Appendix A - Plant Operating Data

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Facilities Management
THE UNIVERSITY OF IOWA

TIME	STEAM FLOW	METERING BIN	COLLECTOR ΔP	BAGHOUSE ΔP	ID FAN VFD
11:00A	11.0K	33.4%	0.9"wc	11.2/11.3"wc	83%
11:15A	11.4K	35.0%	0.9"wc	11.2/11.3"wc	84%
11:30A	10.6K	30.3%	0.8"wc	11.3/11.3"wc	79%
11:45A	12.0K	35.4%	1.4"wc	11.2/11.3"wc	92%
12:00P	10.9K	28.3%	0.8"wc	11.2/11.3"wc	78%
12:15P	10.5K	27.0%	0.8"wc	9.8/9.8"wc	72%
12:30P	10.5K	27%	0.7"wc	9.6/9.7"wc	71%
12:40P	10.4K	27%	0.6"wc	9.1/9.2"wc	70%
1:00P	12.6K	38%	1.1"wc	11.2/11.3"wc	83%
1:15P	11.2K	29%	0.8"wc	10.6/10.5"wc	76%

RUN #1
START @
12:05 P
7-23-2013

~~RUN #1~~
~~START @~~
~~1:00~~

7/23/2013

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TIME	STEAM FLOW	METERING BIN	COLLECTOR ΔP	BAGHOUSE ΔP	ID FAN VFD
1:30 P	11.4 K	33%	0.8" wc	10.6/10.6" wc	76%
1:45 P	11.9 K	33%	1" wc	11.2/11.3" wc	81%
2:00 P	12.1 K	35%	1" wc	11.2/11.3" wc	80%
2:15 P	11.6 K	30%	0.9" wc	11.2/11.1" wc	77%
2:30 P	12.8 K	35%	1.1" wc	11.2/11.3" wc	84%
2:45 P	12.1 K	32%	1.0" wc	11.2/11.3" wc	80%
3:00 P	13.0 K	34%	1.1" wc	11.3/11.3" wc	84%
3:15 P	12.7 K	32%	1.0" wc	11.2/11.3" wc	84%
3:30 P	12.8 K	31%	0.9" wc	11.2/11.3" wc	81%
3:45 P	10.7 K	30%	1.0" W.C.	11.2/11.3" W.C.	81%

7/23/2013

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04-03-13.

Time:	Steam Flow:	Metering:	Collector:	Baghouse:	ID Fan:
6:30p.	12.5K	33%	9" W.C	11.2/11.3" W.C.	79%
6:45p.	11.8K	31%	9"	11.1/11.1"	79%
7:00p.	11.6K	34%	8"	11.1/11.2"	79%
7:15p.	11.6K	30%	7"	10.4/10.4"	74%
7:30p.	11.3K	30%	8"	10.8/10.8"	76%
7:45p.	11.1K	30%	7"	10.4/10.5"	74%
8:00p.	11.7K	34%	9"	11.2/11.3"	79%
8:15p.	12.5	37%	1.2"	11.3/11.3"	80%
8:30p.	11.1	39%	8"	11.1/11.0"	78%
8:45p.	11.9	36%	1.0"	11.2/11.3"	84%

7:54 Run #2 done.

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Facilities Management
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TIME	STEAM FLOW	METERING BIN	COLLECTOR ΔP	BAGHOUSE ΔP	ID FAN VFD
4:00 P	12.7K	33%	1.0" WC	11.2/11.3" WC	83%
4:15 P	13.0K	31%	1.0" WC	11.3/11.3" WC	83%
4:30 P	13.4K	33%	1.0" WC	11.3/11.3" WC	89%
4:45 P	9.7K	18%	.7" WC	7.8/7.9" WC	68%
5:00 P	10.5K	25%	.6"	8.9/8.9"	68%
5:15 P	11.3 K	25.9%	.7"	10.1/10.1"	73.2%
5:30 P	11.9 K	30.2%	.8"	10.6/10.6"	75.3%
5:45 P	12.3 K	30.4%	.9"	11.2/11.2	78.2%
6:00 P	11.5 K	29.4%	.8"	10.8/10.8"	75.4%
6:15 P	11.5K	28%	.7"	10.3/10.3"	74%

← 5:02 P. Run #2 started.

7/23/2013

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07-23-13

Time:	Steam Flow:	Metering:	Collector:	Baghouse:	ID Fan:
~~9:07~~					
9:15p.	10.5K	36%	.8" W.C.	10.8/10.8" W.C.	77%
9:30p.	11.8K	38%	.9"	11.2/11.3"	81%
9:45p.	12K	40%	1.1"	11.2/11.3"	87%
10:00p.	11.5K	35%	.8"	11.2/11.3"	80%
10:15p.	12.2K.	41%	1.4"	11.2/11.3"	94%
10:30p.	10.9K.	39%	.9"	11.2/11.3"	88%
10:45p	11.9K.	43%	1.4"	11.2/11.3	93%
11:00p.	11K.	38%	1.2"	11.3/11.3"	90%
11:15p.	10.7K.	36%	1.0"	11.3/11.3"	85%
11:30p.	12.2K.	39%	1.4"	11.2/11.3"	95%
11:45p.	11.3K.	35%	1.1"	11.2/11.3"	86%
07-24-13					
12:00A	10.6K	29%	.8"	11.3/11.3"	79%

9:18 Start Run #3.

12:05A. run #3 done.

Facilities Management
The University of Iowa

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47720/1-13

Facilities Management
THE UNIVERSITY OF IOWA

TIME	STEAM FLOW	METERING BIN	COLLECTOR ΔP	BAGHOUSE ΔP	ID FAN VFD	
8:15A	10K	21%	0.6"wc	10.5/10.5"wc	73%	
8:30A	10.6K	28%	0.8"wc	11.2/11.3"wc	78%	
10:15A	10.6K	37%	0.8"wc	11.3/11.3"wc	80%	RUN 1 START!
10:30A	11.3K	36%	1.1"wc	11.2/11.3"wc	89%	
10:45A	11.0K	37%	0.9"wc	11.2/11.3"wc	84%	
11:00A	11.1K	38%	1.0"wc	11.2/11.3"wc	84%	
11:15A	11.7K	40%	1.1"wc	11.2/11.3"wc	90%	
11:30A	11.6K	38%	1.1"wc	11.2/11.3"wc	89%	
11:45A	12.3K	38%	1.4"wc	11.3/11.3"wc	96%	RUN 1 COMPLETE!

7/24/2013

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477201-13

Facilities Management
THE UNIVERSITY OF IOWA

TIME	STEAM FLOW	METERING BIN	COLLECTOR ΔP	BAGHOUSE ΔP	ID FAN VFD
12:25p	11.1	32.9	1.0	11.3	83.4
12:40p	11.3	30.9	.9	11.3	81.4
12:55p	11.3	33%	1.0"WC	11.3/11.3"WC	83%
1:10p	12.0K	35%	1.1"WC	11.3/11.3"WC	87%
1:25p	12.0K	38%	1.2"WC	11.2/11.3"WC	93%
1:40p	10.5K	28%	0.7"WC	11.3/11.3"WC	78%

→ RUN 2!

ON

→ IN THIS STATE MIGHT REDUCED AMPERAGE PRESSURE SETPOINT!

* TRIPPED UNIT ON LOW FUEL!

CLEANER CONVEYOR ELECTRIC LETS!

ID FAN : ON
OF FAN : ON
UF FAN : OFF
FGR FAN : OFF
WTR BIN : OFF
CR FAN : OFF

→ ONCE LOW FUEL CLEARED SYSTEM RESTART! → FUEL: AUTOMATIC ONCE ELECTRIC LETS CLEARED BUT LOW O2 UNTIL O FA CORRECTS!

7/24/2013

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Facilities Management
THE UNIVERSITY OF IOWA

TIME	STEAM FLOW	METERING BIN	COLLECTOR ΔP	BAGHOUSE ΔP	ID FAN VFD
2:30p	9.8	28%	0.6"wc	9.6/9.5"wc	70%
2:45p	10.5K	34%	0.7"wc	10.8/10.8"wc	75%
3:00p	11.1K	38%	0.9"wc	11.3/11.3"wc	82%
3:15p	12.6K	44%	1.3"wc	11.2/11.3"wc	92%
3:30p	10.9K	33%	0.8"wc	11.2/11.3"wc	80%
3:45p	11.4K	36%	0.9"wc	11.3/11.3"wc	82%
4:00p	11.5K	34%	0.8"wc	11.2/11.3"wc	80%

RUN #3

7/24/2013

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Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Test Location: Hurst Boiler Exhaust Duct
Test Method: 5/202
Sample Frequency: One sample per run

Run 1

% Hydrogen	3.69
% Carbon	30.20
% Sulfur	0.01
% Nitrogen	0.15
% Oxygen	25.83
HHV (Btu/lb)	5034
Fd(dscf/MMBtu)=	9491.95
Fc(scf/MMBtu)=	1925.74

Run 2

% Hydrogen	3.81
% Carbon	31.15
% Sulfur	0.01
% Nitrogen	0.16
% Oxygen	26.37
HHV (Btu/lb)	5295
Fd(dscf/MMBtu)=	9334.43
Fc(scf/MMBtu)=	1888.41

Run 3

% Hydrogen	3.11
% Carbon	25.58
% Sulfur	0.01
% Nitrogen	0.17
% Oxygen	21.65
HHV (Btu/lb)	4308
Fd(dscf/MMBtu)=	9407.68
Fc(scf/MMBtu)=	1906.03

AVERAGE FUEL FACTORS

Fd(dscf/MMBtu)=	9411.36
Fc(scf/MMBtu)=	1906.73

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Lab No : 201302780-001
Date Rec'd : 7/30/2013
Date Sampled 7/23/2013 to 7/23/2013
Sampled By: CLIENT

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Freeburg, IL 62243

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Certificate # L2179.02-1 Testing

THE UNIVERSITY OF IOWA
POWER PLANT
207 W. BURLINGTON STREET
IOWA CITY, IA 52242
ATTN: BOB LANE

Date : 8/16/2013 9:54:09 AM
P.O.# : B000566424

Remark: WOOD CHIPS - RUN#1, DAY #1

PROXIMATE ANALYSIS		As-Received	Dry Basis
% Moisture	D3302	39.33	******
% Ash	D3174	0.80	1.32
% Volatile	D3175	******	******
% Fixed Carbon	D3172	******	******
BTU	D5865	5034	8298
MAF BTU	D3180	8409	
% Total Sulfur	D4239	< 0.01	< 0.01
SULFUR FORMS			
% Pyritic	D2492	******	******
% Sulfate	D2492	******	******
% Organic	D2492	******	******
% Total Sulfur	D4239	< 0.01	< 0.01
* WATER SOLUBLE			
* % Na2O	ASME1974	******	******
* % K2O	ASME1974	******	******
* % Chlorine	ASME1974	******	******
Alkalies as Na2O	ASME1974	******	******

FUSION TEMP. OF ASH D1857 °F	Reducing	Oxidizing
I.D.	> 2700	******
H=W	> 2700	******
H=1/2W	> 2700	******
FLUID	> 2700	******

GRINDABILITY INDEX D409 ****** @ ****** % Moist.

FREE SWELLING INDEX D720 ******

* Apparent Specific Gravity of Coal ModIC7113 ******

% Equilibrium Moisture D1412 ******

* % Loss on Ignition @ 950C D7348 ******

ULTIMATE ANALYSIS		Weight % As-Received	Weight % Dry Basis
% Moisture	D3302	39.33	******
% Carbon	D5373	30.20	49.78
% Hydrogen	D5373	3.69	6.09
% Nitrogen	D5373	0.15	0.25
% Chlorine	D6721	< 0.01	< 0.01
% Sulfur	D4239	< 0.01	< 0.01
% Ash	D3174	0.80	1.32
% Oxygen (Diff.)	D3176	25.83	42.56

(Chlorine D6721 Dry Basis ug/g 28)

MINERAL ANALYSIS D6349		% Ignited Basis
Phos. Pentoxide, P2O5		******
Silica, SiO2		******
Ferric Oxide, Fe2O3		******
Alumina, Al2O3		******
Titania, TiO2		******
Lime, CaO		******
Magnesia, MgO		******
Sulfur Trioxide, SO3		******
Potassium Oxide, K2O		******
Sodium Oxide, Na2O		******
Barium Oxide, BaO		******
Strontium Oxide, SrO		******
Manganese Dioxide, MnO2		******
Undetermined		******
Type of Ash	ASME1974	******
Silica Value	ASME1974	******
T250 Deg F	BW	******
Base/Acid Ratio	ASME1974	******
lb Ash/mm BTU		1.59
lb SO2/mm BTU		< 0.01
Fouling Index	ASME1974	******
Slagging Index	ASME1974	******

(Mercury D6722 Dry Basis ug/g < 0.010)

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Date Sampled 7/23/2013 to 7/23/2013
Sampled By: CLIENT

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Freeburg, IL 62243

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POWER PLANT
207 W. BURLINGTON STREET
IOWA CITY, IA 52242
ATTN: BOB LANE

Date : 8/16/2013 9:54:09 AM
P.O.# : B000566424

Remark: WOOD CHIPS - RUN#2, DAY #1

PROXIMATE ANALYSIS		As-Received	Dry Basis
% Moisture	D3302	37.53	******
% Ash	D3174	0.98	1.57
% Volatile	D3175	******	******
% Fixed Carbon	D3172	******	******
BTU	D5865	5295	8476
MAF BTU	D3180	8611	
% Total Sulfur	D4239	< 0.01	< 0.01
SULFUR FORMS			
% Pyritic	D2492	******	******
% Sulfate	D2492	******	******
% Organic	D2492	******	******
% Total Sulfur	D4239	< 0.01	< 0.01
* WATER SOLUBLE			
* % Na2O	ASME1974	******	******
* % K2O	ASME1974	******	******
* % Chlorine	ASME1974	******	******
Alkalies as Na2O	ASME1974	******	******

FUSION TEMP. OF ASH D1857 °F	Reducing	Oxidizing
I.D.	2655	******
H=W	> 2700	******
H=1/2W	> 2700	******
FLUID	> 2700	******

GRINDABILITY INDEX D409 ****** @ ****** % Moist.

FREE SWELLING INDEX D720 ******

* Apparent Specific Gravity of Coal ModIC7113 ******

% Equilibrium Moisture D1412 ******

* % Loss on Ignition @ 950C D7348 ******

ULTIMATE ANALYSIS		Weight % As-Received	Weight % Dry Basis
% Moisture	D3302	37.53	******
% Carbon	D5373	31.15	49.87
% Hydrogen	D5373	3.81	6.10
% Nitrogen	D5373	0.16	0.26
% Chlorine	D6721	< 0.01	< 0.01
% Sulfur	D4239	< 0.01	< 0.01
% Ash	D3174	0.98	1.57
% Oxygen (Diff.)	D3176	26.37	42.20

(Chlorine D6721 Dry Basis ug/g 20)

MINERAL ANALYSIS D6349		% Ignited Basis
Phos. Pentoxide, P2O5		******
Silica, SiO2		******
Ferric Oxide, Fe2O3		******
Alumina, Al2O3		******
Titania, TiO2		******
Lime, CaO		******
Magnesia, MgO		******
Sulfur Trioxide, SO3		******
Potassium Oxide, K2O		******
Sodium Oxide, Na2O		******
Barium Oxide, BaO		******
Strontium Oxide, SrO		******
Manganese Dioxide, MnO2		******
Undetermined		******
Type of Ash	ASME1974	******
Silica Value	ASME1974	******
T250 Deg F	BW	******
Base/Acid Ratio	ASME1974	******
lb Ash/mm BTU		1.85
lb SO2/mm BTU		< 0.01
Fouling Index	ASME1974	******
Slagging Index	ASME1974	******

(Mercury D6722 Dry Basis ug/g < 0.010)

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Date Rec'd : 7/30/2013
Date Sampled 7/23/2013 to 7/23/2013
Sampled By: CLIENT

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THE UNIVERSITY OF IOWA
POWER PLANT
207 W. BURLINGTON STREET
IOWA CITY, IA 52242
ATTN: BOB LANE

Date : 8/16/2013 9:54:09 AM
P.O.# : B000586424

Remark: WOOD CHIPS - RUN#3, DAY #1

PROXIMATE ANALYSIS		As-Received	Dry Basis
% Moisture	D3302	48.57	******
% Ash	D3174	0.92	1.78
% Volatile	D3175	******	******
% Fixed Carbon	D3172	******	******
BTU	D5865	4308	8376
MAF BTU	D3180	8528	
% Total Sulfur	D4239	< 0.01	< 0.01
SULFUR FORMS			
% Pyritic	D2492	******	******
% Sulfate	D2492	******	******
% Organic	D2492	******	******
% Total Sulfur	D4239	< 0.01	< 0.01
* WATER SOLUBLE			
* % Na2O	ASME1974	******	******
* % K2O	ASME1974	******	******
* % Chlorine	ASME1974	******	******
Alkalies as Na2O	ASME1974	******	******

FUSION TEMP. OF ASH D1857 °F	Reducing	Oxidizing
I.D.	2675	******
H=W	> 2700	******
H=1/2W	> 2700	******
FLUID	> 2700	******

GRINDABILITY INDEX D409 ****** @ ****** % Moist.

FREE SWELLING INDEX D720 ******

* Apparent Specific Gravity of Coal ModIC7113 ******

% Equilibrium Moisture D1412 ******

* % Loss on Ignition @ 950C D7348 ******

ULTIMATE ANALYSIS		Weight % As-Received	Weight % Dry Basis
% Moisture	D3302	48.57	******
% Carbon	D5373	25.58	49.74
% Hydrogen	D5373	3.11	6.05
% Nitrogen	D5373	0.17	0.33
% Chlorine	D6721	< 0.01	< 0.01
% Sulfur	D4239	< 0.01	< 0.01
% Ash	D3174	0.92	1.78
% Oxygen (Diff.)	D3176	21.65	42.10

(Chlorine D6721 Dry Basis ug/g 17)

MINERAL ANALYSIS D6349		% Ignited Basis
Phos. Pentoxide, P2O5		******
Silica, SiO2		******
Ferric Oxide, Fe2O3		******
Alumina, Al2O3		******
Titania, TiO2		******
Lime, CaO		******
Magnesia, MgO		******
Sulfur Trioxide, SO3		******
Potassium Oxide, K2O		******
Sodium Oxide, Na2O		******
Barium Oxide, BaO		******
Strontium Oxide, SrO		******
Manganese Dioxide, MnO2		******
Undetermined		******
Type of Ash	ASME1974	******
Silica Value	ASME1974	******
T250 Deg F	BW	******
Base/Acid Ratio	ASME1974	******
lb Ash/mm BTU		2.13
lb SO2/mm BTU		< 0.01
Fouling Index	ASME1974	******
Slagging Index	ASME1974	******

(Mercury D6722 Dry Basis ug/g < 0.010)

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Lab No. : 201302780-001

Date Rec'd. : 7/30/2013

Date Sampled : 7/23/2013

Sampled By : CLIENT

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THE UNIVERSITY OF IOWA
POWER PLANT
207 W. BURLINGTON STREET
IOWA CITY, IA 52242
ATTN: BOB LANE

Report Date: 8/16/2013 9:17:51 AM

Sample ID : 201302780-001

P.O. #: B000566424

Remark: WOOD CHIPS - RUN#1, DAY #1

TEST	DRY BASIS CONCENTRATION	UNITS	METHOD	DATE	TECH
Antimony	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Arsenic	0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Barium	32	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Beryllium	< 0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
• Boron	4	µg/g	ICPMS	8/12/2013	JMW
Cadmium	0.11	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Chlorine	28	µg/g	ASTM D6721	8/6/2013	JMB
Chromium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Copper	2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Lead	0.5	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Manganese	40	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Mercury	< 0.010	µg/g	ASTM D6722	8/2/2013	CJH
Molybdenum	< 0.2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Nickel	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Selenium	< 0.1	µg/g	ASTM D4606	8/8/2013	NRJ
Silver	0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Thallium	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Vanadium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Zinc	9	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW

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Respectfully Submitted, Jeremy Weiss

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Date Rec'd. : 7/30/2013

Date Sampled : 7/23/2013

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Freeburg, IL 62243

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THE UNIVERSITY OF IOWA
POWER PLANT
207 W. BURLINGTON STREET
IOWA CITY, IA 52242
ATTN: BOB LANE

Report Date: 8/16/2013 9:17:51 AM

Sample ID : 201302780-002

P.O. #: B000566424

Remark: WOOD CHIPS - RUN#2, DAY #1

TEST	DRY BASIS CONCENTRATION	UNITS	METHOD	DATE	TECH
Antimony	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Arsenic	0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Barium	31	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Beryllium	< 0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
• Boron	4	µg/g	ICPMS	8/12/2013	JMW
Cadmium	0.09	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Chlorine	20	µg/g	ASTM D6721	8/6/2013	JMB
Chromium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Copper	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Lead	0.3	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Manganese	34	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Mercury	< 0.010	µg/g	ASTM D6722	8/2/2013	CJH
Molybdenum	< 0.2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Nickel	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Selenium	< 0.1	µg/g	ASTM D4606	8/8/2013	NRJ
Silver	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Thallium	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Vanadium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Zinc	8	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW

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Lab No. : 201302780-003

Date Rec'd. : 7/30/2013

Date Sampled : 7/23/2013

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Report Date: 8/16/2013 8:17:51 AM

Sample ID : 201302780-003

P.O. #: B000566424

Remark: WOOD CHIPS - RUN#3, DAY #1

TEST	DRY BASIS CONCENTRATION	UNITS	METHOD	DATE	TECH
Antimony	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Arsenic	0.2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Barium	30	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Beryllium	< 0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
• Boron	5	µg/g	ICPMS	8/12/2013	JMW
Cadmium	0.16	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Chlorine	17	µg/g	ASTM D6721	8/6/2013	JMB
Chromium	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Copper	2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Lead	0.6	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Manganese	34	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Mercury	< 0.010	µg/g	ASTM D6722	8/2/2013	CJH
Molybdenum	< 0.2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Nickel	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Selenium	< 0.1	µg/g	ASTM D4606	8/8/2013	NRJ
Silver	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Thallium	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Vanadium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Zinc	11	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW

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Respectfully Submitted, Jeremey Weiss

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Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Project #: M133003

Location: Hurst Boiler Exhaust I
Date: 7/24/13

Test 1	
% Hydrogen	3.09
% Carbon	25.39
% Sulfur	0.01
% Nitrogen	0.14
% Oxygen	21.54
HHV (Btu/lb)	4319
Fd(dscf/MMBtu)=	9310.30
Fc(scf/MMBtu)=	1887.05

Test 2	
% Hydrogen	3.12
% Carbon	25.46
% Sulfur	0.01
% Nitrogen	0.12
% Oxygen	21.54
HHV (Btu/lb)	4313
Fd(dscf/MMBtu)=	9372.76
Fc(scf/MMBtu)=	1894.89

Test 3	
% Hydrogen	3.44
% Carbon	28.49
% Sulfur	0.01
% Nitrogen	0.14
% Oxygen	24.13
HHV (Btu/lb)	4830
Fd(dscf/MMBtu)=	9324.39
Fc(scf/MMBtu)=	1893.43

AVERAGE FUEL FACTORS	
Fd(dscf/MMBtu)=	9335.82
Fc(scf/MMBtu)=	1891.79

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POWER PLANT
207 W. BURLINGTON STREET
IOWA CITY, IA 52242
ATTN: BOB LANE

Date : 8/16/2013 9:54:09 AM
P.O.# : B000566424

Remark: WOOD CHIPS - RUN#1, DAY #2

PROXIMATE ANALYSIS		As-Received	Dry Basis
% Moisture	D3302	48.85	******
% Ash	D3174	0.99	1.94
% Volatile	D3175	******	******
% Fixed Carbon	D3172	******	******
BTU	D5865	4319	8443
MAF BTU	D3180	8610	
% Total Sulfur	D4239	< 0.01	< 0.01
SULFUR FORMS			
% Pyritic	D2492	******	******
% Sulfate	D2492	******	******
% Organic	D2492	******	******
% Total Sulfur	D4239	< 0.01	< 0.01
* WATER SOLUBLE			
* % Na2O	ASME1974	******	******
* % K2O	ASME1974	******	******
* % Chlorine	ASME1974	******	******
Alkalies as Na2O	ASME1974	******	******

FUSION TEMP. OF ASH D1857 °F	Reducing	Oxidizing
I.D.	2642	******
H=W	2664	******
H=1/2W	2666	******
FLUID	2670	******

GRINDABILITY INDEX D409 ****** @ ****** % Moist.

FREE SWELLING INDEX D720 ******

* Apparent Specific Gravity of Coal ModIC7113 ******

% Equilibrium Moisture D1412 ******

* % Loss on Ignition @ 950C D7348 ******

ULTIMATE ANALYSIS		Weight % As-Received	Weight % Dry Basis
% Moisture	D3302	48.85	******
% Carbon	D5373	25.39	49.63
% Hydrogen	D5373	3.09	6.04
% Nitrogen	D5373	0.14	0.28
% Chlorine	D6721	< 0.01	< 0.01
% Sulfur	D4239	< 0.01	< 0.01
% Ash	D3174	0.99	1.94
% Oxygen (Diff.)	D3176	21.54	42.11

(Chlorine D6721 Dry Basis ug/g 30)

MINERAL ANALYSIS D6349		% Ignited Basis
Phos. Pentoxide, P2O5		******
Silica, SiO2		******
Ferric Oxide, Fe2O3		******
Alumina, Al2O3		******
Titania, TiO2		******
Lime, CaO		******
Magnesia, MgO		******
Sulfur Trioxide, SO3		******
Potassium Oxide, K2O		******
Sodium Oxide, Na2O		******
Barium Oxide, BaO		******
Strontium Oxide, SrO		******
Manganese Dioxide, MnO2		******
Undetermined		******
Type of Ash	ASME1974	******
Silica Value	ASME1974	******
T250 Deg F BW		******
Base/Acid Ratio	ASME1974	******
lb Ash/mm BTU		2.30
lb SO2/mm BTU		< 0.01
Fouling Index	ASME1974	******
Slagging Index	ASME1974	******

(Mercury D6722 Dry Basis ug/g < 0.010)

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Date : 8/16/2013 9:54:10 AM
P.O.# : B000586424

Remark: WOOD CHIPS - RUN#2, DAY #2

PROXIMATE ANALYSIS		As-Received	Dry Basis
% Moisture	D3302	48.95	******
% Ash	D3174	0.81	1.58
% Volatile	D3175	******	******
% Fixed Carbon	D3172	******	******
BTU	D5865	4313	8449
MAF BTU	D3180	8585	
% Total Sulfur	D4239	< 0.01	< 0.01

SULFUR FORMS			
% Pyritic	D2492	******	******
% Sulfate	D2492	******	******
% Organic	D2492	******	******
% Total Sulfur	D4239	< 0.01	< 0.01

* WATER SOLUBLE			
* % Na2O	ASME1974	******	******
* % K2O	ASME1974	******	******
* % Chlorine	ASME1974	******	******
Alkalies as Na2O	ASME1974	******	******

FUSION TEMP. OF ASH D1857 °F	Reducing	Oxidizing
I.D.	2660	******
H=W	2673	******
H=1/2W	2675	******
FLUID	2682	******

GRINDABILITY INDEX D409 ****** @ ****** % Moist.

FREE SWELLING INDEX D720 ******

* Apparent Specific Gravity of Coal ModiC7113 ******

% Equilibrium Moisture D1412 ******

* % Loss on Ignition @ 950C D7348 ******

ULTIMATE ANALYSIS		Weight % As-Received	Weight % Dry Basis
% Moisture	D3302	48.95	******
% Carbon	D5373	25.46	49.88
% Hydrogen	D5373	3.12	6.11
% Nitrogen	D5373	0.12	0.23
% Chlorine	D6721	< 0.01	< 0.01
% Sulfur	D4239	< 0.01	< 0.01
% Ash	D3174	0.81	1.58
% Oxygen (Diff.)	D3176	21.54	42.20

(Chlorine D6721 Dry Basis ug/g 32)

MINERAL ANALYSIS D6349		% Ignited Basis
Phos. Pentoxide, P2O5		******
Silica, SiO2		******
Ferric Oxide, Fe2O3		******
Alumina, Al2O3		******
Titania, TiO2		******
Lime, CaO		******
Magnesia, MgO		******
Sulfur Trioxide, SO3		******
Potassium Oxide, K2O		******
Sodium Oxide, Na2O		******
Barium Oxide, BaO		******
Strontium Oxide, SrO		******
Manganese Dioxide, MnO2		******
Undetermined		******
Type of Ash	ASME1974	******
Silica Value	ASME1974	******
T250 Deg F	BW	******
Base/Acid Ratio	ASME1974	******
lb Ash/mm BTU		1.87
lb SO2/mm BTU		< 0.01
Fouling Index	ASME1974	******
Slagging Index	ASME1974	******

(Mercury D6722 Dry Basis ug/g < 0.010)

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Date Sampled	7/24/2013 to 7/24/2013
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Remark: WOOD CHIPS - RUN#3, DAY #2

PROXIMATE ANALYSIS		As-Received	Dry Basis
% Moisture	D3302	42.64	******
% Ash	D3174	1.16	2.03
% Volatile	D3175	******	******
% Fixed Carbon	D3172	******	******
BTU	D5865	4830	8420
MAF BTU	D3180	8594	
% Total Sulfur	D4239	< 0.01	< 0.01
SULFUR FORMS			
% Pyritic	D2492	******	******
% Sulfate	D2492	******	******
% Organic	D2492	******	******
% Total Sulfur	D4239	< 0.01	< 0.01
*** WATER SOLUBLE**			
* % Na2O	ASME1974	******	******
* % K2O	ASME1974	******	******
* % Chlorine	ASME1974	******	******
Alkalies as Na2O	ASME1974	******	******

FUSION TEMP. OF ASH D1857 °F	Reducing	Oxidizing
I.D.	2595	******
H=W	2658	******
H=1/2W	2663	******
FLUID	2671	******

GRINDABILITY INDEX D409 ***** @ ****** % Moist.

FREE SWELLING INDEX D720 ******

* Apparent Specific Gravity of Coal ModIC7113 ******

% Equilibrium Moisture D1412 ******

* % Loss on Ignition @ 950C D7348 ******

ULTIMATE ANALYSIS		Weight % As-Received	Dry Basis
% Moisture	D3302	42.64	******
% Carbon	D5373	28.49	49.67
% Hydrogen	D5373	3.44	6.00
% Nitrogen	D5373	0.14	0.25
% Chlorine	D6721	< 0.01	< 0.01
% Sulfur	D4239	< 0.01	< 0.01
% Ash	D3174	1.16	2.03
% Oxygen (Diff.)	D3176	24.13	42.05

(Chlorine D6721 Dry Basis ug/g 29)

MINERAL ANALYSIS D6349		% Ignited Basis
Phos. Pentoxide, P2O5		******
Silica, SiO2		******
Ferric Oxide, Fe2O3		******
Alumina, Al2O3		******
Titania, TiO2		******
Lime, CaO		******
Magnesia, MgO		******
Sulfur Trioxide, SO3		******
Potassium Oxide, K2O		******
Sodium Oxide, Na2O		******
Barium Oxide, BaO		******
Strontium Oxide, SrO		******
Manganese Dioxide, MnO2		******
Undetermined		******
Type of Ash	ASME1974	******
Silica Value	ASME1974	******
T250 Deg F	BW	******
Base/Acid Ratio	ASME1974	******
lb Ash/mm BTU		2.41
lb SO2/mm BTU		< 0.01
Fouling Index	ASME1974	******
Slagging Index	ASME1974	******

(Mercury D6722 Dry Basis ug/g < 0.010)

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Date Rec'd. : 7/30/2013

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Sample ID : 201302780-004

P.O. #: B000566424

Remark: WOOD CHIPS - RUN#1, DAY #2

TEST	DRY BASIS CONCENTRATION	UNITS	METHOD	DATE	TECH
Antimony	0.03	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Arsenic	0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Barium	27	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Beryllium	< 0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
• Boron	5	µg/g	ICPMS	8/12/2013	JMW
Cadmium	0.14	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Chlorine	30	µg/g	ASTM D6721	8/7/2013	JMB
Chromium	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Copper	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Lead	0.4	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Manganese	21	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Mercury	< 0.010	µg/g	ASTM D6722	8/2/2013	CJH
Molybdenum	< 0.2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Nickel	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Selenium	0.1	µg/g	ASTM D4606	8/8/2013	NRJ
Silver	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Thallium	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Vanadium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Zinc	10	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW

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Report Date: 8/16/2013 9:17:51 AM

Sample ID : 201302780-005

P.O. #: B000566424

Remark: WOOD CHIPS - RUN#2, DAY #2

TEST	DRY BASIS CONCENTRATION	UNITS	METHOD	DATE	TECH
Antimony	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Arsenic	< 0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Barium	31	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Beryllium	< 0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
• Boron	6	µg/g	ICPMS	8/12/2013	JMW
Cadmium	0.11	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Chlorine	32	µg/g	ASTM D6721	8/7/2013	JMB
Chromium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Copper	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Lead	0.3	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Manganese	25	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Mercury	< 0.010	µg/g	ASTM D6722	8/13/2013	CJH
Molybdenum	< 0.2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Nickel	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Selenium	< 0.1	µg/g	ASTM D4606	8/8/2013	NRJ
Silver	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Thallium	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Vanadium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Zinc	7	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW

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Lab No. : 201302780-006

Date Rec'd. : 7/30/2013

Date Sampled : 7/24/2013

Sampled By : CLIENT

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Report Date: 8/16/2013 9:17:51 AM

Sample ID : 201302780-006

P.O. #: B000566424

Remark: WOOD CHIPS - RUN#3, DAY #2

TEST	DRY BASIS CONCENTRATION	UNITS	METHOD	DATE	TECH
Antimony	0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Arsenic	< 0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Barium	42	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Beryllium	< 0.1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
• Boron	7	µg/g	ICPMS	8/12/2013	JMW
Cadmium	0.17	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Chlorine	29	µg/g	ASTM D6721	8/7/2013	JMB
Chromium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Copper	2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Lead	0.3	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Manganese	50	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Mercury	< 0.010	µg/g	ASTM D6722	8/2/2013	CJH
Molybdenum	< 0.2	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Nickel	1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Selenium	< 0.1	µg/g	ASTM D4606	8/8/2013	NRJ
Silver	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Thallium	< 0.02	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Vanadium	< 1	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW
Zinc	15	µg/g	ASTM D6357 - ICP-MS	8/9/2013	JMW

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Respectfully Submitted, Jeremey Weiss

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Appendix B - Test Section Diagrams

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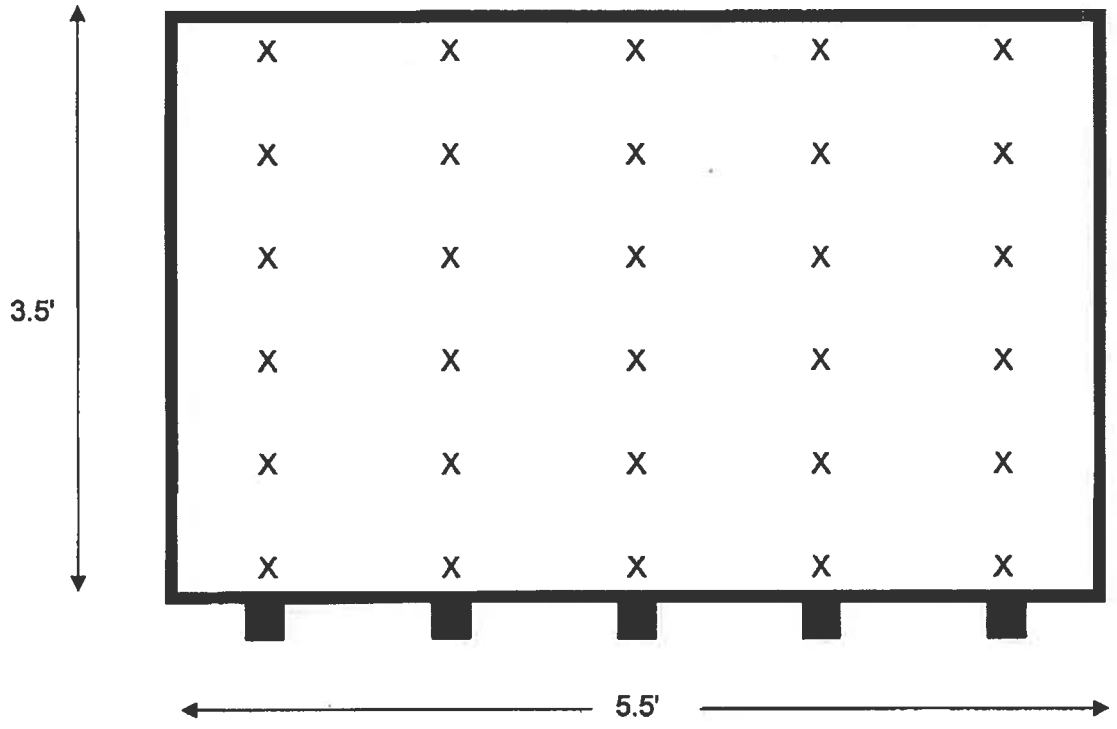
EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS
(TPM Testing)



Job:	The University of Iowa Oakdale Renewable Energy Plant Coralville, Iowa		
Date:	July 23 and 24, 2013	Area:	19.25 Square Feet
Test Location:	Hurst Boiler Exhaust Duct	No. Test Ports:	5
Length:	5.5 Feet	Tests Points per Port:	6
Width:	3.5 Feet		

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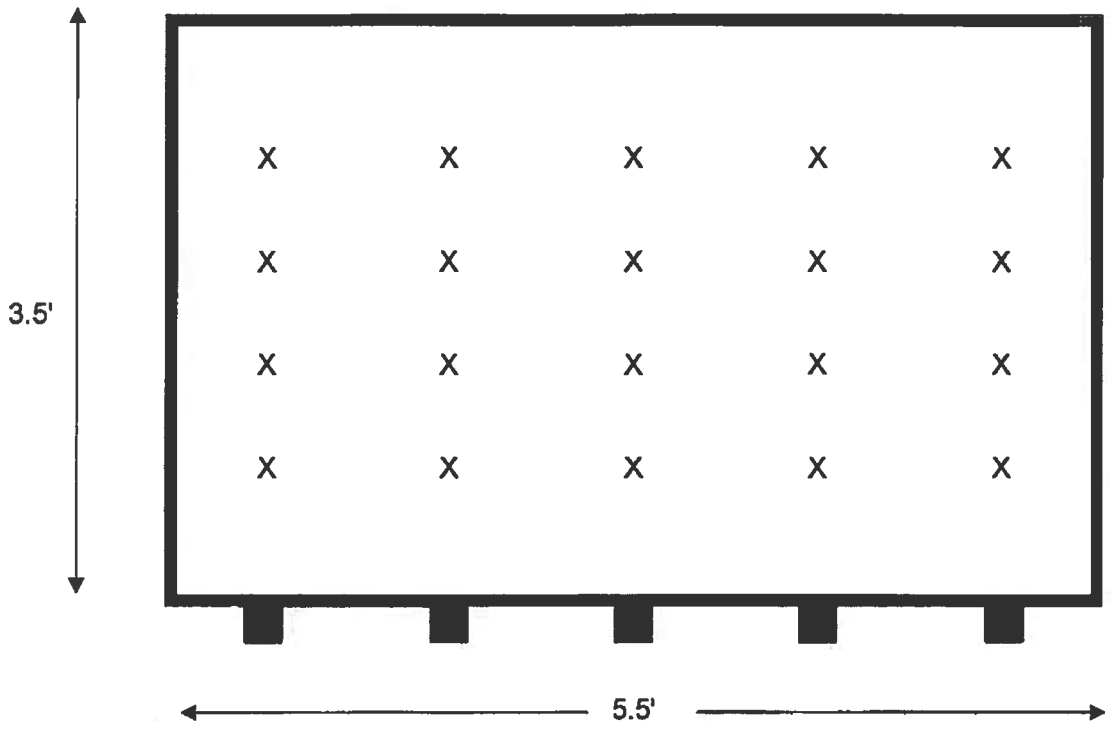
EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS
(Volumetric Flow, NO_X, and CO Testing)



Job:	The University of Iowa Oakdale Renewable Energy Plant Coralville, Iowa		
Date:	July 24, 2013	Area:	19.25 Square Feet
Test Location:	Hurst Boiler Exhaust Duct	No. Test Ports:	5
Length:	5.5 Feet	Tests Points per Port:	4
Width:	3.5 Feet		

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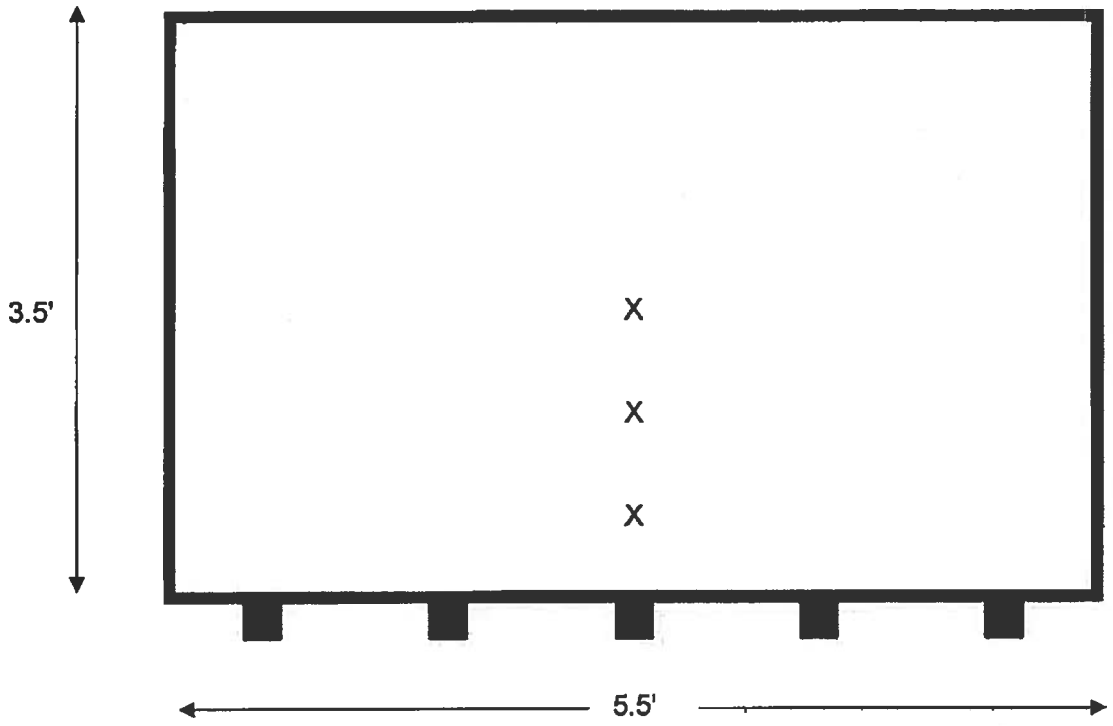
EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS
(Hg Testing)



Job:	The University of Iowa Oakdale Renewable Energy Plant Coralville, Iowa		
Date:	July 24, 2013	Area:	19.25 Square Feet
Test Location:	Hurst Boiler Exhaust Duct	No. Test Ports:	3
Length:	5.5 Feet	Tests Points per Port:	1
Width:	3.5 Feet		

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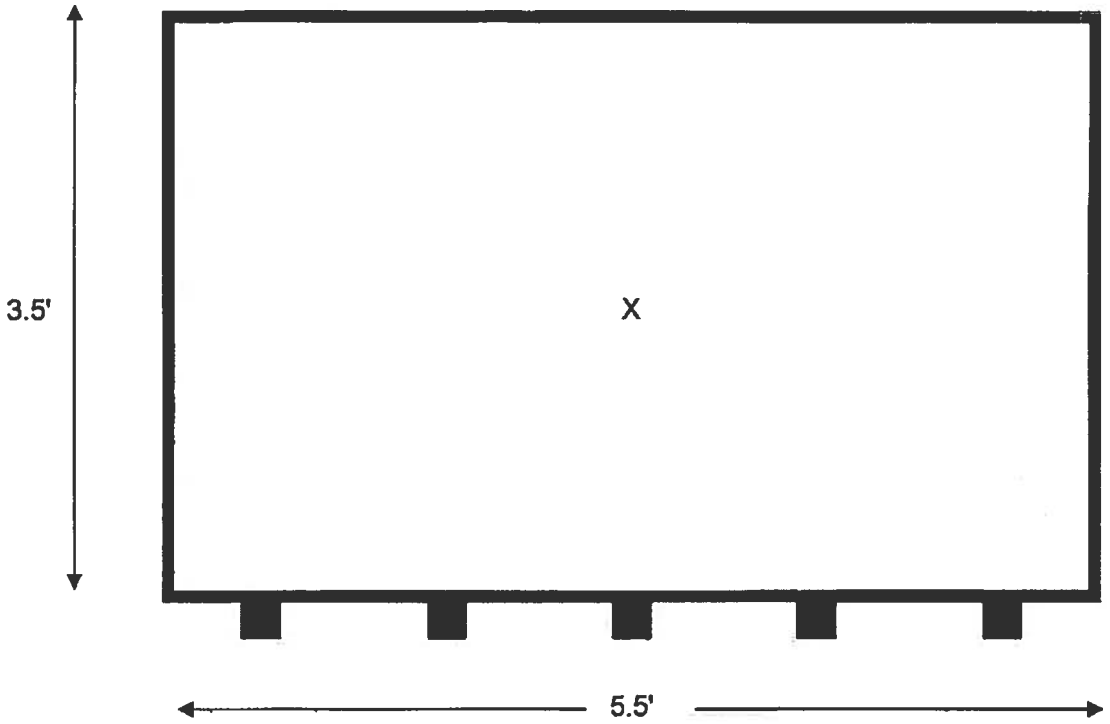
EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS
(HCl Testing)



Job:	The University of Iowa Oakdale Renewable Energy Plant Coralville, Iowa		
Date:	July 23, 2013	Area:	19.25 Square Feet
Test Location:	Hurst Boiler Exhaust Duct	No. Test Ports:	1
Length:	5.5 Feet	Tests Points per Port:	1
Width:	3.5 Feet		

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Appendix C - Sample Train Diagrams

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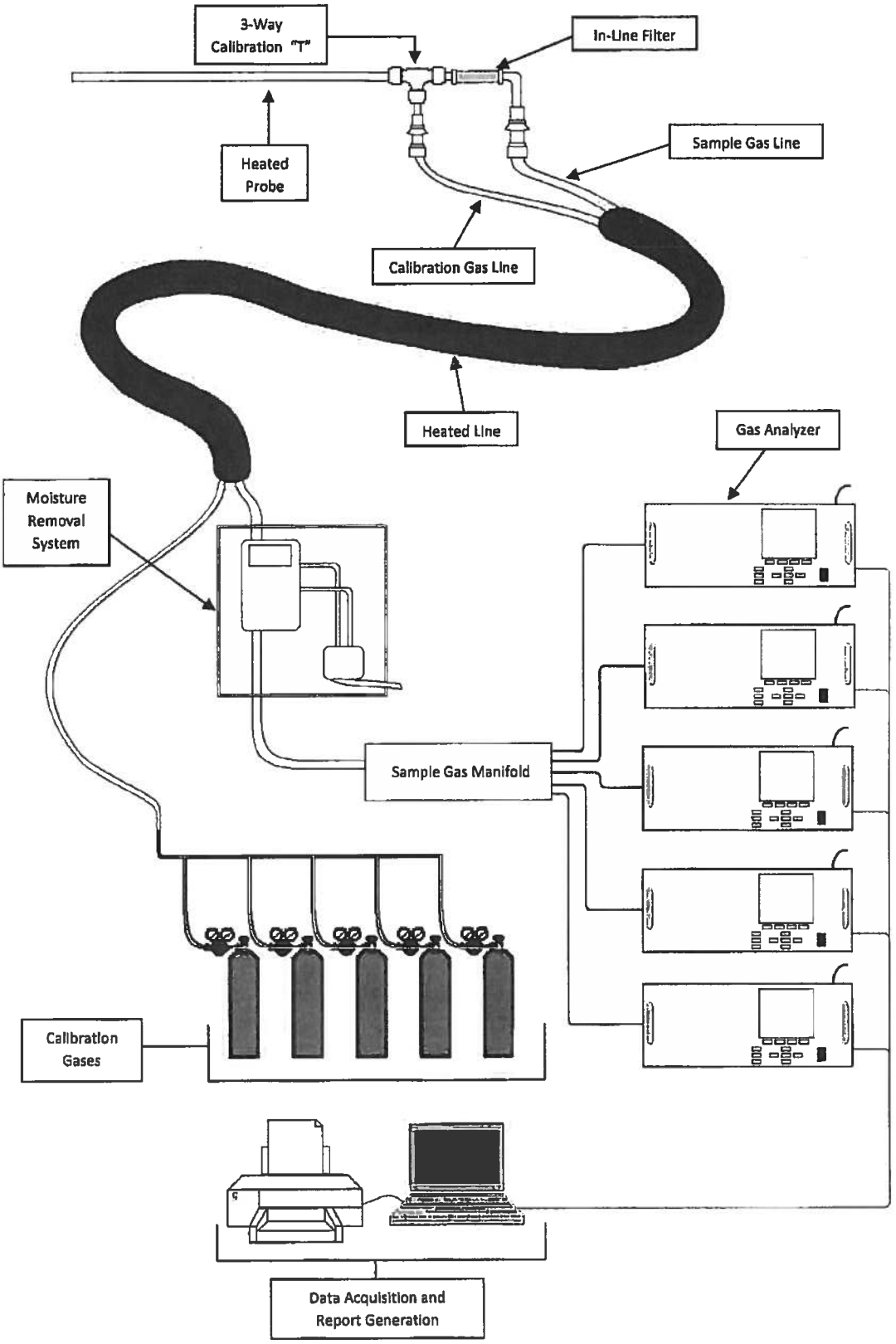
USEPA Methods 3A, 7E, and 10 Extractive Gaseous Sampling Diagram



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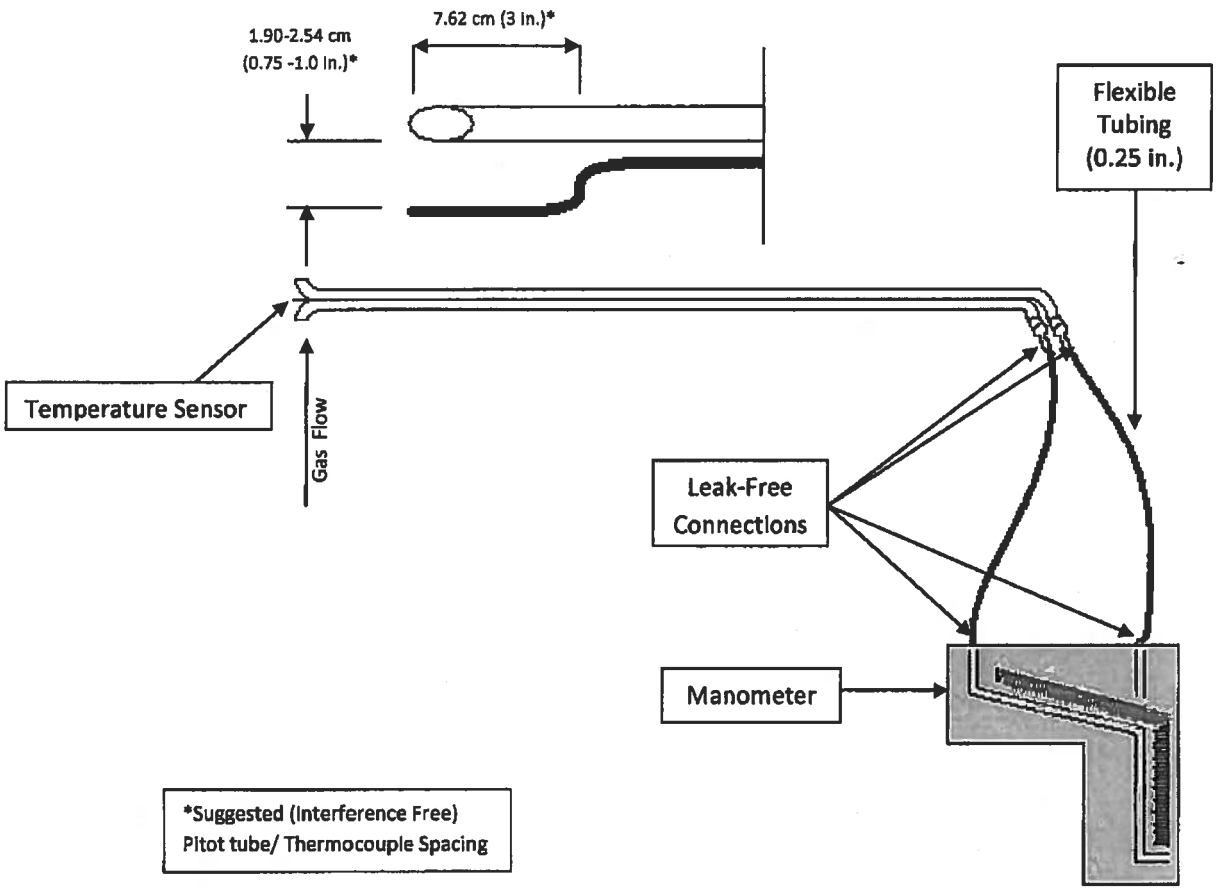
USEPA Method 2- Type S Pitot Tube Manometer Assembly



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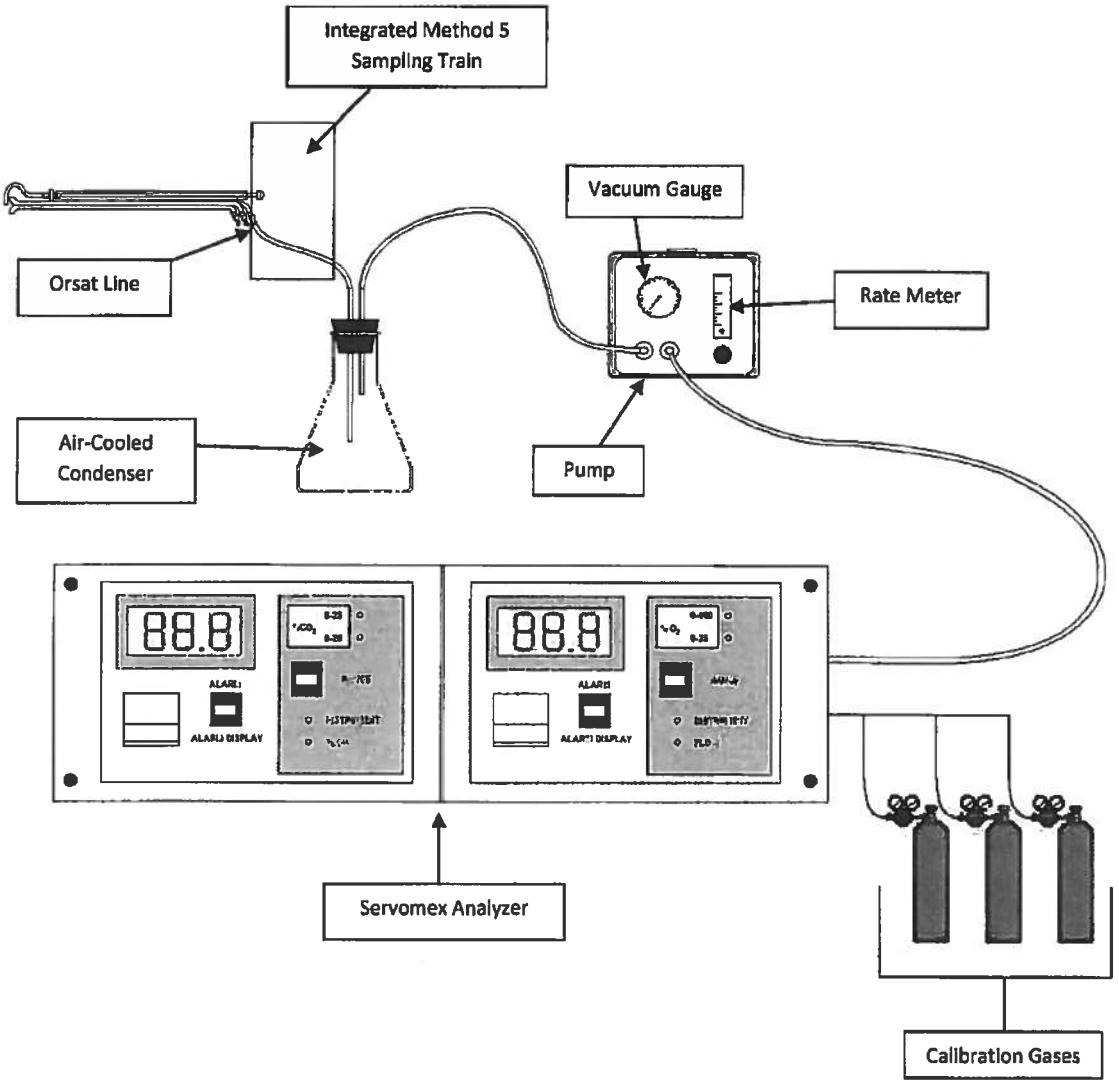
USEPA Method 3A – CO2/O2 Determination



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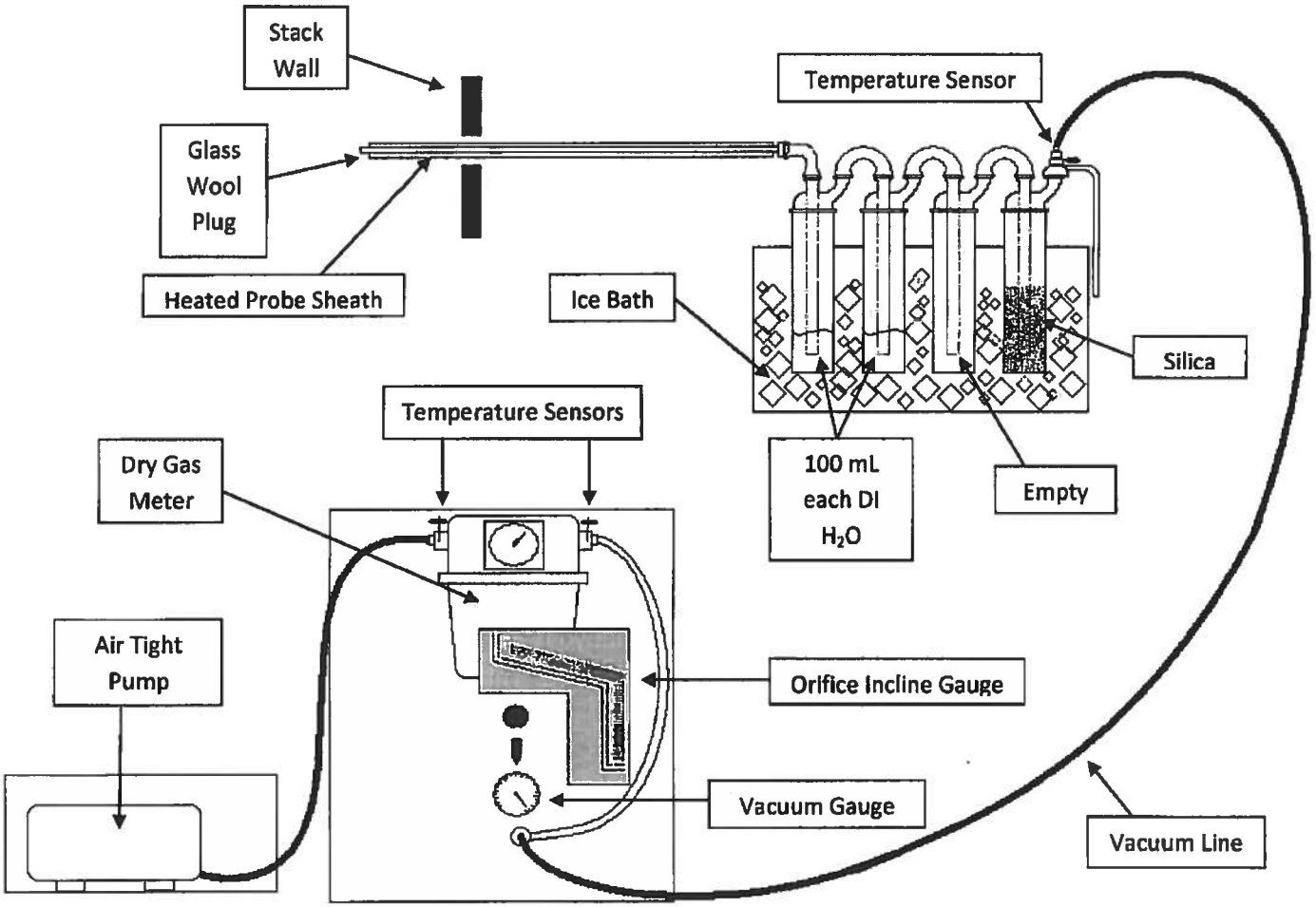
USEPA Method 4- Moisture Content Sample Train Diagram



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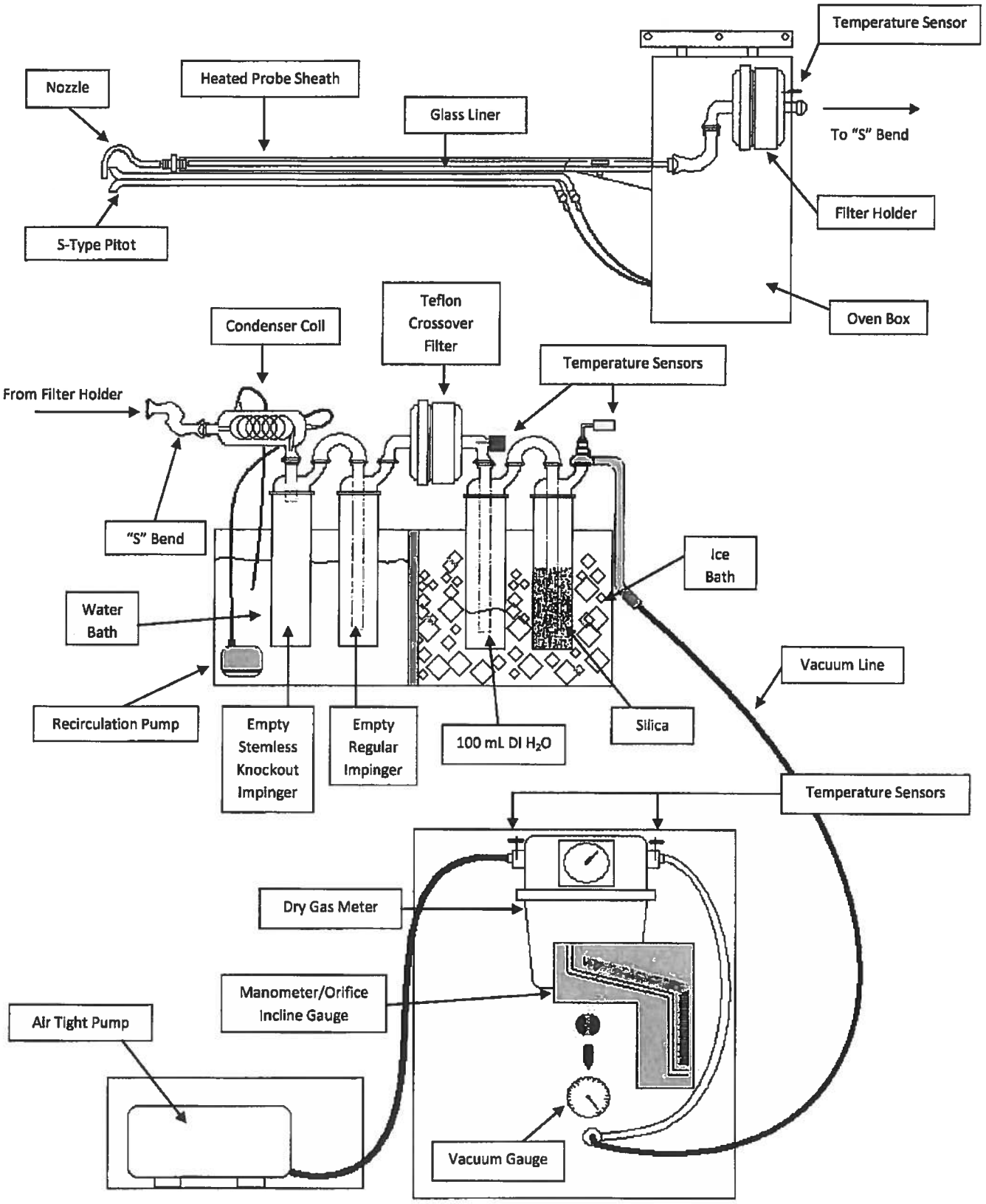
USEPA Method 5/202- Condensable Particulate Matter



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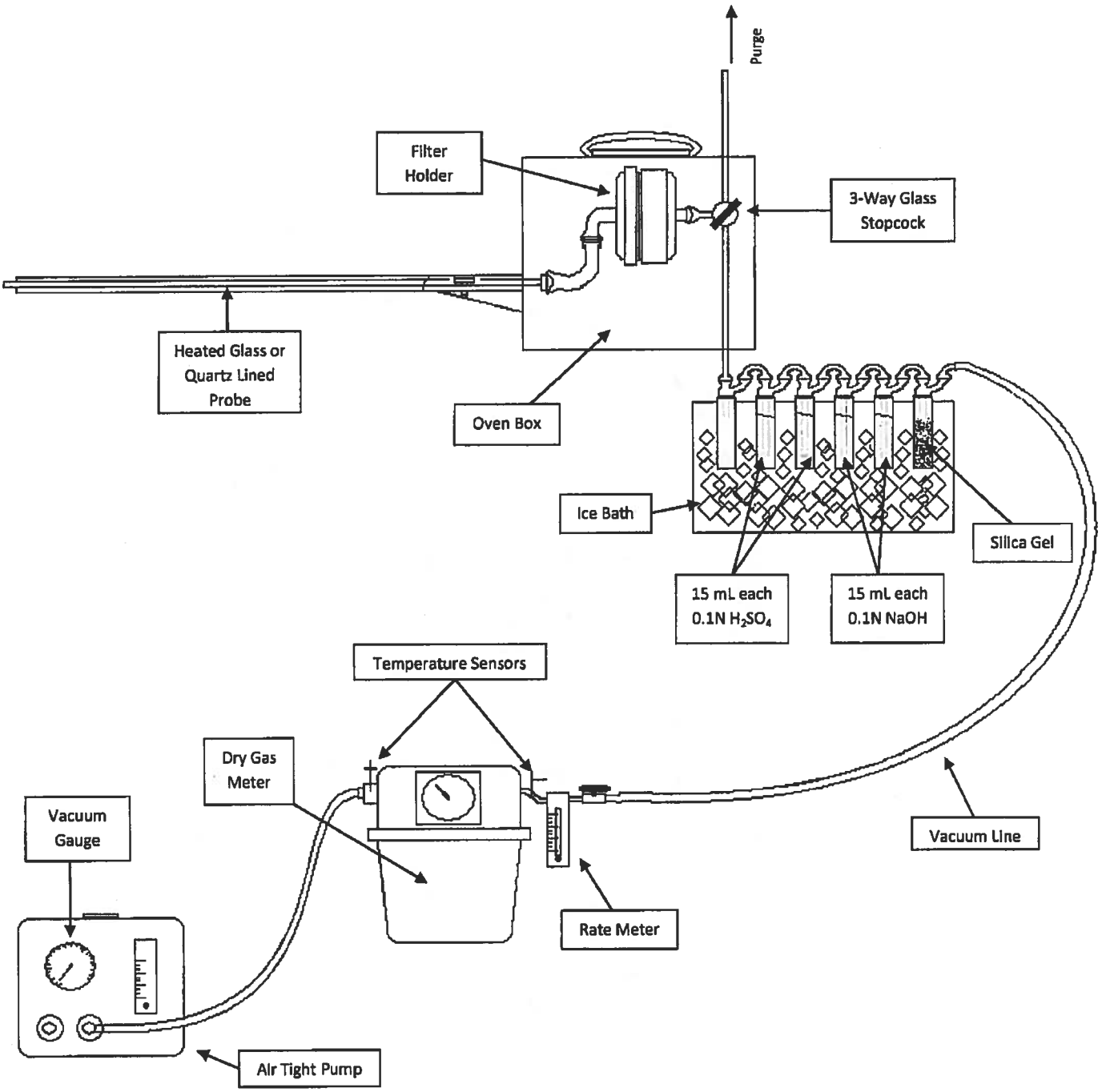
USEPA Method 26 – Halogen Sample Train Diagram



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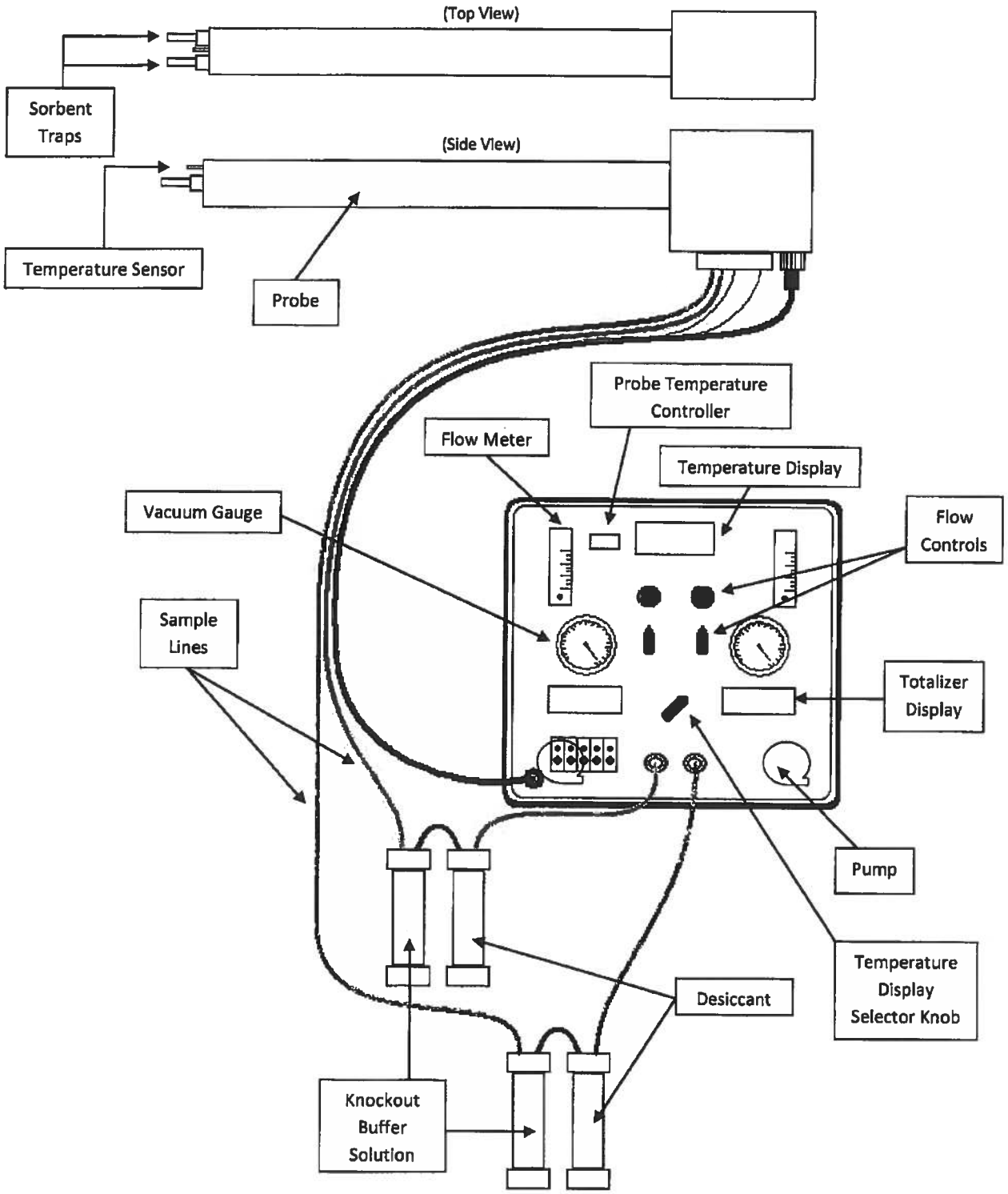
USEPA Method 30B- Mercury Sorbent Trap Sampling Train



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Appendix D - Calculation Nomenclature and Formulas

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Client:	**University of Iowa**
Facility:	**Oakdale Renewable Energy Plant**
Test Location:	**Hurst Boiler Exhaust Duct**
Run:	**1**
Date:	**7/23/2013**
Method:	**5/202**

Dry Molecular Weight

$$Md = 0.44 \times (\%CO_2) + 0.32 \times (\%O_2) + 0.28 \times \%N_2$$

$\%CO_2 =$ 10.9 $\%O_2 =$ 9.8 $\%N_2 =$ 79.3

$Md =$ 30.136

Wet Molecular Weight

$$Ms = Md \times (1-Bws) + (18.0 \times Bws)$$

$Md =$ 30.136 $Bws =$ 0.161

$Ms =$ 28.184

Meter Volume at Standard Conditions

$$Vm(std) = 17.647 \times Y \times Vm \times \frac{(Pbar + DH/13.6)}{Tm}$$

$Y =$ 1.006 $Vm =$ 75.148 $Pbar =$ 29.30

$DH =$ 0.63 $Tm =$ 552.4

$Vm(std) =$ 70.880

Volume of Water Vapor Condensed

$$Vw(std) = 0.0471 \times (\text{net } H_2O \text{ gain})$$

Net $H_2O =$ 288.4

$Vw(std) =$ 13.584

Moisture Content

$$Bws = \frac{Vwc(std)}{Vwc(std) + Vm(std)}$$

$Vw(std) =$ 13.584 $Vm(std) =$ 70.880

$Bws =$ 0.161

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Client:	University of Iowa
Facility:	Oakdale Renewable Energy Plant
Test Location:	Hurst Boiler Exhaust Duct
Run:	1
Date:	7/23/2013
Method:	5/202

Average Duct Velocity

$$Vs = 85.49 \times Cp \times \text{Sqrt DP (avg)} \times (Ts\ (avg)/(Ps \times Ms))^{1/2}$$

Cp = 0.840 Ts (avg) = 819.3 Sqrt DP (avg): 0.148
Ps = 29.29 Ms = 28.184

Vs = 10.602

Volumetric Flow Rate (Actual Basis)

$$Q = Vs \times A \times 60$$

Vs = 10.602 A = 19.250

Q = 12,245

Volumetric Flow Rate (Standard Basis)

$$Qstd = 17.647 \times Q \times \frac{Ps}{Ts\ (avg)}$$

Q = 12,245 Ps = 29.29 Ts (avg) = 819.3

Qstd = 7,726

Volumetric Flow Rate (Standard Dry Basis)

$$Qstd(dry) = Qstd \times (1-Bws)$$

Qstd = 7,726 Bws = 0.161

Qstd(dry) = 6,483

Isokinetic Variation:

$$\%ISO = \frac{0.0945 \times Ts \times Vm(std)}{Vs \times \theta \times An \times Ps \times (1-Bws)}$$

Ts = 819.3 Vm(std) = 70.880 Vs = 10.602
An = 0.0013364 θ = 150 Ps = 29.29
Bws = 0.161

%ISO = 105.0

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Client:	**University of Iowa**
Facility:	**Oakdale Renewable Energy Plant**
Test Location:	**Hurst Boiler Exhaust Duct**
Run:	**1**
Date:	**7/23/2013**
Method:	**5/202**

PM Concentration:
This example represents the filterable fraction. For other fractions, use the obtained mn for that particulate fraction.

$$Co = \frac{m_n \times 15.43}{Vm(std)}$$

m_n (g) = 0.1279 Vm(std) = 70.880

Co = 0.0278 gr/dscf

PM Emission Rate:

$$\text{Emission Rate lb/hr} = \frac{Co}{7000} \times Qstd(dry) \times 60$$

Co = 0.0278 Qstd(dry) = 6,483

Emission Rate lb/hr = 1.5470 lb/hr

F_d= 9492.0 O_2%= 9.8

$$\text{Emission Rate lb/mmBtu } (F_d \text{ Factor}) = \frac{Co}{7000} \times F_d \text{ (dscf/mmBtu)} \times \frac{20.9}{20.9 - O_2\%}$$

Emission Rate lb/mmBtu (F_d Factor) = 0.0711

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Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Project #: M133003

Location: Hurst Boiler Exhaust Duct
Date: 7/24/13

Sample Calculations

NOx ppmvd

$$(36.4 \text{ ppm} - 0.1 \text{ ppm}) \times \frac{45.5 \text{ ppm}}{45.7 \text{ ppm} - 0.1 \text{ ppm}} = 36.3 \text{ ppm}$$

CO ppmvd

$$(2.2 \text{ ppm} - 0.1 \text{ ppm}) \times \frac{15.2 \text{ ppm}}{15.1 \text{ ppm} - 0.1 \text{ ppm}} = 2.1 \text{ ppm}$$

O2 % (dry)

$$(11.31\ \% - 0.01\ \%) \times \frac{11.99\ \%}{11.91\ \% - 0.01\ \%} = 11.40\ \%$$

CO2 % (dry)

$$(9.36\ \% - 0.07\ \%) \times \frac{10.08\ \%}{10.09\ \% - 0.07\ \%} = 9.40\ \%$$

O2 based NOx lb/MMBtu

36.3 ppm x (1.194 x 10-7) = 0.00000433 lbs/dscf

$$0.00000433 \text{ lbs/dscf} \times 9{,}336 \text{ dscf/mmBtu} \times \frac{20.9\%}{(20.9\% - 11.40\ \%)}$$

= 0.089 NOx lbs/mmBtu

O2 based CO lb/MMBtu

2.1 ppm x (7.266 x 10-8) = 0.00000006 lbs/dscf

$$0.00000006 \text{ lbs/dscf} \times 9335.82 \text{ dscf/mmBtu} \quad \frac{20.9\%}{(20.9\% - 11.40\ \%)}$$

= 0.003 CO lbs/mmBtu

$$C_{gas} = (C - C_o) \times \frac{C_{ma}}{C_m - C_o}$$

where:
C_{gas} = Effluent gas concentration, dry basis, ppm
C = Average gas concentration indicated by gas analyzer, dry basis, ppm
C_o = Average of initial and final system calibration bias check responses for the zero gas, ppm
C_m = Average of initital and final system calibration bias check responses for the upscale calibration gas, ppm
C_{ma} = Actual concentration of the upscale calibration gas, ppm

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Client:	**University of Iowa**
Facility:	**Oakdale Renewable Energy Plant**
Test Location:	**Hurst Boiler Exhaust Duct**
Run:	**1A**
Date:	**7/24/2013**

Mercury Meter Volume at Standard Conditions (Liters)

Vm(std) = 17.647 x Y x Vm x $\frac{Pbar}{Tm}$

Y = 1.009 **Vm =** 109.424 **Tm =** 545.30 **Pbar =** 29.25

Vm(std) = 104.512

Hg Concentration:

ppb Hg = (total ng of Hg on trap/1X10^9) X (0.0022046226/Vm(std)*0.0353)*385X10^7/200.59*1000

Total ng Hg = 22.6 **Vm(std) =** 104.512

ppb Hg = 0.03

ug/dscm = (total ng of Hg on trap/1000)/Vm(std)/1000

ug/dscm = 0.22

ug/wscm = ug/dscm*(1-Bws)

ug/wscm = 0.18

Hg Emission Rate:

lb/TBtu (fd factor) = (total ng of Hg on trap/1000000000*0.0022046226/Vm(std)*0.035314667)*Fd Factor*(20.9/(20.9-%O2)*1000000

lb/TBtu (fd factor) = 0.276509

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Volumetric Flow Nomenclature

A = Cross-sectional area of stack or duct, ft^2

B_{ws} = Water vapor in gas stream, proportion by volume

C_p = Pitot tube coefficient, dimensionless

M_d = Dry molecular weight of gas, lb/lb-mole

M_s = Molecular weight of gas, wet basis, lb/lb-mole

M_w = Molecular weight of water, 18.0 lb/lb-mole

P_{bar} = Barometric pressure at testing site, in. Hg

P_g = Static pressure of gas, in. Hg (in. H_2O/13.6)

P_s = Absolute pressure of gas, in. Hg = $P_{bar} + P_g$

P_{std} = Standard absolute pressure, 29.92 in. Hg

Q_{acfm} = Actual volumetric gas flow rate, acfm

Q_{sd} = Dry volumetric gas flow rate corrected to standard conditions, dscf/hr

R = Ideal gas constant, 21.85 In. Hg-ft^3/°R-lb-mole

T_s = Absolute gas temperature, °R

T_{std} = Standard absolute temperature, 528°R

v_s = Gas velocity, ft/sec

$V_{w(std)}$ = Volume of water vapor in gas sample, corrected to standard conditions, scf

Y = Dry gas meter calibration factor

Δp = Velocity head of gas, in. H_2O

K_1 = 17.647 °R/in. Hg

%EA = Percent excess air

$\%CO_2$ = Percent carbon dioxide by volume, dry basis

$\%O_2$ = Percent oxygen by volume, dry basis

$\%N_2$ = Percent nitrogen by volume, dry basis

0.264 = Ratio of O_2 to N_2 in air, v/v

0.28 = Molecular weight of N_2 or CO, divided by 100

0.32 = Molecular weight of O_2 divided by 100

0.44 = Molecular weight of CO_2 divided by 100

13.6 = Specific gravity of mercury (Hg)

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Volumetric Air Flow Calculations

$$Vm\ (std) = 17.647 \times Vm \times \left[\frac{(P_{bar} + (\frac{DH}{13.6}))}{(460 + Tm)} \right] \times Y$$

$$Vw\ (std) = 0.0471 \times Vlc$$

$$Bws = \left[\frac{Vw\ (std)}{Vw\ (std) + Vm\ (std)} \right]$$

$$Md = (0.44 \times \%CO_2) + (0.32 \times \%O_2) + [0.28 \times (100 - \%CO_2 - \%O_2)]$$

$$Ms = Md \times (1 - Bws) + (18 \times Bws)$$

$$Vs = \sqrt{\frac{(Ts + 460)}{Ms \times Ps}} \times \sqrt{DP} \times Cp \times 85.49$$

$$Acfm = Vs \times Area\ (of\ stack\ or\ duct) \times 60$$

$$Scfm = Acfm \times 17.647 \times \left[\frac{Ps}{(460 + Ts)} \right]$$

$$Scfh = Scfm \times 60 \frac{min}{hr}$$

acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
scfh = standard cubic feet per hour

Cp = pitot tube correction factor
Ps = absolute flue gas pressure
Ms = molecular weight of gas (lb/lb mole)
Md = dry molecular weight of gas (lb/lb mole)
Bws = water vapor in gas stream proportion by volume

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Particulate Nomenclature

A = Cross-sectional area of stack or duct, square feet
A_n = Cross-sectional area of nozzle, square feet
B_{ws} = Water vapor in gas stream, by volume
C_a = Acetone blank residue concentration, g/g
C_{acf} = Concentration of particulate matter in gas stream at actual conditions, gr/acf
C_p = Pitot tube coefficient
C_s = Concentration of particulate matter in gas stream, dry basis, corrected to standard conditions, gr/dscf
IKV = Isokinetic sampling variance, must be 90.0 % ≤ IKV ≤ 110.0%
M_d = Dry molecular weight of gas, lb/lb-mole
M_s = Molecular weight of gas, wet basis, lb/lb-mole
M_w = Molecular weight of water, 18.0 lb/lb-mole
m_a = Mass of residue of acetone after evaporation, grams
P_{bar} = Barometric pressure at testing site, inches mercury
P_g = Static pressure of gas, inches mercury (inches water/13.6)
P_s = Absolute pressure of gas, inches mercury = $P_{bar} + P_g$
P_{std} = Standard absolute pressure, 29.92 inches mercury
Q_{acfm} = Actual volumetric gas flow rate, acfm
Q_{sd} = Dry volumetric gas flow rate corrected to standard conditions, dscfh
R = Ideal gas constant, 21.85 inches mercury cubic foot/°R-lb-mole
T_m = Dry gas meter temperature, °R
T_s = Gas temperature, °R
T_{std} = Absolute temperature, 528°R
V_a = Volume of acetone blank, ml
V_{aw} = Volume of acetone used in wash, ml
W_a = Weight of residue in acetone wash, grams
m_n = Total amount of particulate matter collected, grams
V_{1c} = Total volume of liquid collected in impingers and silica gel, ml
V_m = Volume of gas sample as measured by dry gas meter, dcf
$V_{m(std)}$ = Volume of gas sample measured by dry gas meter, corrected to standard conditions, dscf
v_s = Gas velocity, ft/sec
$V_{w(std)}$ = Volume of water vapor in gas sample, corrected to standard conditions, scf
Y = Dry gas meter calibration factor
ΔH = Average pressure differential across the orifice meter, inches water
Δp = Velocity head of gas, inches water
ρ_a = Density of acetone, 0.7855 g/ml (average)
ρ_w = Density of water, 0.002201 lb/ml
θ = Total sampling time, minutes
K_1 = 17.647 °R/in. Hg
K_2 = 0.04707 ft^3/ml
K_4 = 0.09450/100 = 0.000945
K_p = Pitot tube constant, $85.49 \frac{ft}{sec}\left[\frac{(lb/lb-mole)(in.Hg)}{(°R)(in.H_2O)}\right]^{1/2}$
%EA = Percent excess air
$\%CO_2$ = Percent carbon dioxide by volume, dry basis
$\%O_2$ = Percent oxygen by volume, dry basis
%CO = Percent carbon monoxide by volume, dry basis
$\%N_2$ = Percent nitrogen by volume, dry basis
0.264 = Ratio of O_2 to N_2 in air, v/v
28 = Molecular weight of N_2 or CO
32 = Molecular weight of O_2
44 = Molecular weight of CO_2
13.6 = Specific gravity of mercury (Hg)

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Particulates Calculation Formulas

1. $V_{w(std)} = V_{lc}\left(\frac{\rho_w}{M_w}\right)\left(\frac{RT_{std}}{P_{std}}\right) = K_2 V_{lc}$

2. $V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m}\right)\left(\frac{(P_{bar} + (\frac{\Delta H}{13.6}))}{P_{std}}\right) = K_1 V_m Y \frac{(P_{bar} + (\frac{\Delta H}{13.6}))}{T_m}$

3. $B_{ws} = \frac{V_{w(std)}}{(V_{m(std)} + V_{w(std)})}$

4. $M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$

5. $M_s = M_d(1 - B_{ws}) + 18.0(B_{ws})$

6. $C_a = \frac{m_a}{V_a \rho_a}$

7. $W_a = C_a V_{av} \rho_a$

8. $C_{acf} = 15.43 K_i \left(\frac{m_n P_s}{V_{w(std)} + V_{m(std)}\ T_s}\right)$

9. $C_S = (15.43 \text{ grains/gram})\ (m_n / V_{m(std)})$

10. $v_s = K_p C_p \sqrt{\frac{\Delta P\ T_s}{P_s M_s}}$

11. $Q_{acfm} = v_s A(60_{sec/min})$

12. $Q_{sd} = (3600_{sec/hr})(1 - B_{ws})\ v_s \left(\frac{T_{std} P_s}{T_s P_{std}}\right) A$

13. E (emission rate, lbs/hr) $= Q_{std}(C_s/7000 \text{ grains/lb})$

14. $IKV = \frac{T_s V_{m(std)} P_{std}}{T_{std} v_s \theta A_n P_s 60(1 - B_{ws})} = K_4 \frac{T_s V_{m(std)}}{P_s v_s A_n \theta (1 - B_{ws})}$

15. $\%EA = \left(\frac{\%O_2 - (0.5\%CO)}{0.264\%N_2 - (\%O_2 - 0.5\%CO)}\right) \times 100$

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Method 30B Determination of Vapor Phase Mercury Nomenclature

B = Breakthrough (%).

Bws = Moisture content of sample gas as measured by Method 4, percent/100.

Ca = Concentration of Hg for the sample collection period, for sorbent trap "a" (µg/dscm).

Cb = Concentration of Hg for the sample collection period, for sorbent trap "b"(µg/dscm).

Cd = Hg concentration, dry basis (µg/dscm).

Crec = Concentration of spiked compound measured (µg/m3).

Cw = Hg concentration, wet basis (µg/m3).

m1 = Mass of Hg measured on sorbent trap section 1 (µg).

m2 = Mass of Hg measured on sorbent trap section 2 (µg).

mrecovered= Mass of spiked Hg recovered in Analytical Bias or Field Recovery Test (µg).

ms = Total mass of Hg measured on spiked trap in Field Recovery Test (µg).

mspiked = Mass of Hg spiked in Analytical Bias or Field Recovery Test (µg).

mu = Total mass of Hg measured on unspiked trap in Field Recovery Test (µg).

R = Percentage of spiked mass recovered (%).

RD = Relative deviation between the Hg concentrations from traps "a" and "b" (%).

vs = Volume of gas sampled, spiked trap in Field Recovery Test (dscm).

Vt = Total volume of dry gas metered during the collection period (dscm); for the purposes of this method, standard temperature and pressure are defined as 20° C and 760 mm Hg, respectively.

vu = Volume of gas sampled, unspiked trap in Field Recovery Test (dscm).

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MOISTURE CALCULATIONS

$$V_{wc(std)} = \frac{(V_f - V_i)\,\rho_w\,R\,T_{std}}{P_{std}M_w} = 0.04707(V_f - V_i)$$

$$V_{wsg(std)} = \frac{(W_f - W_i)\,R\,T_{std}}{P_{std}\,M_w} = 0.04715\,(W_f - W_i)$$

$$V_{m(std)} = 17.64\;V_m\;Y\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}$$

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}}$$

Where:

B_{ws} = Water vapor in gas stream, proportion by volume
M_w = Molecular weight of water, 18.015 lb/lb-mole
P_{bar} = Barometric pressure at the testing site, in. Hg
P_{std} = Standard absolute pressure, 29.92 in. Hg
R = Ideal gas constant, 0.048137 (in. Hg)(ft^3)/(g-mole)(°R) = [21.8348(in. Hg)(ft^3)/(lb-mole)(°R)]/453.592 g-mole/lb-mole
T_m = Absolute average dry gas meter temperature, °R
T_{std} = Standard absolute temperature, 528 °R
V_f = Final volume of condenser water, ml
V_i = Initial volume of condenser water, ml
V_m = Dry gas volume measured by dry gas meter, dcf
$V_{m(std)}$ = Dry gas volume measured by dry gas meter, corrected to standard conditions, scf
$V_{wc(std)}$ = Volume of condensed water vapor, corrected to standard conditions, scf
$V_{wsg(std)}$ = Volume of water vapor collected in silica gel, corrected to standard conditions, scf
W_f = Final weight of silica gel, g
W_i = Initial weight of silica gel, g
Y = Dry gas meter calibration factor
ΔH = Average pressure exerted on dry gas meter outlet by gas sample bag, in. H_2O
ρ_w = Density of water, 0.9982 g/ml
13.6 = Specific gravity of mercury (Hg)
17.64 = T_{std}/P_{std}
0.04707 = ft^3/ml 0.04715 = ft^3/g

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Pollutant Concentration Correction 3% for Percent Oxygen

$$C_{adj} = C_d \frac{20.9 - 3\%}{20.9 - \%O_2}$$

where:

C_{adj}	=	Pollutant concentration corrected to percent O_2
20.9- 3%	=	Percent O_2, the defined O_2 correction value, percent
20.9	=	Percent O_2 in air
$\%O_2$	=	Measured O_2 concentration dry basis, percent
C_d	=	Pollutant concentration measured, dry basis, ppm.

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Calculations for Hydrogen Chloride by Method 26 or 26A

Concentration

$$\frac{\text{lb HCl}}{\text{dscf}} = \frac{\mu\text{g HCl in sample}}{4.536 \times 10^8 \times \text{dscf}}$$

where:

$4.536 \times 10^8 = \mu g/lb$

dscf = Volume of gas sampled

$$\mu g/\text{lb HCl} = \mu g\ \text{Cl} \times \frac{36.453}{35.453}$$

Parts Per Million

$$\text{ppm HCl} = \frac{\text{lb HCl}}{\text{dscf}} \div \frac{36.453}{385 \times 10^6}$$

where:

385 = Volume of 1 lb mole of gas at 68°F and 29.92 in. Hg

10^6 = Conversion of ppm v/v

Emission Rate

lb HCl/dscf × dscfm × 60 min/hr = lb/hr HCl

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ppm Conversion Calculations and Factors

ppm to lbs/scf

(ppm X) x (conversion factor X) = X lbs/scf

lbs/scf to lbs/hr

Dry ppm's with dry flow, and wet ppm's with wet flow.

(X lbs/scf) x (airflow scf/min) x (60 min/hr) = X lbs/hr

lbs/scf to lbs/mmBtu

Dry ppm's with dry diluent, and wet ppm's with wet diluent.

CO_2 – (X lbs/scf) x (F_c) x ($100/CO_2$) = X lbs/mmBtu

O_2 – (X lbs/scf) x (F_d) x ($20.9/(20.9-O_2)$) = X lbs/mmBtu

Conversion Factors

NO_x – 1.19396×10^{-7}

SO_2 – 1.6625×10^{-7}

CO – 7.2664×10^{-8}

CH_4 – 4.1637×10^{-8}

C_3H_8 – 1.1419×10^{-7}

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ppmv to lb/hr Conversion Calculations

1. $$\text{ppm } SO_2 \times 1.660 \times 10^{-7} = \frac{\text{lbs}/SO_2}{\text{scf}}$$

$$\frac{\text{lbs } SO_2}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} = \frac{\text{lbs } SO_2}{\text{hr}}$$

2. $$\text{ppm } NO_x \times 1.194 \times 10^{-7} = \frac{\text{lbs}/NO_x}{\text{scf}}$$

$$\frac{\text{lbs } NO_x}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} = \frac{\text{lbs } NO_x}{\text{hr}}$$

3. $$\text{ppm CO} \times 7.266 \times 10^{-8} = \frac{\text{lbs}/\text{CO}}{\text{scf}}$$

$$\frac{\text{lbs CO}}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} = \frac{\text{lbs CO}}{\text{hr}}$$

4. $$\text{ppm } C_3H_8 \times 1.142 \times 10^{-7} = \frac{\text{lbs}C_3H_8}{\text{scf}}$$

$$\frac{\text{lbs } C_3H_8}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} = \frac{\text{lbs } C_3H_8}{\text{hr}}$$

5. $$\text{ppm } CH_4 \times 4.164 \times 10^{-8} = \frac{\text{lbs}CH_4}{\text{scf}}$$

$$\frac{\text{lbs } CH_4}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} = \frac{\text{lbs } CH_4}{\text{hr}}$$

6. $$\text{ppmv NMHC as } C_3H_8 \times 9.3427 \times 10^{-8} = \frac{\text{lbs C}}{\text{scf}}$$

$$\frac{\text{lbs C}}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60\text{min}}{\text{hr}} = \frac{\text{lbs C}}{\text{hr}}$$

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Appendix E - Laboratory Data

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Client:	**University of Iowa**		
Facility:	**Oakdale Renewable Energy Plant**		
Project Number:	**M133003**		
Test Location:	**Hurst Boiler Exhaust Duct**		
Test Method:	**5/202**	**Filter Drying Temp °F:**	**220**
Filterable Analysis Date:	**7/31/2013**	**Analyst:**	**JMG**
Condensable Analysis Date:	**8/6/2013**	**Analyst:**	**JMG**

Description	Date	ID#	vol. (ml)	Initial Weight (grams)	Final Weight (grams)	Net Weight Gain (grams)
Filterable Particulate						
Test No. 1	7/23/2013					
M5 Filter		6093		0.4599	0.5709	0.1110
Acetone Wash (M5 Pans)		1274	100 ml	5.3145	5.3317	0.0172
Acetone Blank						0.0003
Total Front Half Weight						**0.1279**
Condensable Particulate						
Acetone/Hexane Wash		1122	240 ml	2.6587	2.6641	0.0054
DI Wash		1283	225 ml	5.3043	5.3209	0.0166
NH_4OH Correction			0 ml			0.0000
Field Blank						0.0020
Total Back Half Weight						**0.0200**
Total Particulate Weight						**0.1479**
Filterable Particulate						
Test No. 2	7/23/2013					
M5 Filter		6092		0.4656	0.5668	0.1012
Acetone Wash (M5 Pans)		1275	65 ml	5.3118	5.3188	0.0070
Acetone Blank						0.0002
Total Front Half Weight						**0.1080**
Condensable Particulate						
Acetone/Hexane Wash		1123	230 ml	2.6504	2.6529	0.0025
DI Wash		1284	226 ml	5.3163	5.3297	0.0134
NH_4OH Correction			0 ml			0.0000
Field Blank						0.0020
Total Back Half Weight						**0.0139**
Total Particulate Weight						**0.1219**
Filterable Particulate						
Test No. 3	7/23 & 24/13					
M5 Filter		6101		0.4629	0.5744	0.1115
Acetone Wash (M5 Pans)		1276	65 ml	5.3062	5.3153	0.0091
Acetone Blank						0.0002
Total Front Half Weight						**0.1204**
Condensable Particulate						
Acetone/Hexane Wash		1124	215 ml	2.6692	2.6720	0.0028
DI Wash		1285	262 ml	5.3180	5.3373	0.0193
NH_4OH Correction			0 ml			0.0000
Field Blank						0.0020
Total Back Half Weight						**0.0201**
Total Particulate Weight						**0.1405**
Field Train Blank Summary						
Acetone/Hexane Wash		1125	215 ml	2.6607	2.6618	0.0011
DI Wash		1286	315 ml	5.3130	5.3142	0.0012
NH_4OH Correction			0 ml			0.0000
Total Field Train Blank						0.0023
Normality of NH_4OH						0.0990
Reagent Blank Summary						
Acetone Wash (M5 Pans)		1277	125 ml	5.3039	5.3043	0.0004

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Chain-of-Custody Form

Project Number: M133003

Date Results Required:

Client: UNIVERSITY OF IOWA

TAT Required:

Plant/Test Location: HURST BOILER OUTLET DUCT

Project Supervisor: DT/JFR

Sample Number	Sample Date	Sample Point Identification	# of Conts	Sub Lab	Analysis Required	Volume, mls
001	7/23	BOILER OUTLET DUCT TEST 1	5		M5/202	
002	7/23	BOILER OUTLET DUCT TEST 2	5		M5/202	
003	7/23	BOILER OUTLET DUCT TEST 3	5		M5/202	
004	7/23	PROOF BLANK	2		M5/202	
005	7/23	TRAIN BLANK	5		M5/202	
006	7/23	REAGENT BLANK	4		M5/202	
007	7/23	BOILER OUTLET DUCT TEST 1	2		M26	
008	7/23	BOILER OUTLET DUCT TEST 2	2		M26	
009	7/23	BOILER OUTLET DUCT 3	2		M26	
010	7/23	NAOH REAGENT BLANK	1		M26	
011	7/23	H_2SO_4 REAGENT BLANK	1		M26	
012	7/24	BOILER OUTLET DUCT TEST 1	2		30B (Hg)	
013	7/24	BOILER OUTLET DUCT TEST 2	2		30B (Hg)	
014	7/24	BOILER OUTLET DUCT TEST 3	2		30B (Hg)	
015						
016						
017						
018						
019						
020						

Delivered to Lab by:	Date/Time:	Received by:	Date/Time:	Processed by:	Date/Time:
DAN TUIDER	1345 7/25/13	Jane Thorne	7/25/13	Jane Thorne	8/6/13

Laboratory Notes:

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Your P.O. #: MP1778
Your Project #: M133003
Site Location: UNIVERSITY OF IOWA - OAKDALE, HURST BOILER OUTLET DUCT
Your C.O.C. #: 005, 004, 001, 002, 003, 006

Attention: Data Reporting
Mostardi Platt
888 Industrial Rd
Elmhurst, IL
USA 60126-1121

Report Date: 2013/08/15

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B3C5508
Received: 2013/07/31, 18:30

Sample Matrix: Stack Sampling Train
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Anions in Water by Ion Chromatography (1)	1	N/A	2013/08/08	BRL SOP-00105	EPA 300.0
Hydrogen Halides -Midget H2SO4 Imp	5	2013/08/08	2013/08/08	BRL SOP-00108	EPA Method 26
Volume of Sulfuric Acid Impinger	5	N/A	2013/08/01		

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) SCC/CAEAL

Encryption Key

Clayton Johnson
15 Aug 2013 09:49:04 -04:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Clayton Johnson, Project Manager - Air Toxics, Source Evaluation
Email: CJohnson@maxxam.ca
Phone# (905) 817-5769

==========

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Total cover pages: 1

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Maxxam Job #: B3C5508
Report Date: 2013/08/15

Mostardi Platt
Client Project #: M133003
Site Location: UNIVERSITY OF IOWA - OAKDALE, HURST BOILER OUTLET DUCT
Your P.O. #: MP1778

EPA M26 HYDROGEN HALIDES AND HALOGENS(M)

Maxxam ID		SM4151	SM4152	SM4153	SM4153			
Sampling Date		2013/07/23 00:01	2013/07/23 00:01	2013/07/23 00:01	2013/07/23 00:01			
COC Number		005	004	001	001			
	Units	RB-H2O	RB-H2SO4	TEST 1	TEST 1 Lab-Dup	RDL	QC Batch	MDL
Sulfuric Acid Volume	ml	160	51	53	N/A	1	3307529	1
Hydrochloric Acid	ug	<30	<30	43	42	30	3307998	6.0

N/A = Not Applicable
RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
QC Batch = Quality Control Batch

Maxxam ID		SM4154	SM4155			
Sampling Date		2013/07/23 00:01	2013/07/23 00:01			
COC Number		002	003			
	Units	TEST 2	TEST 3	RDL	QC Batch	MDL
Sulfuric Acid Volume	ml	52	48	1	3307529	1
Hydrochloric Acid	ug	<30	55	30	3307998	6.0

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B3C5508
Report Date: 2013/08/15

Mostardi Platt
Client Project #: M133003
Site Location: UNIVERSITY OF IOWA - OAKDALE, HURST BOILER OUTLET DUCT
Your P.O. #: MP1778

RESULTS OF ANALYSES OF STACK SAMPLING TRAIN

Maxxam ID		SM4156			
Sampling Date		2013/07/23 00:01			
COC Number		006			
	Units	AUDIT-1440-072313B	RDL	QC Batch	MDL
Chloride (Cl)	mg/L	11	0.1	3307538	0.01

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B3C5508
Report Date: 2013/08/15

Mostardi Platt
Client Project #: M133003
Site Location: UNIVERSITY OF IOWA - OAKDALE, HURST BOILER OUTLET DUCT
Your P.O. #: MP1778

Test Summary

Maxxam ID SM4151 **Collected** 2013/07/23
Sample ID RB-H2O **Shipped**
Matrix Stack Sampling Train **Received** 2013/07/31

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hydrogen Halides -Midget H2SO4 Imp	IC/SPEC	3307998	2013/08/08	2013/08/08	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		3307529	N/A	2013/08/01	Frank Mo

Maxxam ID SM4152 **Collected** 2013/07/23
Sample ID RB-H2SO4 **Shipped**
Matrix Stack Sampling Train **Received** 2013/07/31

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hydrogen Halides -Midget H2SO4 Imp	IC/SPEC	3307998	2013/08/08	2013/08/08	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		3307529	N/A	2013/08/01	Frank Mo

Maxxam ID SM4153 **Collected** 2013/07/23
Sample ID TEST 1 **Shipped**
Matrix Stack Sampling Train **Received** 2013/07/31

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hydrogen Halides -Midget H2SO4 Imp	IC/SPEC	3307998	2013/08/08	2013/08/08	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		3307529	N/A	2013/08/01	Frank Mo

Maxxam ID SM4153 Dup **Collected** 2013/07/23
Sample ID TEST 1 **Shipped**
Matrix Stack Sampling Train **Received** 2013/07/31

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hydrogen Halides -Midget H2SO4 Imp	IC/SPEC	3307998	2013/08/08	2013/08/08	Ann-Marie Stern

Maxxam ID SM4154 **Collected** 2013/07/23
Sample ID TEST 2 **Shipped**
Matrix Stack Sampling Train **Received** 2013/07/31

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hydrogen Halides -Midget H2SO4 Imp	IC/SPEC	3307998	2013/08/08	2013/08/08	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		3307529	N/A	2013/08/01	Frank Mo

Maxxam ID SM4155 **Collected** 2013/07/23
Sample ID TEST 3 **Shipped**
Matrix Stack Sampling Train **Received** 2013/07/31

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hydrogen Halides -Midget H2SO4 Imp	IC/SPEC	3307998	2013/08/08	2013/08/08	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		3307529	N/A	2013/08/01	Frank Mo

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Report Date: 2013/08/15

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Client Project #: M133003
Site Location: UNIVERSITY OF IOWA - OAKDALE, HURST BOILER OUTLET DUCT
Your P.O. #: MP1778

Test Summary

Maxxam ID SM4156
Sample ID AUDIT-1440-072313B
Matrix Stack Sampling Train

Collected 2013/07/23
Shipped
Received 2013/07/31

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Anions in Water by Ion Chromatography	IC/EC	3307538	N/A	2013/08/08	Ann-Marie Stern

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Report Date: 2013/08/15

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Client Project #: M133003
Site Location: UNIVERSITY OF IOWA - OAKDALE, HURST BOILER OUTLET DUCT
Your P.O. #: MP1778

GENERAL COMMENTS

Results relate only to the items tested.

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Attention: Data Reporting
Client Project #: M133003
P.O. #: MP1778
Site Location: UNIVERSITY OF IOWA - OAKDALE, HURST BOILER OUTLET DUCT

Quality Assurance Report

Maxxam Job Number: GB3C5508

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3307998 A_S	Matrix Spike (SM4153)	Hydrochloric Acid	2013/08/08		100	%	80 - 120
	Spiked Blank	Hydrochloric Acid	2013/08/08		100	%	90 - 110
	Method Blank	Hydrochloric Acid	2013/08/08	<30		ug	
	RPD - Sample/Sample Dup	Hydrochloric Acid	2013/08/08	NC		%	20

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

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Validation Signature Page

Maxxam Job #: B3C5508

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Frank Mo, B.Sc., Inorganic Lab. Manager

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PO# MP1778

Chain-of-Custody Form

Project Number: M133003	Date Results Required:
Client: University of Iowa	TAT Required:
Plant/Test Location: Oakdale, Hurst Boiler Outlet Duct	Project Supervisor: DT/JFR

Sample Number	Sample Date	Sample Point Identification	# of Cans	Sub Unit	Analysis Required	Volume mls
001	7/23/13	Test 1- H2SO4 Impe	1	Mex	M26-HCl	53
002	7/23/13	Test 2- H2SO4 Impe	1	Mex	M26-HCl	52
003	7/23/13	Test 3- H2SO4 Impe	1	Mex	M26-HCl	48
004	7/23/13	H2SO4 Reagent Blank	1	Mex	M26-HCl	51
005	7/23/13	DI Reagent Blank	1	Mex	M26-HCl	160
006	7/23/13	Audit Sample	1	Mex	M26-HCl	
007						
008						
009						
010						
011						
012						
013						
014						
015						
016						
017						
018						
019						
020						

Delivered to Lab by:	Date/Time:	Received by:	Date/Time:	Processed by:	Date/Time:
[illegible]	7/31/13	[illegible]	7/31/13 16:40		

Laboratory Notes:

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Ohio Lumex Calibration and Results Summary
University of Iowa
Oakdale Renewable Energy Center
Hurst Boiler Exhaust Duct
July 24, 2013

No	Description	M, mg	C, ng/g	Area	Maximum	Time
1	Std__10 Ricca	1		18500	1190	8:43:23 AM
2	Std__100 Ricca	1	100	83600	7920	8:46:36 AM
3	Std__50 Ricca	1	49	40700	3800	8:50:19 AM
4	Std__25 Ricca	1	26	22300	2350	8:52:57 AM
5	Std__250 Ricca	1	249	207000	15400	8:55:28 AM
6	Std__10 Ricca	1	11	9280	626	8:57:38 AM
7	Std__25 HP ICV	1	27	22600	2430	9:51:47 AM
8	U of Iowa Test 1A Trap 168444 Section 1	1	22	18800	791	10:03:46 AM
9	U of Iowa Test 1A Trap 168444 Section 2	1	0.6	533	13	10:06:11 AM
10	U of Iowa Test 1B Trap 124022 Section 1 25ng Spike	1	45	37500	1550	10:09:35 AM
11	U of Iowa Test 1B Trap 124022 Section 2 25ng Spike	1	0.7	585	13	10:12:38 AM
12	U of Iowa Test 2A Trap 168405 Section 1	1	12	10700	490	10:16:30 AM
13	U of Iowa Test 2A Trap 168405 Section 2	1	0.4	341	9	10:20:12 AM
14	U of Iowa Test 2B Trap 123480 Section 1 25ng Spike	1	37	31200	1300	10:23:38 AM
15	U of Iowa Test 2B Trap 123480 Section 2 25ng Spike	1	0.6	487	12	10:26:56 AM
16	Std__25 Ricca	1	23	19500	1270	10:29:42 AM
17	U of Iowa Test 3A Trap 168415 Section 1	1	10	8680	323	10:34:04 AM
18	U of Iowa Test 3A Trap 168415 Section 2	1	0.6	477	13	10:37:10 AM
19	U of Iowa Test 3B Trap 122453 Section 3 25ng Spike	1	33	28000	1720	10:39:39 AM
20	U of Iowa Test 3B Trap 122453 Section 3 25ng Spike	1	0.5	407	13	10:42:42 AM
21	Std__25 Ricca	1	23	19400	1600	10:46:32 AM
22		1				

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ERA
A Waters Company

August 15, 2013

Jenna Ghanma
Mostardi Platt
888 Industrial Drive
Elmhurst, IL 60123

Enclosed is your final report for ERA's Stationary Source Audit Sample (SSAS) Program. Your final report includes an evaluation of all results submitted by your laboratory to ERA.

Data Evaluation Protocols: All analytes in ERA's SSAS Program have been evaluated comparing the reported result to the acceptance limits generated using the criteria contained in the TNI SSAS Table.

For any "Not Acceptable" results, please contact your state regulator for any corrective action requirements.

Thank you for your participation in ERA's SSAS Program. If you have any questions, please contact our Proficiency Testing Department at 1-800-372-0122.

Sincerely,

Kristina Sanchez
Quality Officer

cc: Project File Number 072313B

16341 Table Mountain Pkwy • Golden, CO 80403 • 800.372.0122 • 303.431.8454 • fax 303.421.0159 • www.eraqc.com

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ERA
A Waters Company

Recipient Type	Report Recipient	Contact
Agency	IA-DNR (SSAS) 7900 Hickman Road Suite 1 Windsor Heights, IA 50324 USA	Dennis Thielen dennis.thielen@dnr.iowa.gov Phone: 515-281-4899
Facility	University of Iowa - Oakdale Campus 2320 Crosspark Rd Coralville, IA 52241 USA	Mark Maxwell mark.maxwell@uiowa.edu Phone: 319-335-6185
Lab	Maxxam Analytics Inc 6740 Campobello Rd Mississauga, AL L5N 2L8 USA	Clayton Johnson cjohnson@maxxamanalytics.com Phone: (905) 817-5769
Tester	Mostardi Platt 888 Industrial Drive Elmhurst, IL 60123 USA	Jenna Ghanma jghanma@mp-mail.com Phone: 630-993-2685

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072313B Laboratory Exception Report

A Waters Company

Clayton Johnson
Maxxam Analytics Inc
6740 Campobello Rd
Mississauga, AL L5N 2L8
(905) 817-5769

EPA ID: **Not Reported**
ERA Customer Number: **M748564**

Evaluation Checks

There are no values reported with < where the assigned value was greater than 0.

Not Acceptable Evaluations

There were no Not Acceptable evaluations for this study.

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ERA
A Waters Company

SSAP Evaluation Report

Project Number: **072313B**

ERA Customer Number: **M748564**

Laboratory Name: **Maxxam Analytics Inc**

Inorganic Results

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ERA

A Waters Company

Project No. M133003
Hurst Boiler Exhaust Duct

Final Report Results For Laboratory
Maxxam Analytics Inc

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072313B Evaluation Final Complete Report

ERA
A Waters Company

Clayton Johnson
Maxxam Analytics Inc
6740 Campobello Rd
Mississauga, AL L5N 2L8
(905) 817-5769

EPA ID: Not Reported
ERA Customer Number: M748564

Project No. M133003
Hurst Boiler Exhaust Duct

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
SSAP Hydrogen Halides in Impinger Solution (cat# 1140-1) Study Dates: 07/23/13 - 08/15/13												
1770	Hydrogen Chloride	mg/L	10.6	10.0	9.00 - 11.0	Acceptable	EPA Method 26 2000	8/8/2013	0			
1775	Hydrogen Fluoride	mg/L		< 4.50	0.00 - 4.50	Not Reported						

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Appendix F - Reference Method Test Data (Computerized Sheets)

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Compliance Stratification Test Results Summary
University of Iowa
Oakdale Renewable Energy Plant
Hurst Boiler Exhaust Duct
July 24, 2013

Number of Ports Sampled:	5
Number of Points per Port:	4
Total Number of Traverse Points:	20

Port No.	Point No.	Point Marking, Inches	Time	O_2%	Actual % Difference O_2%	CO_2%	Actual % Difference CO_2%	NO_x ppm	Actual % Difference NO_x ppm	CO ppm	Actual % Difference CO ppm
1	1	11.25	10:15	14.85	30.02	5.91	36.15	20.8	42.71	2.2	1.79
	2	21.75	10:19	14.60	27.83	6.18	33.23	24.1	33.62	2.0	10.71
	3	32.25	10:23	12.43	8.83	8.26	10.76	34.6	4.70	2.0	10.71
	4	42.75	10:27	10.73	6.05	9.96	7.61	38.2	5.22	4.3	91.96
2	1	53.25	10:35	13.73	20.22	7.07	23.61	25.2	30.59	1.7	24.11
	2	63.75	10:39	10.78	5.61	9.91	7.07	34.9	3.87	2.2	1.79
	3	11.25	10:43	10.27	10.08	10.38	12.15	37.7	3.84	2.2	1.79
	4	21.75	10:47	11.92	4.37	8.78	5.14	33.9	6.62	1.8	19.64
3	1	32.25	10:54	9.79	14.28	10.82	16.90	43.9	20.92	2.5	11.61
	2	42.75	10:58	10.56	7.54	10.12	9.34	42.2	16.24	2.0	10.71
	3	53.25	11:02	11.07	3.07	9.64	4.15	34.3	5.52	2.3	2.68
	4	63.75	11:06	14.46	26.61	6.30	31.93	23.8	34.44	1.5	33.04
4	1	11.25	11:11	9.79	14.28	10.79	16.58	43.9	20.92	2.2	1.79
	2	21.75	11:15	10.00	12.44	10.63	14.85	43.7	20.37	2.2	1.79
	3	32.25	11:19	9.93	13.05	10.70	15.61	43.6	20.09	2.4	7.14
	4	42.75	11:23	11.24	1.58	9.47	2.32	36.6	0.81	2.0	10.71
5	1	53.25	11:32	9.62	15.77	10.95	18.31	42.9	18.17	2.2	1.79
	2	63.75	11:36	9.65	15.51	10.93	18.09	42.9	18.17	2.4	7.14
	3	11.25	11:40	9.23	19.18	11.37	22.85	43.6	20.09	2.6	16.07
	4	21.75	11:44	13.77	20.57	6.94	25.02	35.3	2.77	2.1	6.25
Average				**11.42**		**9.26**		**36.3**		**2.2**	

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Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Project #: M133003
Test Location: Hurst Boiler Exhaust Duct
Operating Condition: Normal
Date: 7/24/13

Run 1

Time	NOx ppmvd	CO ppmvd	O2 % (dry)	CO2 % (dry)
10:15	20.80	2.20	14.85	5.91
10:16	21.80	2.20	14.56	6.23
10:17	23.10	2.40	14.51	6.28
10:18	23.80	2.50	14.35	6.44
10:19	24.10	2.00	14.60	6.18
10:20	25.20	2.20	13.58	7.21
10:21	33.20	2.50	12.13	8.57
10:22	34.80	2.50	12.09	8.60
10:23	34.60	2.00	12.43	8.26
10:24	33.50	2.40	12.24	8.45
10:25	33.40	2.10	12.44	8.25
10:26	35.90	3.20	11.30	9.41
10:27	38.20	4.30	10.73	9.96
10:35	25.20	1.70	13.73	7.07
10:36	26.10	1.90	12.04	8.72
10:37	33.30	2.40	10.87	9.82
10:38	34.40	2.30	10.66	10.02
10:39	34.90	2.20	10.78	9.91
10:40	35.20	2.10	10.65	10.02
10:41	36.50	1.90	10.51	10.15
10:42	37.30	2.00	10.45	10.21
10:43	37.70	2.20	10.27	10.38
10:44	39.00	2.10	10.39	10.24
10:45	34.70	1.80	12.24	8.45
10:46	33.30	1.70	11.93	8.76
10:47	33.90	1.80	11.92	8.78
10:54	43.90	2.50	9.79	10.82
10:55	45.30	2.00	9.83	10.79
10:56	46.30	1.80	10.01	10.62
10:57	45.10	1.90	10.26	10.39
10:58	42.20	2.00	10.56	10.12
10:59	39.90	2.10	10.71	9.98
11:00	37.10	2.10	11.27	9.44
11:01	34.50	2.10	11.20	9.51
11:02	34.30	2.30	11.07	9.64
11:03	34.20	2.10	12.55	8.14
11:04	22.80	1.50	14.77	5.99
11:05	22.30	1.50	14.60	6.17
11:06	23.80	1.50	14.46	6.30
11:10	43.50	2.10	9.93	10.68
11:11	43.90	2.20	9.79	10.79
11:12	44.60	2.30	9.77	10.81
11:13	44.10	2.20	9.91	10.70
11:14	43.80	2.20	9.97	10.64
11:15	43.70	2.20	10.00	10.63
11:16	43.40	2.30	10.19	10.43
11:17	42.20	2.40	10.08	10.55
11:18	43.40	2.40	9.60	11.00
11:19	43.60	2.40	9.93	10.70
11:20	42.00	2.20	10.72	9.95
11:21	37.40	2.00	11.25	9.45
11:22	37.30	2.00	11.45	9.25
11:23	36.60	2.00	11.24	9.47
11:32	42.90	2.20	9.62	10.95
11:33	42.50	2.30	9.75	10.83
11:34	42.30	2.40	9.70	10.88
11:35	43.30	2.40	9.58	10.99
11:36	42.90	2.40	9.65	10.93
11:37	42.20	2.40	9.75	10.84
11:38	42.40	2.40	9.62	10.98
Average	**36.40**	**2.20**	**11.31**	**9.38**

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Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Project #: M133003
Test Location: Hurst Boiler Exhaust Duct
Operating Condition: Normal
Date: 7/24/13
Run 2

Time	NOx ppmvd	CO ppmvd	O2 % (dry)	CO2 % (dry)
12:29	40.50	1.90	9.54	11.02
12:30	40.90	1.90	9.55	11.01
12:31	40.30	1.90	9.67	10.89
12:32	39.50	1.90	9.80	10.78
12:33	38.70	1.90	9.82	10.77
12:34	38.20	2.00	9.63	10.94
12:35	38.50	2.00	9.72	10.85
12:36	38.10	2.00	9.80	10.78
12:37	37.70	2.00	9.53	11.05
12:38	39.20	2.00	9.08	11.52
12:39	40.50	1.90	9.19	11.41
12:40	40.50	1.90	9.27	11.33
12:44	38.00	1.80	9.98	10.61
12:45	37.50	1.80	9.97	10.82
12:46	36.30	1.80	10.09	10.51
12:47	35.70	1.80	10.07	10.55
12:48	36.10	2.00	9.93	10.67
12:49	36.60	2.20	9.97	10.62
12:50	37.00	2.00	9.95	10.65
12:51	37.70	1.80	9.89	10.70
12:52	38.90	1.80	9.77	10.80
12:53	39.70	1.70	9.76	10.82
12:54	40.20	1.70	9.48	11.09
12:55	41.70	1.80	9.47	11.10
13:01	38.10	1.80	10.16	10.46
13:02	37.80	1.90	10.17	10.45
13:03	37.00	1.80	10.25	10.37
13:04	37.00	1.90	10.18	10.45
13:05	38.10	2.30	9.36	11.22
13:06	40.80	2.90	9.60	10.97
13:07	39.60	2.20	10.39	10.26
13:08	38.30	1.70	10.48	10.17
13:09	35.20	1.60	11.72	8.95
13:10	33.00	1.60	11.80	8.88
13:11	32.10	1.60	12.03	8.63
13:12	30.90	1.70	11.93	8.75
13:19	29.30	1.50	13.02	7.71
13:20	29.30	1.80	13.06	7.67
13:21	30.20	1.70	12.93	7.79
13:22	33.00	1.80	10.77	9.91
13:23	42.30	2.10	9.84	10.76
13:24	42.60	2.30	9.97	10.64
13:25	41.90	2.40	10.07	10.54
13:26	41.00	2.40	10.26	10.37
13:27	40.40	2.60	10.37	10.27
13:28	40.60	2.80	10.63	9.99
13:29	24.50	3.20	17.49	3.30
13:30	10.90	2.00	17.76	3.07
13:38	16.20	1.70	15.55	5.20
13:39	15.70	1.70	15.41	5.33
13:40	18.10	1.80	14.24	6.54
13:41	19.80	2.20	13.96	6.82
13:42	20.00	2.30	13.51	7.26
13:43	22.80	2.90	12.66	8.04
13:44	26.00	3.20	12.06	8.62
13:45	29.70	3.50	11.04	9.65
13:46	34.40	3.30	10.60	10.05
13:47	36.50	3.10	10.42	10.22
13:48	36.90	3.10	10.47	10.18
13:49	29.70	2.90	14.74	5.94
Average	**34.60**	**2.10**	**11.03**	**9.61**

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Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Project #: M133003
Test Location: Hurst Boiler Exhaust Duct
Operating Condition: Normal
Date: 7/24/13
Run 3

Time	NOx ppmvd	CO ppmvd	O2 % (dry)	CO2 % (dry)
14:45	20.90	7.10	14.58	6.15
14:46	20.70	7.10	15.06	5.64
14:47	18.90	5.10	15.26	5.44
14:48	20.40	2.20	15.41	5.28
14:49	19.70	2.30	15.48	5.22
14:50	22.20	2.90	13.59	7.12
14:51	30.20	2.80	12.44	8.22
14:52	32.90	3.80	11.43	9.23
14:53	33.70	3.30	11.66	9.00
14:54	33.00	5.10	11.43	9.24
14:55	35.00	3.90	10.83	9.82
14:56	34.90	4.50	10.84	9.81
15:00	30.40	3.60	12.09	8.55
15:01	30.30	5.10	11.89	8.77
15:02	30.30	7.30	12.02	8.64
15:03	30.90	3.40	11.27	9.39
15:04	36.20	2.10	10.24	10.37
15:05	37.00	1.90	10.32	10.31
15:06	37.40	2.30	10.16	10.44
15:07	38.10	2.50	10.05	10.53
15:08	38.10	3.50	10.10	10.48
15:09	37.80	3.80	10.11	10.47
15:10	35.60	4.00	11.61	9.00
15:11	33.30	4.10	11.68	8.96
15:16	39.90	7.00	10.31	10.29
15:17	40.00	5.30	10.42	10.19
15:18	39.00	4.50	10.45	10.17
15:19	38.60	3.40	10.48	10.13
15:20	39.10	2.60	10.29	10.32
15:21	38.20	3.00	10.36	10.25
15:22	37.40	3.10	10.47	10.14
15:23	35.00	3.40	10.78	9.87
15:24	35.20	4.30	10.55	10.08
15:25	35.60	3.30	10.53	10.10
15:28	27.10	1.90	15.18	5.49
15:27	15.80	1.30	16.19	4.53
15:33	32.90	2.50	10.01	10.57
15:34	33.20	2.70	10.03	10.55
15:35	33.70	2.30	9.94	10.62
15:36	33.90	2.30	10.22	10.36
15:37	32.90	2.10	10.44	10.17
15:38	32.70	2.00	10.36	10.25
15:39	33.30	2.00	10.26	10.34
15:40	34.40	2.60	10.17	10.42
15:41	34.40	3.30	10.14	10.44
15:42	33.90	2.10	10.19	10.40
15:43	33.80	2.20	10.23	10.37
15:44	34.00	2.50	10.01	10.57
15:49	37.60	2.20	9.61	10.92
15:50	38.40	2.60	8.88	11.68
15:51	40.20	3.30	8.86	11.71
15:52	40.80	2.80	9.22	11.33
15:53	39.60	2.00	9.47	11.06
15:54	37.90	1.90	9.65	10.89
15:55	36.20	1.90	9.72	10.84
15:56	35.10	2.10	9.65	10.89
15:57	34.40	2.10	9.66	10.88
15:58	34.40	2.20	9.54	11.00
15:59	34.50	2.30	9.45	11.08
16:00	33.30	2.40	9.89	10.67
Average	**33.40**	**3.20**	**11.02**	**9.59**

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University of Iowa
Oakdale Renewable Energy Plant
Hurst Boiler Exhaust Duct
Volumetric Flow Data - Normal Load

Test Run	Test Date	Pre Flow SCFH	Post Flow SCFH	Average Reference Method Flow SCFH
Pre 1/Post 1	07/24/13	446,268	471,904	459,086
Pre 2/Post 2	07/24/13	471,904	474,939	473,421
Pre 3/Post 3	07/24/13	474,939	487,909	481,424

Test Run	Test Date	Pre Flow SCFM	Post Flow SCFM	Average Reference Method Flow SCFM
Pre 1/Post 1	07/24/13	7,438	7,865	7,651
Pre 2/Post 2	07/24/13	7,865	7,916	7,890
Pre 3/Post 3	07/24/13	7,916	8,132	8,024

Test Run	Test Date	Pre Flow DSCFM	Post Flow DSCFM	Average Reference Method Flow DSCFM
Pre 1/Post 1	07/24/13	6,106	6,457	6,282
Pre 2/Post 2	07/24/13	6,457	6,475	6,466
Pre 3/Post 3	07/24/13	6,475	6,684	6,580

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Client:	University of Iowa	
Facility:	Oakdale Renewable Energy Plant	
Test Location:	Hurst Boiler Exhaust Duct	
Project #:	M133003	
Test Method:	2 (Compliance)	
Test Engineer:	DT	
Test Technician:	AD	
Type of Fuel Firing:	Wood	
Temp ID:	CM6	
Meter ID:	CM6	
Pitot ID:	170	
Pitot Type:	S-Type	
Pitot Tube Coefficient:	0.840	
Probe Length:	4.0	**ft**
Sample Plane:	Horizontal	
Port Length:	6.00	**in.**
Port Size (diameter):	6.00	**in.**
Port Type:	Flange	
Duct Shape:	Rectangular	
Length (traverse side of duct):	3.5	**ft**
Width:	5.5	**ft**
Location of Test Ports:	Side of duct	
Duct Area:	19.25	**Sq. Ft.**
Equivalent Diameter Rectangular Duct:	4.278	
Upstream Diameters:	>0.5	
Downstream Diameters:	>2	
Number of Ports Sampled:	5	
Number of Points per Port:	4	
Total Number of Traverse Points:	20	
Operating Level:	Normal	
Servomex Serial Number:	01440D1/4446	
Moisture Balance ID:	S10-36	
Stack Liner Material:	S	
Default WAF:	0.995	
Type of WAF Applied:	N	
Actual WAF Applied to all runs:		

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METHOD 2 VOLUMETRIC FLOW DATA

Project Number:	M133003	**Operating Level:**	Normal		
Client:	University of Iowa	**Run No.:**	Pre 1		
Facility:	Oakdale Renewable Energy Plant	**Test Date:**	7/24/2013		
Test Location:	Hurst Boiler Exhaust Duct	**Start Time:**	9:57		
Pitot ID:	170	**End Time:**	10:10		
Pitot Coefficient:	0.840	**Test Engineer:**	DT	**Test Tech:**	AD
Probe Length, Feet:	4	**Port Length, Inches:**	6		

Port	Point	DP (in. H_2O)	Sqrt. DP	Temp (°F)	Velocity (V)
A	1	0.015	0.1225	379.0	8.93
A	2	0.015	0.1225	385.0	8.96
A	3	0.015	0.1225	385.0	8.96
A	4	0.015	0.1225	368.0	8.87
B	1	0.025	0.1581	370.0	11.47
B	2	0.020	0.1414	373.0	10.28
B	3	0.015	0.1225	372.0	8.90
B	4	0.010	0.1000	359.0	7.21
C	1	0.030	0.1732	365.0	12.53
C	2	0.030	0.1732	368.0	12.55
C	3	0.025	0.1581	369.0	11.46
C	4	0.015	0.1225	340.0	8.72

Port	Point	DP (in. H_2O)	Sqrt. DP	Temp (°F)	Velocity (V)
D	1	0.030	0.1732	351.0	12.42
D	2	0.030	0.1732	355.0	12.45
D	3	0.035	0.1871	359.0	13.48
D	4	0.030	0.1732	354.0	12.44
E	1	0.010	0.1000	324.0	7.05
E	2	0.015	0.1225	319.0	8.61
E	3	0.015	0.1225	316.0	8.59
E	4	0.020	0.1414	309.0	9.88

Test Parameters

P_{bar} - Barometric pressure, inches Hg	29.25	% CO_2	9.40
P_g - Stack Pressure, inches of H_2O	-0.20	% O_2	11.40
P_s - Absolute stack pressure, inches Hg	29.24	% N_2	79.20
t_s - Average stack temperature, °F	356.0	Md - dry basis lb/lb mole	29.96
Duct Shape:	Rectangular	Ms - wet basis lb/lb mole	27.819
Length, Feet	3.5		
Width, Feet	5.5		
		Bws - Moisture content fraction	**0.179**
Cross Sectional Area of Stack, Ft^2	19.25	Moisture determined by wb/db?	N

Method 2 Results

Average DP	0.0208	Q - ACFM	11,764
Average Sqrt DP	0.1416	Qsd - DSCFM	6,106
Average Velocity Vs (ft/sec)	10.185	Qs - SCFM	7,438
		Qs - SCFH	446,268

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METHOD 2 VOLUMETRIC FLOW DATA

Project Number:	M133003	**Operating Level:**	Normal		
Client:	University of Iowa	**Run No.:**	Post 1/Pre 2		
Facility:	Oakdale Renewable Energy Plant	**Test Date:**	7/24/2013		
Test Location:	Hurst Boiler Exhaust Duct	**Start Time:**	11:53		
Pitot ID:	170	**End Time:**	12:03		
Pitot Coefficient:	0.840	**Test Engineer:**	DT	**Test Tech:**	AD
Probe Length, Feet:	4	**Port Length, Inches:**	6		

Port	Point	DP (in. H_2O)	Sqrt. DP	Temp (°F)	Velocity (V)
A	1	0.020	0.1414	306.0	9.86
A	2	0.025	0.1581	309.0	11.04
A	3	0.025	0.1581	324.0	11.15
A	4	0.025	0.1581	339.0	11.25
B	1	0.035	0.1871	338.0	13.31
B	2	0.040	0.2000	367.0	14.48
B	3	0.045	0.2121	374.0	15.43
B	4	0.030	0.1732	357.0	12.47
C	1	0.030	0.1732	354.0	12.44
C	2	0.035	0.1871	365.0	13.53
C	3	0.020	0.1414	370.0	10.26
C	4	0.015	0.1225	343.0	8.74

Port	Point	DP (in. H_2O)	Sqrt. DP	Temp (°F)	Velocity (V)
D	1	0.020	0.1414	373.0	10.28
D	2	0.025	0.1581	382.0	11.55
D	3	0.015	0.1225	384.0	8.96
D	4	0.015	0.1225	375.0	8.91
E	1	0.015	0.1225	380.0	8.94
E	2	0.015	0.1225	384.0	8.96
E	3	0.010	0.1000	388.0	7.33
E	4	0.010	0.1000	386.0	7.32

Test Parameters

P_{bar} - Barometric pressure, Inches Hg	29.25	% CO_2	9.40
P_g - Stack Pressure, inches of H_2O	-0.20	% O_2	11.40
P_s - Absolute stack pressure, inches Hg	29.24	% N_2	79.20
t_s - Average stack temperature, °F	359.9	Md - dry basis lb/lb mole	29.96
Duct Shape:	Rectangular	Ms - wet basis lb/lb mole	27.819
Length, Feet	3.5		
Width, Feet	5.5		
		Bws - Moisture content fraction	**0.179**
Cross Sectional Area of Stack, Ft^2	19.25	Moisture determined by wb/db?	N

Method 2 Results

Average DP	0.0235	Q - ACFM	12,499
Average Sqrt DP	0.1501	Qsd - DSCFM	6,457
Average Velocity Vs (ft/sec)	10.822	Qs - SCFM	7,865
		Qs - SCFH	471,904

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METHOD 2 VOLUMETRIC FLOW DATA

Project Number:	M133003	**Operating Level:**	Normal		
Client:	University of Iowa	**Run No.:**	Post 2/Pre 3		
Facility:	Oakdale Renewable Energy Plant	**Test Date:**	7/24/2013		
Test Location:	Hurst Boiler Exhaust Duct	**Start Time:**	14:31		
Pitot ID:	170	**End Time:**	14:42		
Pitot Coefficient:	0.840	**Test Engineer:**	DT	**Test Tech:**	AD
Probe Length, Feet:	4	**Port Length, Inches:**	6		

Port	Point	DP (In. H_2O)	Sqrt. DP	Temp (°F)	Velocity (V)
A	1	0.015	0.1225	375.0	8.91
A	2	0.020	0.1414	378.0	10.31
A	3	0.020	0.1414	381.0	10.33
A	4	0.015	0.1225	379.0	8.94
B	1	0.025	0.1581	365.0	11.44
B	2	0.025	0.1581	366.0	11.45
B	3	0.020	0.1414	366.0	10.24
B	4	0.015	0.1225	354.0	8.80
C	1	0.035	0.1871	360.0	13.49
C	2	0.035	0.1871	362.0	13.51
C	3	0.025	0.1581	361.0	11.41
C	4	0.020	0.1414	361.0	10.21
D	1	0.035	0.1871	357.0	13.47
D	2	0.035	0.1871	363.0	13.52
D	3	0.035	0.1871	361.0	13.50
D	4	0.025	0.1581	339.0	11.26
E	1	0.020	0.1414	311.0	9.89
E	2	0.020	0.1414	310.0	9.89
E	3	0.015	0.1225	300.0	8.50
E	4	0.010	0.1000	300.0	6.94

Test Parameters

P_{bar} - Barometric pressure, inches Hg	29.25	% CO_2	9.60
P_g - Stack Pressure, Inches of H_2O	-0.20	% O_2	11.10
P_s - Absolute stack pressure, inches Hg	29.24	% N_2	79.30
t_s - Average stack temperature, °F	352.5	Md - dry basis lb/lb mole	29.98
Duct Shape:	Rectangular	Ms - wet basis lb/lb mole	27.800
Length, Feet	3.5		
Width, Feet	5.5		
		Bws - Moisture content fraction	**0.182**
Cross Sectional Area of Stack, Ft^2	19.25	Moisture determined by wb/db?	N

Method 2 Results

Average DP	0.0233	Q - ACFM	12,465
Average Sqrt DP	0.1503	Qsd - DSCFM	6,475
Average Velocity Vs (ft/sec)	10.792	Qs - SCFM	7,916
		Qs - SCFH	474,939

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METHOD 2 VOLUMETRIC FLOW DATA

Project Number:	M133003	**Operating Level:**	Normal		
Client:	University of Iowa	**Run No.:**	Post 3/Pre 4		
Facility:	Oakdale Renewable Energy Plant	**Test Date:**	7/24/2013		
Test Location:	Hurst Boiler Exhaust Duct	**Start Time:**	16:06		
Pitot ID:	170	**End Time:**	16:16		
Pitot Coefficient:	0.840	**Test Engineer:**	DT	**Test Tech:**	AD
Probe Length, Feet:	4	**Port Length, inches:**	6		

Port	Point	DP (in. H_2O)	Sqrt. DP	Temp (°F)	Velocity (V)
A	1	0.010	0.1000	387.0	7.32
A	2	0.015	0.1225	388.0	8.98
A	3	0.010	0.1000	389.0	7.33
A	4	0.010	0.1000	374.0	7.27
B	1	0.020	0.1414	376.0	10.29
B	2	0.025	0.1581	377.0	11.51
B	3	0.020	0.1414	381.0	10.32
B	4	0.015	0.1225	366.0	8.86
C	1	0.035	0.1871	378.0	13.63
C	2	0.040	0.2000	382.0	14.61
C	3	0.030	0.1732	384.0	12.66
C	4	0.025	0.1581	351.0	11.33

Port	Point	DP (in. H_2O)	Sqrt. DP	Temp (°F)	Velocity (V)
D	1	0.025	0.1581	358.0	11.38
D	2	0.035	0.1871	360.0	13.48
D	3	0.045	0.2121	367.0	15.35
D	4	0.030	0.1732	348.0	12.39
E	1	0.030	0.1732	325.0	12.21
E	2	0.030	0.1732	328.0	12.24
E	3	0.030	0.1732	335.0	12.29
E	4	0.025	0.1581	322.0	11.13

Test Parameters

P_{bar} - Barometric pressure, inches Hg	29.25	% CO_2	9.60
P_g - Stack Pressure, inches of H_2O	-0.20	% O_2	11.10
P_s - Absolute stack pressure, inches Hg	29.24	% N_2	79.30
t_s - Average stack temperature, °F	363.8	Md - dry basis lb/lb mole	29.98
Duct Shape:	Rectangular	Ms - wet basis lb/lb mole	27.848
Length, Feet	3.5		
Width, Feet	5.5		
		Bws - Moisture content fraction	**0.178**
Cross Sectional Area of Stack, Ft^2	19.25	Moisture determined by wb/db?	N

Method 2 Results

Average DP	0.0253	Q - ACFM	12,985
Average Sqrt DP	0.1556	Qsd - DSCFM	6,684
Average Velocity Vs (ft/sec)	11.242	Qs - SCFM	8,132
		Qs - SCFH	487,909

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METHOD 4 MOISTURE DETERMINATION

Project Number:	M133003	**Run Number:**	1		
Client:	University of Iowa	**Operating Level:**	Normal		
Facility:	Oakdale Renewable Energy Plant	**Time:**	**Start-** 10:25	**End-** 11:10	
Test Location:	Hurst Boiler Exhaust Duct	**Test Engineer:**	DT		
Test Date:	7/24/2013	**Test Tech:**	AD		
Pressure, Barometric(Hg"):	29.25	**Meter Calibration (Y):**	1.006		
Delta H:	1.518	**Meter Delta H (dH):**	1.518		
Meter Initial Volume:	600.810	**Initial Wt:**	2059.3		
Meter Final Volume:	633.100	**Final Wt:**	2177.5		
Meter Temperature:	85.40	**Initial Volume:**	851.9		
Meter Volume dscf:	30.860	**Final Volume:**	876.1		
		Water Vapor in Flue Gas (Bws):	**0.179**		

Project Number:	M133003	**Run Number:**	2		
Client:	University of Iowa	**Operating Level:**	Normal		
Facility:	Oakdale Renewable Energy Plant	**Time:**	**Start-** 12:31	**End-** 13:16	
Test Location:	Hurst Boiler Exhaust Duct	**Test Engineer:**	DT		
Test Date:	7/24/2013	**Test Tech:**	AD		
Pressure, Barometric(Hg"):	29.25	**Meter Calibration (Y):**	1.006		
Delta H:	1.518	**Meter Delta H (dH):**	1.518		
Meter Initial Volume:	634.263	**Initial Wt:**	2100.9		
Meter Final Volume:	666.551	**Final Wt:**	2235.2		
Meter Temperature:	90.95	**Initial Volume:**	742.4		
Meter Volume dscf:	30.548	**Final Volume:**	752.6		
		Water Vapor in Flue Gas (Bws):	**0.182**		

Project Number:	M133003	**Run Number:**	3		
Client:	University of Iowa	**Operating Level:**	Normal		
Facility:	Oakdale Renewable Energy Plant	**Time:**	**Start-** 14:46	**End-** 15:31	
Test Location:	Hurst Boiler Exhaust Duct	**Test Engineer:**	DT		
Test Date:	7/24/2013	**Test Tech:**	AD		
Pressure, Barometric(Hg"):	29.25	**Meter Calibration (Y):**	1.006		
Delta H:	1.518	**Meter Delta H (dH):**	1.518		
Meter Initial Volume:	666.521	**Initial Wt:**	1988.6		
Meter Final Volume:	699.207	**Final Wt:**	2120.2		
Meter Temperature:	91.90	**Initial Volume:**	853.0		
Meter Volume dscf:	30.871	**Final Volume:**	863.1		
		Water Vapor in Flue Gas (Bws):	**0.178**		

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Client:	University of Iowa			
Facility:	Oakdale Renewable Energy Plant			
Test Location:	Hurst Boiler Exhaust Duct			
Project #:	M133003			
Test Method:	5/202			
Test Engineer:	DT			
Test Technician:	AD			
lb/mmBtu Emissions by:	Calculated			
Type of Fuel Firing:	Wood			
	R1	**R2**	**R3**	
Calculated Fuel Factor Fd, dscf/mmBtu:	9491.95	9334.43	9407.68	
Temp ID:	CM6	CM6	CM6	
Meter ID:	CM6	CM6	CM6	
Pitot ID:	203	203	203	
Nozzle Diameter:	0.495	0.495	0.495	**in.**
Meter Calibration Factor (Y):	1.006	1.006	1.006	
Meter Orifice Setting (Delta H):	1.518	1.518	1.518	
Pitot Tube Coefficient:	0.840			
Probe Length:	4.0			**ft**
Probe Liner Material:	Glass			
Nozzle Kit ID Number and Material:	SS # 7			
Sample Plane:	Horizontal			
Port Length:	6.00			**in.**
Port Size (diameter):	6.00			**in.**
Port Type:	Flange			
Duct Shape:	Rectangular			
Length	3.5			**ft**
Width	5.5			**ft**
Duct Area:	19.250			**Sq. Ft.**
Equivalent Diameter Rectangular Duct:	4.278			
Upstream Diameters:	>.5			
Downstream Diameters:	>2			
Number of Ports Sampled:	5			
Number of Points per Port:	6			
Minutes per Point:	5.0			
Minutes per Reading:	5.0			
Total Number of Traverse Points:	30			
Test Length:	150			**min.**
Train Type:	Hot Box			
Source Condition:	Normal			
Servomex Serial Number:	01440D1/4663			
Moisture Balance ID:	S10-39			
# of Runs	3			

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Run 1-Method 5/202

Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Test Location: Hurst Boiler Exhaust Duct
Source Condition: Normal

Date: 7/23/13
Start Time: 12:05
End Time: 16:01

DRY GAS METER CONDITIONS

ΔH:	0.63	in. H_2O
Meter Temperature, Tm:	92.4	°F
Sqrt ΔP:	0.148	in. H_2O
Stack Temperature, Ts:	359.3	°F
Meter Volume, Vm:	75.148	ft^3
Meter Volume, Vmstd:	70.880	dscf
Meter Volume, Vwstd:	13.584	wscf
Isokinetic Variance:	105.0	%I
Calculated Fuel Factor Fd:	9,491.95	dscf/mmBtu
Test Length	150.00	in mins.
Nozzle Diameter	0.495	in inches
Barometric Pressure	29.30	in Hg
Calculated Fo:	1.02	

STACK CONDITIONS

Static Pressure	-0.10	in. H_2O
Flue Pressure (Ps):	29.29	in. Hg. abs.
Carbon Dioxide:	10.90	%
Oxygen:	9.80	%
Nitrogen:	79.30	%
Gas Weight dry, Md:	30.136	lb/lb mole
Gas Weight wet, Ms:	28.184	lb/lb mole
Excess Air:	86.009	%
Gas Velocity, Vs:	10.602	fps
Volumetric Flow:	12,245	acfm
Volumetric Flow:	8,483	dscfm
Volumetric Flow:	7,726	scfm
Fo Validity:	Pass	

MOISTURE DETERMINATION

Initial Impinger Content:	1937.5	ml	Silica Initial Wt.	523.8	grams
Final Impinger Content:	2205.4	ml	Silica Final Wt.	544.3	grams
Difference:	267.9		Difference:	20.5	
Total Water Gain:	288.4		Moisture, Bws:	0.161	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Sqrt. Δp	Collected Vol. ft^3	Point Vel ft/sec
1-1	12:05:00	0.015	0.40	371.873	379	89	88	0.122	1.227	8.781
1-1	12:08:00	0.015	0.40	373.100	379	89	88	0.122	1.220	8.781
1-2	12:11:00	0.015	0.40	374.320	378	90	89	0.122	1.190	8.781
1-2	12:14:00	0.015	0.40	375.510	378	90	89	0.122	1.210	8.781
1-3	12:17:00	0.015	0.40	376.720	377	91	89	0.122	1.210	8.781
1-3	12:20:00	0.015	0.40	377.930	377	91	89	0.122	1.210	8.781
1-4	12:23:00	0.010	0.30	379.140	373	92	89	0.100	1.080	7.154
1-4	12:26:00	0.010	0.30	380.220	373	92	89	0.100	0.880	7.154
1-5	12:29:00	0.010	0.30	381.100	373	92	89	0.100	1.160	7.154
1-5	12:32:00	0.010	0.30	382.260	377	93	89	0.100	1.230	7.154
	12:35:00			383.490						
2-1	12:40:00	0.025	0.70	383.490	368	92	90	0.158	1.590	11.311
2-1	12:43:00	0.025	0.70	385.080	368	92	90	0.158	1.570	11.311
2-2	12:46:00	0.020	0.55	386.650	364	94	90	0.141	1.470	10.117
2-2	12:49:00	0.020	0.55	388.120	364	94	90	0.141	1.280	10.117
2-3	12:52:00	0.015	0.40	389.410	365	94	91	0.122	1.200	8.781
2-3	12:55:00	0.015	0.40	390.610	365	94	91	0.122	1.220	8.781
2-4	12:58:00	0.015	0.40	391.830	366	94	91	0.122	1.220	8.781
2-4	13:01:00	0.015	0.40	393.050	368	94	91	0.122	1.210	8.781
2-5	13:04:00	0.010	0.30	394.260	367	94	91	0.100	0.980	7.154
2-5	13:07:00	0.010	0.30	395.240	367	94	91	0.100	1.410	7.154
	13:10:00			396.650						
3-1	13:15:00	0.030	0.80	396.650	393	94	91	0.173	1.742	12.390
3-1	13:18:00	0.030	0.80	398.400	393	94	91	0.173	1.730	12.390
3-2	13:21:00	0.030	0.80	400.130	392	94	91	0.173	1.710	12.390
3-2	13:24:00	0.030	0.80	401.840	392	94	91	0.173	1.760	12.390
3-3	13:27:00	0.030	0.80	403.600	385	95	91	0.173	1.700	12.390
3-3	13:30:00	0.030	0.80	405.300	385	95	91	0.173	1.840	12.390
3-4	13:33:00	0.020	0.60	407.140	345	95	92	0.141	1.280	10.117
3-4	13:36:00	0.020	0.60	408.420	345	95	92	0.141	1.420	10.117
3-5	13:39:00	0.015	0.40	409.840	347	95	92	0.122	1.230	8.781
3-5	13:42:00	0.015	0.40	411.070	347	95	92	0.122	1.440	8.781
	13:45:00			412.510						
4-1	13:53:00	0.035	1.00	412.510	361	93	92	0.187	1.880	13.383
4-1	13:56:00	0.035	1.00	414.390	361	93	92	0.187	1.860	13.383
4-2	13:59:00	0.035	1.00	416.250	364	94	92	0.187	1.880	13.383
4-2	14:02:00	0.035	1.00	418.130	364	94	92	0.187	1.840	13.383
4-3	14:05:00	0.040	1.10	419.970	364	96	92	0.200	1.990	14.307
4-3	14:08:00	0.040	1.10	421.960	364	96	92	0.200	2.020	14.307
4-4	14:11:00	0.030	0.80	423.980	357	96	92	0.173	1.710	12.390
4-4	14:14:00	0.030	0.80	425.690	357	96	92	0.173	1.740	12.390
4-5	14:17:00	0.030	0.80	427.430	359	96	92	0.173	1.720	12.390
4-5	14:20:00	0.030	0.80	429.150	359	96	92	0.173	1.815	12.390
	14:23:00			430.965						
5-1	14:31:00	0.025	0.70	430.965	323	94	92	0.158	1.625	11.311
5-1	14:34:00	0.025	0.70	432.590	323	94	92	0.158	1.610	11.311
5-2	14:37:00	0.025	0.70	434.200	323	95	92	0.158	1.600	11.311
5-2	14:40:00	0.025	0.70	435.800	323	95	92	0.158	1.590	11.311
5-3	14:43:00	0.020	0.60	437.390	321	95	92	0.141	1.440	10.117
5-3	14:46:00	0.020	0.60	438.830	321	95	92	0.141	1.430	10.117
5-4	14:49:00	0.025	0.70	440.260	354	95	92	0.158	1.620	11.311
5-4	14:52:00	0.025	0.70	441.880	354	95	92	0.158	1.590	11.311
5-5	14:55:00	0.030	0.90	443.470	368	95	92	0.173	1.750	12.390
5-5	14:58:00	0.030	0.90	445.220	365	95	92	0.173	1.601	12.390
	15:01:00			447.021						
Total				75.148		93.8	91.0		75.148	
Average			0.63		359.3	92.4		0.148		
Min			0.30		321.0	88.0		0.100		
Max			1.10		379.0	96.0		0.200		

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Run 2-Method 5/202

Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Test Location: Hurst Boiler Exhaust Duct
Source Condition: Normal

Date: 7/23/13
Start Time: 16:30
End Time: 19:54

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	0.57	in. H_2O	Static Pressure	-0.10	in. H_2O
Meter Temperature, Tm:	93.9	°F	Flue Pressure (Ps):	29.28	in. Hg. abs.
Sqrt ΔP:	0.139	in. H_2O	Carbon Dioxide:	10.20	%
Stack Temperature, Ts:	359.0	°F	Oxygen:	10.50	%
Meter Volume, Vm:	70.090	ft^3	Nitrogen:	79.3	%
Meter Volume, Vmstd:	65.914	dscf	Gas Weight dry, Md:	30.052	lb/lb mole
Meter Volume, Vwstd:	11.587	wscf	Gas Weight wet, Ms:	28.250	lb/lb mole
Isokinetic Variance:	102.7	%I	Excess Air:	—	%
Calculated Fuel Factor Fd:	9,334.43	dscf/mmBtu	Gas Velocity, Vs:	9.945	fps
Test Length	150.00	in mins.	Volumetric Flow:	11,486	acfm
Nozzle Diameter	0.495	in inches	Volumetric Flow:	6,165	dscfm
Barometric Pressure	29.30	in Hg	Volumetric Flow:	7,249	scfm
Calculated Fc:	1.02		Fc Validity:	Pass	

MOISTURE DETERMINATION

Initial Impinger Content:	1929.4	ml	Silica Initial Wt.	820.5	grams
Final Impinger Content:	2158.5	ml	Silica Final Wt.	837.4	grams
Difference:	229.1		Difference:	16.9	
Total Water Gain:	246.0		Moisture, Bws:	0.150	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Sqrt. Δp	Collected Vol. ft^3	Point Vel ft/sec
1-1	16:30:00	0.020	0.65	450.145	392	91	91	0.141	1.445	10.104
	16:33:00			451.590						
1-1	17:00:00	0.015	0.41	451.590	374	92	92	0.122	1.210	8.750
1-2	17:03:00	0.015	0.41	452.800	378	93	92	0.122	1.320	8.750
1-2	17:06:00	0.015	0.41	454.120	378	93	92	0.122	1.250	8.750
1-3	17:09:00	0.010	0.30	455.370	381	93	92	0.100	0.840	7.144
1-3	17:12:00	0.010	0.30	456.210	381	93	92	0.100	1.090	7.144
1-4	17:15:00	0.010	0.30	457.300	369	93	92	0.100	1.070	7.144
1-4	17:18:00	0.010	0.30	458.370	369	93	92	0.100	0.820	7.144
1-5	17:21:00	0.010	0.30	459.190	369	93	92	0.100	0.925	7.144
1-5	17:24:00	0.010	0.30	460.115	369	93	92	0.100	1.053	7.144
	17:27:00			461.168						
2-1	17:33:00	0.020	0.55	461.168	370	93	92	0.141	1.442	10.104
2-1	17:36:00	0.020	0.55	462.610	370	93	92	0.141	1.360	10.104
2-2	17:39:00	0.020	0.55	463.970	373	94	92	0.141	1.410	10.104
2-2	17:42:00	0.020	0.55	465.380	373	94	92	0.141	1.370	10.104
2-3	17:45:00	0.020	0.55	466.750	369	95	92	0.141	1.430	10.104
2-3	17:48:00	0.020	0.55	468.180	369	95	92	0.141	1.360	10.104
2-4	17:51:00	0.015	0.41	469.540	367	95	92	0.122	1.210	8.750
2-4	17:54:00	0.015	0.41	470.750	367	95	92	0.122	1.210	8.750
2-5	17:57:00	0.010	0.30	471.960	366	95	93	0.100	0.990	7.144
2-5	18:00:00	0.010	0.30	472.950	366	95	93	0.100	1.060	7.144
	18:03:00			474.030						
3-1	18:06:00	0.025	0.70	474.030	390	94	93	0.158	1.590	11.298
3-1	18:11:00	0.025	0.70	475.620	388	94	93	0.158	1.580	11.298
3-2	18:14:00	0.025	0.70	477.200	385	95	93	0.158	1.580	11.298
3-2	18:17:00	0.025	0.70	478.780	385	95	93	0.158	1.590	11.298
3-3	18:20:00	0.025	0.70	480.350	387	96	93	0.158	1.580	11.298
3-3	18:23:00	0.025	0.70	481.930	387	96	93	0.158	1.570	11.298
3-4	18:26:00	0.015	0.42	483.500	392	96	93	0.122	1.230	8.750
3-4	18:29:00	0.015	0.42	484.730	392	96	93	0.122	1.230	8.750
3-5	18:32:00	0.010	0.30	485.960	390	96	94	0.100	1.010	7.144
3-5	18:35:00	0.010	0.30	486.970	390	96	94	0.100	1.115	7.144
	18:38:00			488.085						
4-1	18:45:00	0.030	0.83	488.085	388	94	93	0.173	1.735	12.374
4-1	18:48:00	0.030	0.83	489.820	388	94	93	0.173	1.780	12.374
4-2	18:51:00	0.030	0.83	491.600	388	96	93	0.173	1.690	12.374
4-2	18:54:00	0.030	0.83	493.290	388	96	93	0.173	1.690	12.374
4-3	18:57:00	0.035	0.97	495.170	384	96	93	0.187	1.710	13.366
4-3	19:00:00	0.035	0.97	496.880	384	96	93	0.187	1.860	13.366
4-4	19:03:00	0.035	0.97	498.740	388	97	94	0.187	1.880	13.366
4-4	19:06:00	0.035	0.97	500.620	388	97	94	0.187	1.840	13.366
4-5	19:09:00	0.030	0.83	502.470	381	97	94	0.173	1.730	12.374
4-5	19:12:00	0.030	0.83	504.200	381	97	94	0.173	1.865	12.374
	19:15:00			506.065						
5-1	19:24:00	0.020	0.58	506.065	317	95	94	0.141	1.445	10.104
5-1	19:27:00	0.020	0.58	507.510	317	95	94	0.141	1.460	10.104
5-2	19:30:00	0.020	0.58	508.990	312	96	94	0.141	1.430	10.104
5-2	19:33:00	0.020	0.58	510.420	312	96	94	0.141	1.430	10.104
5-3	19:36:00	0.020	0.58	511.850	332	96	94	0.141	1.420	10.104
5-3	19:39:00	0.020	0.58	513.270	332	96	94	0.141	1.440	10.104
5-4	19:42:00	0.020	0.58	514.710	335	96	94	0.141	1.490	10.104
5-4	19:45:00	0.020	0.58	516.200	335	96	94	0.141	1.430	10.104
5-5	19:48:00	0.015	0.44	517.630	334	96	94	0.122	1.250	8.750
5-5	19:51:00	0.015	0.44	518.880	334	96	94	0.122	1.355	8.750
	19:54:00			520.235						
Total				70.090		94.9	92.9		70.090	
Average			0.57		359.0	93.9		0.139		
Min			0.30		312.0	91.0		0.100		
Max			0.97		392.0	97.0		0.187		

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Run 3-Method 5/202

Client: University of Iowa
Facility: Oakdale Renewable Energy Plant
Test Location: Hurst Boiler Exhaust Duct
Source Condition: Normal

Date: 7/23 & 24/13
Start Time: 21:18
End Time: 0:05

DRY GAS METER CONDITIONS

ΔH:	0.72	in. H_2O
Meter Temperature, Tm:	91.0	°F
Sqrt ΔP:	0.158	in. H_2O
Stack Temperature, Ts:	366.4	°F
Meter Volume, Vm:	78.963	ft^3
Meter Volume, Vmstd:	74.673	dscf
Meter Volume, Vwstd:	18.546	wscf
Isokinetic Variance:	106.1	%I
Calculated Fuel Factor Fd:	9,407.88	dscf/mmBtu
Test Length	150.00	in mins.
Nozzle Diameter	0.495	in inches
Barometric Pressure	29.30	in Hg
Calculated Fc:	1.02	

STACK CONDITIONS

Static Pressure	-0.10	in. H_2O
Flue Pressure (Ps):	29.29	in. Hg. abs.
Carbon Dioxide:	10.40	%
Oxygen:	10.30	%
Nitrogen:	79.3	%
Gas Weight dry, Md:	30.076	lb/lb mole
Gas Weight wet, Ms:	27.886	lb/lb mole
Excess Air:	86.848	%
Gas Velocity, Vs:	11.439	fps
Volumetric Flow:	13,212	acfm
Volumetric Flow:	6,765	dscfm
Volumetric Flow:	6,264	scfm
Fo Validity:	Pass	

MOISTURE DETERMINATION

Initial Impinger Content:	1814.9	ml	Silica Initial Wt.	513.4	grams
Final Impinger Content:	2145.9	ml	Silica Final Wt.	533.7	grams
Difference:	331.0		Difference:	20.3	
Total Water Gain:	351.3		Moisture, Bws:	0.181	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Sqrt. Δp	Collected Vol. ft^3	Point Vel ft/sec
1-1	21:18:00	0.015	0.41	521.550	379	91	91	0.122	1.220	8.848
1-1	21:21:00	0.015	0.41	522.770	379	91	91	0.122	1.210	8.848
1-2	21:24:00	0.015	0.41	523.980	373	91	91	0.122	1.190	8.848
1-2	21:27:00	0.015	0.41	525.170	373	91	91	0.122	1.290	8.848
1-3	21:30:00	0.015	0.41	526.400	378	92	91	0.122	1.180	8.848
1-3	21:33:00	0.015	0.41	527.580	378	92	91	0.122	1.240	8.848
1-4	21:36:00	0.015	0.41	528.820	381	92	91	0.122	1.240	8.848
1-4	21:39:00	0.015	0.41	530.060	381	92	91	0.122	1.180	8.848
1-5	21:42:00	0.010	0.30	531.220	382	92	91	0.100	0.970	7.223
1-5	21:45:00	0.010	0.30	532.190	382	92	91	0.100	1.023	7.223
	21:48:00			533.213						
2-1	21:51:00	0.030	0.82	533.213	381	92	91	0.173	1.897	12.511
2-1	21:54:00	0.030	0.82	534.910	381	92	91	0.173	1.730	12.511
2-2	21:57:00	0.030	0.82	536.640	376	93	91	0.173	1.710	12.511
2-2	22:00:00	0.030	0.82	538.350	376	93	91	0.173	1.880	12.511
2-3	22:03:00	0.025	0.68	540.040	383	93	91	0.158	1.570	11.421
2-3	22:06:00	0.025	0.68	541.610	383	93	91	0.158	1.530	11.421
2-4	22:09:00	0.020	0.55	543.140	376	93	91	0.141	1.410	10.215
2-4	22:12:00	0.020	0.55	544.550	376	93	91	0.141	1.390	10.215
2-5	22:15:00	0.015	0.41	545.940	381	93	90	0.122	1.190	8.848
2-5	22:18:00	0.015	0.41	547.130	381	93	90	0.122	1.238	8.848
	22:21:00			548.368						
3-1	22:24:00	0.030	0.83	548.368	374	92	90	0.173	1.732	12.511
3-1	22:27:00	0.030	0.83	550.100	374	92	90	0.173	1.710	12.511
3-2	22:30:00	0.030	0.83	551.810	376	92	90	0.173	1.820	12.511
3-2	22:33:00	0.030	0.83	553.630	376	92	90	0.173	1.630	12.511
3-3	22:36:00	0.035	0.97	555.260	379	93	90	0.187	2.030	13.513
3-3	22:39:00	0.035	0.97	557.290	379	93	90	0.187	1.710	13.513
3-4	22:42:00	0.030	0.83	559.000	374	93	90	0.173	1.720	12.511
3-4	22:45:00	0.030	0.83	560.720	374	93	90	0.173	1.710	12.511
3-5	22:48:00	0.025	0.70	562.430	372	93	90	0.158	1.550	11.421
3-5	22:51:00	0.025	0.70	563.980	372	93	90	0.158	1.797	11.421
	22:54:00			565.777						
4-1	22:58:00	0.040	1.11	565.777	362	92	90	0.200	2.013	14.448
4-1	23:02:00	0.040	1.11	567.790	362	92	90	0.200	1.950	14.448
4-2	23:06:00	0.045	1.24	569.740	360	93	89	0.212	2.094	15.322
4-2	23:08:00	0.045	1.24	571.834	360	93	89	0.212	2.146	15.322
4-3	23:11:00	0.040	1.11	573.980	379	93	89	0.200	1.940	14.448
4-3	23:14:00	0.040	1.11	575.920	379	93	89	0.200	1.980	14.448
4-4	23:17:00	0.040	1.11	577.900	377	93	89	0.200	1.980	14.448
4-4	23:20:00	0.040	1.11	579.880	377	93	89	0.200	1.980	14.448
4-5	23:23:00	0.040	1.11	581.860	377	93	89	0.200	1.980	14.448
4-5	23:26:00	0.040	1.11	583.840	377	93	89	0.200	2.027	14.448
	23:29:00			585.867						
5-1	23:35:00	0.020	0.57	585.867	319	90	89	0.141	1.443	10.215
5-1	23:38:00	0.020	0.57	587.310	319	90	89	0.141	1.440	10.215
5-2	23:41:00	0.020	0.57	588.750	324	91	89	0.141	1.460	10.215
5-2	23:44:00	0.020	0.57	590.210	324	91	89	0.141	1.390	10.215
5-3	23:47:00	0.020	0.57	591.600	322	91	89	0.141	1.440	10.215
5-3	23:50:00	0.020	0.57	593.040	322	91	89	0.141	1.410	10.215
5-4	23:53:00	0.025	0.72	594.450	317	91	89	0.158	1.780	11.421
5-4	23:56:00	0.025	0.72	596.230	317	91	89	0.158	1.450	11.421
5-5	23:59:00	0.020	0.57	597.680	316	91	89	0.141	1.510	10.215
5-5	0:02:00	0.020	0.57	599.190	316	91	88	0.141	1.323	10.215
	0:05:00			600.513						
Total				78.963		92.1	90.0		78.963	
Average			0.72		366.4	91.0		0.158		
Min			0.30		316.0	88.0		0.100		
Max			1.24		383.0	93.0		0.212		

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METHOD 26 TEST RESULTS

Date:	7/23/2013	**Condition:**	Normal
Project:	M133003	**Data Taken By:**	AD
Company:	University of Iowa	**Source:**	
Plant:	Oakdale Renewable Energy Plant		
Location:	Hurst Boiler Exhaust Duct		

Test Number:	1	**Time:**	12:05-13:05
Pressure, Barometric(Hg"):	29.300	Carbon Dioxide Content(%):	10.90
Pressure, Static(H_2O"):	-0.10	Oxygen Content(%):	9.80
Pressure, Stack(Hg"):	29.293	Nitrogen Content(%):	79.30
Initial Volume (cu.ft.)	0	HCl (mg)	0.043
Final Volume (cu.ft.)	4.252	Water Vapor in Flue Gas (Bws):	0.161
Meter Temperature (°F)	90.00	HCl (ppm):	0.25
Meter Volume (dscf)	4.05		
Meter Calibration (Y)	1.009		
Average Delta H (ΔH)	2.000		

Test Number:	2	**Time:**	13:35-14:35
Pressure, Barometric(Hg"):	29.300	Carbon Dioxide Content(%):	10.90
Pressure, Static(H_2O"):	-0.10	Oxygen Content(%):	9.80
Pressure, Stack(Hg"):	29.293	Nitrogen Content(%):	79.30
Initial Volume (cu.ft.)	0	HCl (mg)	0.030
Final Volume (cu.ft.)	4.252	Water Vapor in Flue Gas (Bws):	0.161
Meter Temperature (°F)	91.69	HCl (ppm):	0.17
Meter Volume (dscf)	4.04		
Meter Calibration (Y)	1.009		
Average Delta H (ΔH)	2.000		

Test Number:	3	**Time:**	14:45-15:55
Pressure, Barometric(Hg"):	29.300	Carbon Dioxide Content(%):	10.90
Pressure, Static(H_2O"):	-0.10	Oxygen Content(%):	9.80
Pressure, Stack(Hg"):	29.293	Nitrogen Content(%):	79.30
Initial Volume (cu.ft.)	0.000	HCl (mg)	0.055
Final Volume (cu.ft.)	4.247	Water Vapor in Flue Gas (Bws):	0.161
Meter Temperature (°F)	92.00	HCl (ppm):	0.32
Meter Volume (dscf)	4.03		
Meter Calibration (Y)	1.009		
Average Delta H (ΔH)	2.000		

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METHOD 30B TEST RESULTS

Project #:	M133003	Location:	Hurst Boiler Exhaust Duct
Client:	University of Iowa	Condition:	Normal
Facility:	Oakdale Renewable Energy Plant	Data Taken By:	D. Tulder
Fuel Type:	Wood	Fuel Factor:	9335.8
Hg Analyzer ID:		Diluent:	O2 %

Test Number: 1A	Trap Number: 168444	Start Time: 10:18 End Time: 11:18	Date: 7/24/2013
Pressure, Barometric(Hg"):	29.250	Hg (ng)	22.6
Initial Volume (liters)	0	Water Vapor in Flue Gas (Bws):	0.179
Final Volume (liters)	109.424	Meter Volume (Standard liters)	104.512
Meter Temperature (°F)	85.30	Hg (ppb)	0.03
Meter Calibration (Y)	1.009	Hg (ug/dscm)	0.22
Flowrate (SCFH)	459,060	Hg (ug/wscm)	0.18
CO2 %	9.40	Hg (oz/hr)	0.000081
O2 %	11.40	Hg (lb/Tbtu), Fd Factor	0.276509

Test Number: 2A	Trap Number: 168405	Start Time: 12:30 End Time: 13:30	Date: 7/24/2013
Pressure, Barometric(Hg"):	29.250	Hg (ng)	12.4
Initial Volume (liters)	0	Water Vapor in Flue Gas (Bws):	0.182
Final Volume (liters)	100.212	Meter Volume (Standard liters)	94.844
Meter Temperature (°F)	90.30	Hg (ppb)	0.02
Meter Calibration (Y)	1.009	Hg (ug/dscm)	0.13
Flowrate (SCFH)	473,400	Hg (ug/wscm)	0.11
CO2 %	9.60	Hg (oz/hr)	0.000051
O2 %	11.10	Hg (lb/Tbtu), Fd Factor	0.183147

Test Number: 3A	Trap Number: 168415	Start Time: 14:45 End Time: 15:45	Date: 7/24/2013
Pressure, Barometric(Hg"):	29.250	Hg (ng)	10.6
Initial Volume (liters)	0	Water Vapor in Flue Gas (Bws):	0.178
Final Volume (liters)	100.23	Meter Volume (Standard liters)	94.449
Meter Temperature (°F)	92.70	Hg (ppb)	0.01
Meter Calibration (Y)	1.009	Hg (ug/dscm)	0.11
Flowrate (SCFH)	481,440	Hg (ug/wscm)	0.09
CO2 %	9.60	Hg (oz/hr)	0.000044
O2 %	11.10	Hg (lb/Tbtu), Fd Factor	0.139325

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METHOD 30B TEST RESULTS

Project #:	M133003	Location:	Hurst Boiler Exhaust Duct
Client:	University of Iowa	Condition:	Normal
Facility:	Oakdale Renewable Energy Plant	Data Taken By:	D. Tulder
Fuel Type:	Wood	Fuel Factor:	9336.8
Hg Analyzer ID:	0	Diluent:	O2 %

Test Number: 1B	Trap Number: 124022	Start Time: 10:18 End Time: 11:18	Date: 7/24/2013
Pressure, Barometric(Hg"):	29.250	Hg (ng):	20.7
Initial Volume (liters)	0	Water Vapor In Flue Gas (Bws):	0.179
Final Volume (liters)	98.85	Meter Volume (Standard liters)	93.516
Meter Temperature (°F)	87.80	Hg (ppb)	0.03
Meter Calibration (Y)	1.004	Hg (ug/dscm)	0.22
Flowrate (SCFH)	459,060	Hg (ug/wscm)	0.18
CO2 %	9.40	Hg (oz/hr)	0.000083
O2 %	11.40	Hg (lb/Tbtu), Fd Factor	0.283817
		Spiked Trap Run	Y
		Spike Concentration	25

Test Number: 2B	Trap Number: 123480	Start Time: 12:30 End Time: 13:30	Date: 7/24/2013
Pressure, Barometric(Hg"):	29.250	Hg (ng):	12.6
Initial Volume (liters)	0	Water Vapor In Flue Gas (Bws):	0.182
Final Volume (liters)	100.14	Meter Volume (Standard liters)	93.761
Meter Temperature (°F)	93.50	Hg (ppb)	0.02
Meter Calibration (Y)	1.004	Hg (ug/dscm)	0.13
Flowrate (SCFH)	473,400	Hg (ug/wscm)	0.11
CO2 %	9.60	Hg (oz/hr)	0.000052
O2 %	11.10	Hg (lb/Tbtu), Fd Factor	0.167033
		Spiked Trap Run	Y
		Spike Concentration	25

Test Number: 3B	Trap Number: 122453	Start Time: 14:45 End Time: 15:45	Date: 7/24/2013
Pressure, Barometric(Hg"):	29.250	Hg (ng):	8.5
Initial Volume (liters)	0	Water Vapor In Flue Gas (Bws):	0.178
Final Volume (liters)	100.159	Meter Volume (Standard liters)	93.474
Meter Temperature (°F)	95.30	Hg (ppb)	0.01
Meter Calibration (Y)	1.004	Hg (ug/dscm)	0.09
Flowrate (SCFH)	481,440	Hg (ug/wscm)	0.07
CO2 %	9.60	Hg (oz/hr)	0.000036
O2 %	11.10	Hg (lb/Tbtu), Fd Factor	0.113026
		Spiked Trap Run	Y
		Spike Concentration	25

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