefits to be said for each direction.

Streitman: As I said before, as we try to consummate this order, we want something that's achievable. That's why we are here. We are willing to invest and get into this technology and learn about it, but we'd like to have something that's achievable.

Atkinson: if we are talking % reduction, are we talking about monitoring up stream and downstream emissions? Or assaying the feedstock? Seems like, analytically, lbs. per ton clinker is the easiest measurement.

Streitman: I don't think we determined that, obviously you have the carbon traps on the stack so you know what your output was. It may be the easiest thing to measure but it may not be a limit you can achieve all the time, with the variability.

Hope: Again, I believe that you can address the variability issue by choosing an averaging length of time, quarterly, yearly, etc. You chose a time-frame that allows for the variation.

Streitman: A short averaging time wouldn't work.

Hope: A quarter, a year, or something. Bottom line, whatever averaging time you choose, that's what you look at.

Wood: Bruce, remember last time we showed a slide with the table of sampling. There has been a tremendous amount of sampling done. A lot of that sampling was done during a time period when the detection limits were much higher, so we don't have enough data to say that over the next 30-40 years, what is going to be the annual variation on the mercury within that quarry. It would be a much easier way to monitor if we knew what the concentration was.

Hope: Don't set limits on the variation yet, look at the average and set a median. We have some way of saying what the variation is.

Papish: To set a production limit, you do want a lot of good data to establish what your average mercury is going to be in the raw materials. The Department would have to do that exercise, try to figure out what it would be. We would have a percent reduction in mind. We would look at all the sampling data from the past, try to figure out what we'd call the average and then divide that by the percent reduction and set that initial limit.

Reeve: Uri, you talk about the Boardman plant having the option to choose either % reduction or production based limit, do you see any downside from DEQ's point, using that model approach here? Do we lose enforceability or certainty or validity? Or do you feel like that would be appropriate.

Papish: I don't see any real drawbacks.

Reeve: So far, I have not heard back from the committee a real strong sense we should do one particular way or the other. That's why I am exploring the concept of putting both ways in the MAO to allow for flexibility.

Stiff: Seems like we are really going to need to look at 3-5 year period to really nail down what is good and what is bad, and what is economically feasible and still stay in business. To take samples of your ore to see what is going into the system and some kind of measure of what came out. From here on out we are going to do this or change this system, depending on what we find.

Riskedahl: Is the analysis of the emissions limit going to be based upon levels to address public health or on levels that are technologically achievable?

Papish: The latter. We don't know what levels are needed for public health. We are focusing on what the technology can do. To answer your (Mark Reeve's) question I don't see any real drawbacks to having the flexibility to do either one, except there could be a little difficulty for us establishing that production based limit. We have to go based off the testing they did, which was a short-term testing.

Cox: I'd like to come back to the public protection issue. Look at the maximum exposed individual and the ill health effects, and what the cost to that person would be.

Hope: We haven't fully reviewed it. Ash Grove did a human health risk assessment. They investigated the impact to what would be considered the "reasonably maximum exposed individual." The farm child, who eats fish and soil from the garden. At face value, the analysis says that at Ash Grove's current rate of emissions there is little risk to human health.

Conners: There may be some uncertainties in the modeled data.

Hope: I am trying to be diplomatic here. I haven't had a chance to look more closely at some of the issues in the report. Rather than have that discussion let's just address the mercury and reduce it. Less is better.

Reeve: That is not unusual situation in terms of any laws or regulations that look to control the technology. When you are focusing on technology you are not doing at risk assessments for every source.

Wood: In the 1990 clean air act amendments Congress got rid of the risk assessment approach because it was taking 15-20 years per standard to come up with a health risk number. From Ash Grove's perspective, the risk assessment has been done because the company wanted to make sure that there wasn't any clear health risk being posed. But you don't see us talking about it because we don't want to get stuck talking about risk. It might come out that we stay right were we are today, but that's not what Ash Grove wants to do.

Hope: The last thing I'll say on this, because we have a disconnect between risk assessments and moral questions, is that I think it speaks to a level of reduction that's lower than what is possible here.

Reeve: This leads to the next section I'd like a discussion about - percentages. I'd like to know if the committee is comfortable making and leaving both recommendations in the order: % reduction and tons per clinker.

Hofmann: Isn't the difference between the two primarily mathematical? I am comfortable leaving both. But I'm lost here - because we don't have good numbers on what's going in, it seems that this would require us to sample what's coming in and what's coming out. Where will you get your numbers?

Papish: We'd take the average mercury content of the materials going in.

Hofmann: But we don't have that.

Papish: We do.

Streitman: We have some numbers, but not 5 or 10 years' worth of data which would make us more comfortable in trying to understand what the ranges are.

Hofmann: What makes me concerned is coming up with a % reduction on those numbers when those numbers frankly could be a little bit bogus. I'm concerned from the company's standpoint. If we take EERC's 77% - how would you know, 77% of what?

Streitman: You could do it a couple of ways. As Dean suggested, you could put a carbon trap in and out and calculate reduction and measure material going in and take a sample every day and at end of month and then you know what was going in and coming out and then figure out the % reduction.

Hofmann: What I'm saying is, are we agreeing it would have to be measured? We have no information right now that you would feel comfortable basing that in-coming number on. Are you saying you would have to measure what's going in?

Streitman: To do a % reduction absolutely. I would say the numbers going in are not good enough if you based it on the highest numbers we have going in.

Hofmann: That wouldn't be fair any more than basing it on the lowest numbers going in.

Streitman: We have to measure it, if that's what we have to do, we'll figure it out with DEQ. It's feasible, its not something that cannot be done.

Reeve: Uri, let me ask - does the 90% at Boardman include what is going into the ash or is the 90% at Boardman going to be what's coming into the control device? And it's the control devise that is getting the 90% out.

Papish: No. I believe it includes what's going into the ash, it's the raw materials going in and they have years of coal data which makes it a lot more easy to establish the averages. From this conversation its sounds like Ash Grove is going to chose the % reduction if we give them the option.

Wood: Having the option is not bad – at this point in time that is what we have data on.

Reeve: Is it feasible to go to a vender and say that this is the spec you need to adhere to and put it on them to achieve a particular reduction from input flue gas to exit flue gas?

Streitman: They are going to ask what's going in (mercury content).

Jones: Engineering firms can offer a solution but I haven't seen a guaranteed performance level. That is just the state of the performance level.

Riskedahl: What's your assessment of the available universe of vendors?

Jones: There are groups that will construct to specifications, but that is different than guaranteeing results.

Stiff: In your sampling system, what percentage did you reduce it?

Jones: It depended on the situation: raw mill on we were achieving in the neighborhood of 90%, raw mill off it dropped to the 60s. I think there maybe a spurious data point out there at the end of the curve. This shows a clear trend.

Wood: This is ten times the normal injection rate for the industry – normal is 1 lb. rate, at the high end it was 10 lbs. This could stress the system.

Jones: I was advocating a 3 lbs injection rate, with the caveat to wait longer periods of time before adding more carbon. Don't want to create stress to the system. This is not based on a cleaning cycle, just what we've seen in the test for conditioning the bag.

Streitman: Don't confuse conditioning with cleaning. The bag cleaning cycle could be as low as once every four hours and as high as once every 8 hours. That's just pulsing it to change the carbon. But the conditioning, it could take that long to achieve a good base line where the fabric and the carbon cake on the material will perform consistently over a period of time.

Wood: That was the point I was trying to make before, if you are pushing large amounts of carbon into the system you could get back pressures because you'd have to increase the cleaning cycles. You'd end up dropping down to a 3 or 4 hour pulse. You'd drop the carbon off the bag and have to recoat it. But you don't want to end up have a lot of pulses, especially during the raw mill off time, because that's where if you put too much carbon in it could be self-defeating because you end up having to clean more often.

Reeve: We haven't talked about the size of the bag house as a variable, obviously it could be an economic factor when you talk bigger or smaller, but from a frequency of cleaning or an efficiency standpoint, are there trade-offs there in terms of sizing?

Jones: We looked at that in the testing. The more bag you have the lower velocity you have of throughput.

Conners: In terms of cubic feet per minute, what is the size range that you have? For gas flow.

Streitman: The gas flow is about 270,000 cubic feet per minute.

Reeve: Welcomes some additional thoughts about the general approach. Either shooting for more of what is currently achievable vs. going with a higher target with off ramps. What EERC recommends doesn't really show off-ramps.

Jones: What we recommend is what we have seen as achievable.

Hofmann: That tends to make my goal lower. Technology is going to determine this, but we can pick any number. If this had been done before that would be one thing, but this is new technology. We could set ourselves up for failure, doesn't matter how many off ramps you have. Ultimately the goal is like Bruce said, to reduce emissions. My feeling is not to make it 90-95%, but closer to 75-80%.

Stiff: Rather than saying lets shoot for 90, we take a system that appears to be helpful, measure input and output over 3-5 years, coming back and say this is what is possible to do. Do we want to install something more that will make it better? Sit down and think about it then.

Riskedahl: Setting a high target with off-ramps sets us up for success, not for failure. Ash Grove set a noble goal of no lost work days due to injury, and that is a great accomplishment. I should think setting a similarly high target on this important environmental matter would be consistent with the company's clear commitment to excellence."

Hofmann: I agree with that Mark, but my statement is that science suggests that it is not possible. It is noble, but realistically what is value of setting a noble emissions goal when science says we cannot get there.

Hope: Water treatment plants set goals of 0%, maybe one day we can get there. With technology it may be possible some day.

Wood: Bruce, I like that concept, but just remember what you're here for, which is an advisory committee for a mutual agreement and order, which is not necessarily a mechanism which is ideal for Ash Grove. This is one where the partner puts on enforceable limits. I want to be clear on that. You talk about a noble goal Mark, but there is no enforcement mechanism if they don't meet their safety goal. But what you're talking about here is something with an enforcement mechanism if Ash Grove doesn't actually meet the performance measure set in the order. I see it as a big difference. I'd also toss out there, just as a context, the statement EPA made 10 months ago as they did the mercury rule for cement kilns, they said at the time they want to collect more information, out of date the minute they wrote it, but that 42% mercury control was the greatest

amount they could consistently expect to see from Portland cement kilns. We've taken it up to 77%. This is an aggressive goal.

Conners: I want to make sure public health is protected and we are looking at the right measure. Can someone please clarify why lbs./hr is not a viable option?

Hofmann: I heard measuring lbs. per hour was not really feasible and that emission testing is done over a week.

Wood: We are concerned about long term impacts, not really so much what is coming out in an hour.

Papish: When we establish the production-based limit, we don't have a lot of long-term data on the mercury content of the material. That's a drawback. It may not be a very valid number.

Wood: I think the challenge is the legal prohibition on doing a plant site emission limit for a hazardous air pollutant. The state has a whole program for putting limits on air pollutants. Up until 2001 the situation was that individual PSELs were applied for hazardous air pollutant. Now you can do a hazardous air pollutant limit for a source, it keeps it just below the major source threshold. But the Department does not have the authority to require PSEL for a facility for an individual hazardous air pollutant. Is that your understanding Jerry?

Jerry: We need a rule authority to put something in the permit.

Papish: For the coal plant, that average is a monthly rolling figure for the year. It kind of dulls out the variability. If the company wants to test the monthly inlet and outlet, that seems perfectly good way of putting the standard in and it takes us out from having to guess what the average mercury content of the raw materials going in is.

Reeve: We are already suggesting off ramps, if it really doesn't work at all, the order should have an off-ramp available, whether missing by a little or a lot. Whether it is missing shorter term or longer term. Our committee isn't probably well suited to come up with the language.

Joni: We can include language to require better technology if it becomes available.

Reeve: I tend to come down more on side of having higher target with an off-ramp that the company feels comfortable with, so that there is clear incentive or guidance to make tweaks possible. All things being equal, higher rates of carbon tend to have a positive effect. I would think something between 80-90 is a reasonable target. Particularly if you see utilities looking at 90%, MSW combustors have a federal 85% level and achieving over 90, it seems feasible. It doesn't seem unreasonable to set that target over a longer period of time. I do understand from the company's perspective that you don't want to set it too high. It doesn't seem like failure, but more like progress towards a goal. I am more on the side of setting the goal out there. Honestly, I see there is some diversity of committee and I just don't want to force people. You all have good independent opinions and we just have to be cognizant that there are different approaches. As a committee, we can make a single recommendation.

Stiff: Has the activated charcoal bag method been put to use at the power plant?

Jones: There is one facility operating in a long term mode. There are a number of facilities where it has been operating short term. A lot of testing on the bags to look for any unintended consequences.

Wood: There is one facility operating long term.

Stiff: How long do you think it would take to design and put in a system at Ash Grove?

Jones: I'm estimating 18 months to design and construct.

Streitman: We can look at this a little closer. We think we can start off the unit in the 1st quarter of 2010.

Hofmann: I'm ok with 90%. But we need to be explicit that if we set a high number that we are being optimistic and that available science today suggests that it may not be possible. We need to make sure there are off-ramps for the company not to be penalized if noble and optimistic goals are not met.

Reeve: I was thinking 85%. It pushes a little bit, but goes along with the utilities' goals.

Streitman: We are here voluntarily. We are going to be signing a consent order that has stipulated penalties. As a company you hate to sign anything that has stipulated penalties. I know the people I am dealing with today. I have no idea 4 years from now who I will be dealing with. Board has asked Mike Hrizuk and me to come up with an achievable goal. We've spent over a million dollars and we have to report back to the Board. EERC are the best out there. We've made that commitment. We cannot get a guarantee on the equipment. We feel comfortable we can get 77%. No one has done this before, not in the cement industry. We think 77% is a push target, 2000 lbs. of mercury is achievable. We understand we have a problem and we want to help. We want to start reducing mercury by 2010.

Papish: You can have it set up so the stipulated penalty is for the date of installation and those off-ramps are not penalized until a temporary level is issued or the permanent level is unable to reach the secondary level – not necessarily penalized if unable to achieve the goal.

Reeve: In my mind it's just a different perspective. Frankly I've seen it from both sides, both from regulatory side and from regulated side. You want a number of steps to go through. Go to lower limit only if going through a number of steps. If you go to a lower limit you have to really justify that you cannot achieve the higher limit. If you cannot do it, then we'll off-ramp. I also understand the board's view, there is a lot of risk involved, they don't want to paint themselves into a corner, or set themselves up for failure. It really is a different perspective. It cannot always be reconciled, I think often it can be compromised. Ultimately, this committee isn't going to make the compromise for them. Either DEQ and company will sign an order both agree to or they won't. It has been helpful to air these questions. We can put our personal opinions up there – but those two will have to emerge, compromise and reach an order or not. It will include public comment.

Stiff: 90 would be a great percentage. Ash Grove is saying we can make 77% and we think we can do it with the technology that is out there. But if it turns out the technology cannot do it, they've been penalized already, because they put a big bunch of bucks into something that doesn't

work. And then to think the EPA is going to say 'we're going to fine you' well they've already been fined badly by spending over a million to study this. How can you penalize that?

Reeve: The purpose of the committee is to provide discussion and provide input conceptually and it is not to get into any kind of writing or reviewing or editing of what might actually be in the order. In our personal capacity as members of the public we can comment on what is put out. But as a committee we are really only looking at concepts. When we can agree conceptually on a concept, then we can make a recommendation. We are proposing to write up a summary of this discussion, make it available to DEQ and public. Summary report of what we've heard, what our discussion has been and what our recommendations are. I think you can give comments on the report.

Papish: You're talking about the report. Have the group review and make sure the recommendations are the ones the group made. Then DEQ would take that report and draft up an MAO and then we would put it out on public notice and for public comment.

Reeve: It's always been my contention that DEQ can do whatever it wants.

Stiff: Will the committee get a copy of the report to look at and provide comments?

Papish: Yes, absolutely.

Conners: Can we put something in there that says, from the public health side, that if it looks like mercury emissions are really going to increase, that Ash Grove will notify DEQ?

Reeve: We do have the topic of monitoring and reporting that we hope to get through in a bit.

Reeve: Before we go I think everyone needs to make sure they've weighed in on this concept of how to set the goals. Deanna do you feel like you've said what you want to?

Conners: Yes

Reeve: Dean, do you have anything to add?

Atkinson: No

Reeve: John?

Cox: I am trying to get feel for whether I've done the best I could to cleanup mercury in the environment. Fishing lifestyle exposes our people to mercury more. Not sure I've done the best I could. Tribal people eat 10 times as many fish as average person. Mercury poses more health risk in tribal persons than average person.

Reeve: Joni?

Hammond: I am hopeful that we can get a stronger recommendation to DEQ. Because if we have multiple recommendations, then DEQ has to negotiate with company.

Reeve: Well, let me try one thing again. Can we achieve some consensus if we set a slightly higher target, for discussion purposes say 85%. But, 77% is included as a level at which enforcement or penalties would really kick in, or potentially it could be a kind of default, back-up, set up as a surrogate TAEL, and the possibility of a PAEL even below 77%, if company cannot make it. Would we have consensus on the committee if we set the slightly higher amount, but that we would only begin the penalty if a 77% is not reached?

Hope: I'd say 75% - 77% is too "sure" of a number. It would be nice to have something firm and something hopeful.

Hofmann: As long as TAEL or PAEL kicks in at 77 or 75. I am OK with that. As long as we get to our goal of reducing mercury.

Cox: Didn't the public come back to PGE and ask for more reduction? What happened there? Didn't the public come back with a knee jerk reaction and ask for more?

Papish: We put some options out on public notice, 65% control. Based on how much the federal cap was for controlling mercury. A big public outcry from environmental groups, tribal groups and the media as well that it was inadequate. We re-looked at it, came back with another option, we basically responded to public comment.

Riskedahl: This process is so different. PGE was basically dragged into the process kicking and screaming. Ash Grove, dramatic difference, says a lot about the corporate leadership, much more pleasurable to be working with company and DEQ and not beating them up.

Wood: Either way, you're pushing my client's back to the wall. They are being forced to take higher number. They have already spent over a million dollars to look at this and move forward. A lot of the feel I get from around the table is, how can we push these guys some more. And if you want a message that is going to discourage somebody from taking that path and saying I am going to take the moral high ground and I am not going to wait for a rule, to force them into doing something, I think you're doing it. I represent both those companies. What can I say, I have one client who is less enthusiastic about embracing the technology and another client that is more, and yet they end up in the exact same place. In the end, they both get their back pushed up against the wall saying "do more than what the science says is possible. Be forced to take risks beyond what the experts say you can do." I see it as when you start pushing that far, you start disincentivizing the concern – they stop saying I am going to go out and lick that problem. If Ash Grove would walk away from this right now, because the reason they want this order is because this can go to finish in about 2 to 3 years faster than a rule. What we're talking about is a 10% disagreement, roughly 250 lbs/year, if Ash Grove says "I'm walking away" – that's 3 years before the Department could ever have something in place. That's 7,500 lbs. of mercury. How many years will it take to make up that 7,500 lbs?

Hope: 75% to 85% - I look at that in a much more 'aspirational' way. But if we don't put something out there, we won't have something to move toward.

Wood: 77% is an 'aspirational' goal, we're not sure it will work.

Riskedahl: You're producing some pretty strident advocacy, I don't think it's appropriate given the collaborative nature of this forum, not being a member of panel. Fran, do you feel backed into a corner by the discussion we're having?

Streitman: I think it's good to have an open discussion. Like I said, we would like to have an achievable number, that's what I think our board will approve and we'd like to get to that point. But we need to have an achievable number. It's all experimental. We'd like to work together and come up with something achievable.

Reeve: 75% is a reasonably achievable, a good place to start from. I think the committee would also like to see a higher number included in there, without any particular suggestion to make it enforceable or a penalty associated with it. But also including in the recommendation the ability to go lower than 75%, if it turns out that upon scaling up that 75% isn't achievable. Putting in an off-ramp or TAEL or PEAL that are available. I thought our discussion was appreciative of Ash Grove's approach to this whole problem and I do not want to be perceived as throwing cold water on a voluntary effort or being unappreciative of this collaborative approach. Having said that, well-meaning people can differ in the details and differ in their approaches and yet still be respectable and work toward a similar goal. I think I've heard general consensus that some type of approach like this is something that the committee is generally comfortable with. We have to try to come around to consensus and we are starting to.

Cox: I want 90% I want 95%, but I am supposed to be a technical person. Experiments were done and the values are on the table. I see we can get 77%. We have to look at what we have.

Doug Welch – Presentation on Monitoring, Reporting.

Doug: We need to implement these standards and put them into the permit, but this means nothing unless we can determine whether the source is in compliance with it or not. If the technology is there, we'd like to have continuous monitoring. If you don't have monitoring units you can rely on, you can do periodic source testing, and to complement that, we establish operating parameters. We say that if you see these ranges when you are testing, and they are in within compliance under those operating conditions, then you should be in compliance the rest of the time. We would establish limits and ranges in the permit and say you must remain within those limits. If you fall outside these ranges then you will face an action to bring you back into compliance. What we need to look at in the order, and the permit as well, is how to determine that they are in compliance. We talk about the percent reduction and there is discussion about whether you're entering raw materials into the system or what emissions are going in and out of the carbon injection bag house.

EERC is proposing that carbon tube traps be used to monitor mercury emissions. Based on the committee's proposed limit of a removal efficiency across the carbon injection unit, the monitoring would involve placing a carbon tube before and after the carbon injection unit in order to calculate compliance.

Ash Grove proposes pulling the carbon tubes and analyzing them every 7 days, although they indicate that they can adjust the flow rates to sample over a shorter time period. This could result in the removal efficiency being averaged over the monitoring period (7 days). Assume Ash Grove has to bring the raw mill down for about 8 hours every 7 days for maintenance (this is what they indicated was typical during the meeting). If the monitoring period (the length of time the carbon tubes are left in the stack) is 7 days, the monitoring will capture the removal efficiency during both

raw mill on and raw mill off configurations. However, the average would be biased for the 95% of the time the raw mill was on.

Question: How do you treat non-detect limits?

Doug: Reduce the frequency of testing. If they are well below the limits, you can reduce the frequency of testing. We can have a less stringent testing requirement if a track record shows good compliance.

Reeve: I think we heard pretty clearly earlier that EERC looked carefully at the availability of monitoring technology. I think we heard clearly that the recommendation of EERC is to do carbon trap monitoring.

Jones: With Method K for verification.

Conners: Do we have flexibility, can we change the length of carbon traps to less than 7 days?

Jones: What you have to look at is that it is an established procedure with a guideline. So it depends on the flow rate through the carbon traps, the exposure time, and the amount of carbon you put in the traps. We can do that, but you have to watch the capacity of traps so that you do not develop problems.

Streitman: For planned outages, when you know you are shutting the raw mill down, you can change the tubes, run the tubes even for 8 hours raw mill on/off you need this much flow.

Papish: What if you want to adjust your carbon-loading rate when the raw mill is off and see how effective it is at a different carbon injection rate? Could you do that with that monitoring approach?

Jones: if you had a block of time, you could have it set up for a short period, pull the gas through, we would know what the carbon loading level was. I hesitate to use a short time period because of the variability in the system, makes me uncomfortable as to what that means.

Papish: It just seems you might want to make some adjustment to your system to get the optimal mercury reduction possible. To know what impact your changes are having on the system.

Hofmann: As I read report, it seems to me that there is an adjustment and fine-tuning process period of 18 months or so. Are we going to talk about when the timing of the 75% goal will kick in?

Reeve: Yes, and I think we can talk about that now. As far as monitoring, I think we are all on the same page. Regarding implementation, I have consistently heard that after installation, there is then this 18 month period for optimization. So, 24 months for engineering, procurement, installation. Then after installation, there is an optimization period of roughly 18 months. Altogether about 3.5 years.

Hofmann: I put that out to about June 2011.

Riskedahl: I'd like to revisit the issue of a mobile CEMs unit. After installation, could we check back into availability of CEMS technology? Maybe bring a unit out for a week to check if the other monitoring method is working.

Jones: Yes it's doable, but depends on what you are trying to accomplish. The Ontario hydro is accepted now for the regulatory check.

Reeve: I think Mark's idea was just to get out and do a stack test. Sounds like the Ontario Hydro is the accepted way right now. Those sources are used to doing stack testing. Maybe we can leave that up to DEQ and the company to do testing.

Streitman: We would commit to some kind of QA/QC. Some way to verify what you are getting. We'll work that out with DEQ.

Reeve: In terms of implementation schedule, 24 months to engineer and install, then 18 months time for optimization.

Atkinson: I suggest getting monitoring in 6 months in advance to establish a baseline.

Streitman: I don't see a problem with that, it makes sense. It takes 12 months just to get the equipment, we've overlapped the schedule as much as we can. We're going to do 3 lbs. raw mill on and 5 lbs. raw mill off. But we won't be sitting there with 1 lb. of carbon, will be trying to figure out the best way to do it, that takes some time.

Reeve: Any other comments on the schedule? We seem to be on board that this is a reasonable commitment. The committee would recommend the company and DEQ to proceed and work out details. Are they any issues we haven't touched on? If not, we should move to wrap up.

We'll try to come up with a summary of today's discussion and circulate it to the committee for corrections or additions. Put in final form for DEQ to include in their information for the public. Form the MAO and put final recommendation out to the public in the form of a formal MAO.

Expect DEQ's notes and report out in about 2 weeks. And then a reasonable expectation of a week turn-around time for the committee to review.

The MAO will be posted on website.

Draft and final MAO will be sent out to each of the committee members.

Reeve thanked the committee members for their time, energy and for coming to Baker City. Fran thank you, I hope we've been helpful.

Fran: A round of applause for the Chair.