

October 17, 2013

Dear Mr. Mooney:

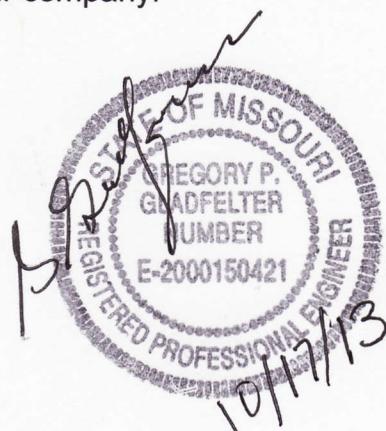
I am pleased to provide this commissioning report for your use in concluding your project for Hampton Alternative Energy Products LLC (HAEP). You have stated that a requirement of your contract with HAEP is to have a Missouri state licensed engineer witness and approve the commissioning of the digestate drying facility. On October 3, 2013 I visited the site and observed the facility operating. I later reviewed the collected data and provide this report confirming the commissioning of the HAEP digestate drying facility was successful. I have monitored the test protocol and analyzed the subsequent data. It is my opinion the commissioning which occurred from October 1st to October 4th, 2013 has proven the system operates according to the intention of the design.

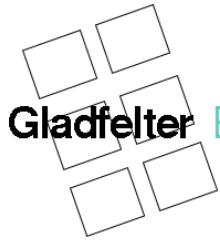
I appreciate the opportunity to work with you and your company.

Thank you.

Respectfully,
GLADFELTER ENGINEERING GROUP,

Gregory P. Gladfelter, PE
Principal





Gladfelter Engineering Group

**Ecoremedy® Digestate Drying System
Commissioning Report**

for

Enginuity Energy, LLC

Sold to

Hampton Alternative Energy Products

Located on

Hampton Feedlot,
23551 Highway 11
Triplet, Missouri 65286

System Reviewed by
Gladfelter Engineering Group
Greg Gladfelter, PE

October 14, 2013

Executive Summary:

Gladfelter Engineering Group is a boutique engineering firm specializing in distributed energy and tri-generation facilities. Our principal place of business is 3710 Robinson Pike, Grandview, MO 64030.

Mr. Greg Gladfelter, Principal of Gladfelter Engineering Group and Missouri state licensed professional engineer, witnessed the commissioning of Hampton Alternative Energy Products' (HAEP) Ecoremedy® Digestate Drying Facility on October 3, 2013 and authored this report.

Purpose:

As part of a contract requirement, Enginuity Energy must have a professional engineer licensed in the state of Missouri review the commissioning of the Digestate Drying Facility and certify the plant has met the stated intention and performance guarantees.

Successful commissioning occurs when the drying system achieves a NET drying rate (material used for fuel not included) of 10 tons per week of 35%MC, or lower, based on an input of 1,400 lbs/hr of "wet" material at 67%MC, or lower, ("Qualified Solids") to the dryer.

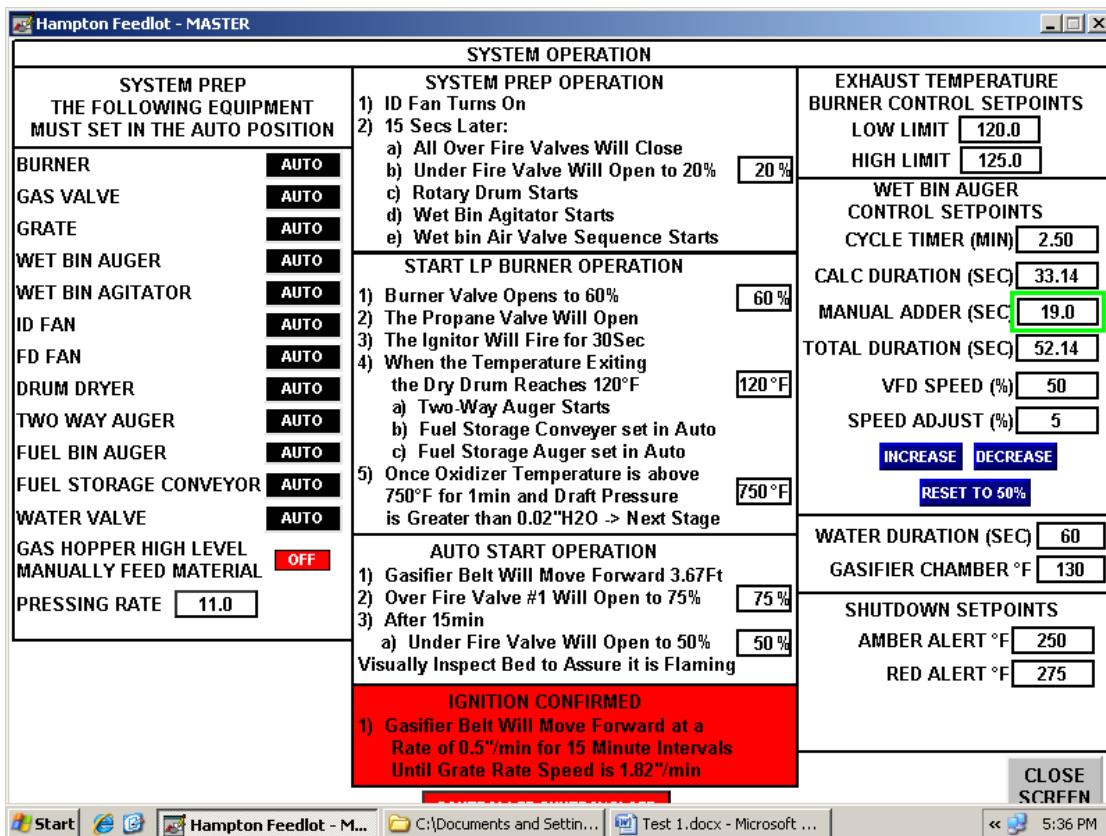
Finding:

I have monitored the test protocol and analyzed the subsequent data. It is my opinion the commissioning which occurred from October 1st to October 4th, 2013 has proven the system operates according to the intention of the design.

Key Observations:

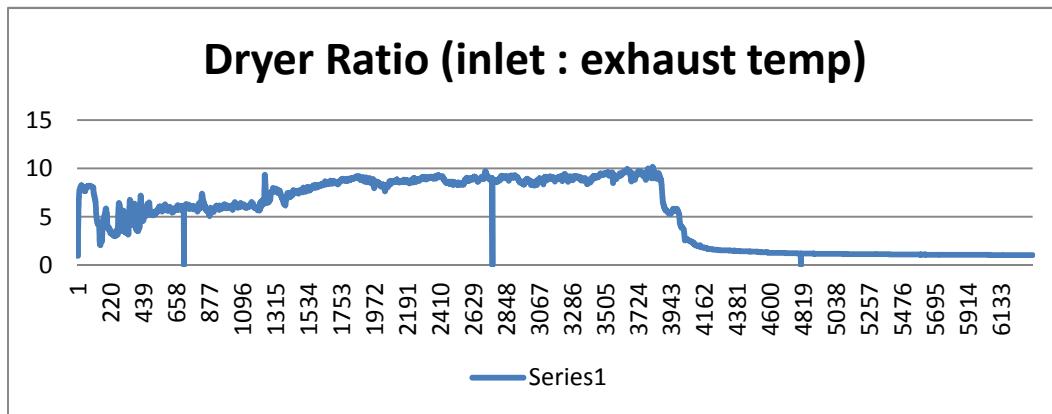
The following key observations confirm successful commissioning of the Ecoremedy® drying facility.

1. The screen shot below clearly indicates the system achieved the design dryer throughput of 1,400 lbs/hr which correlates to 16.8 tons per day of Qualified Solids input to the dryer.

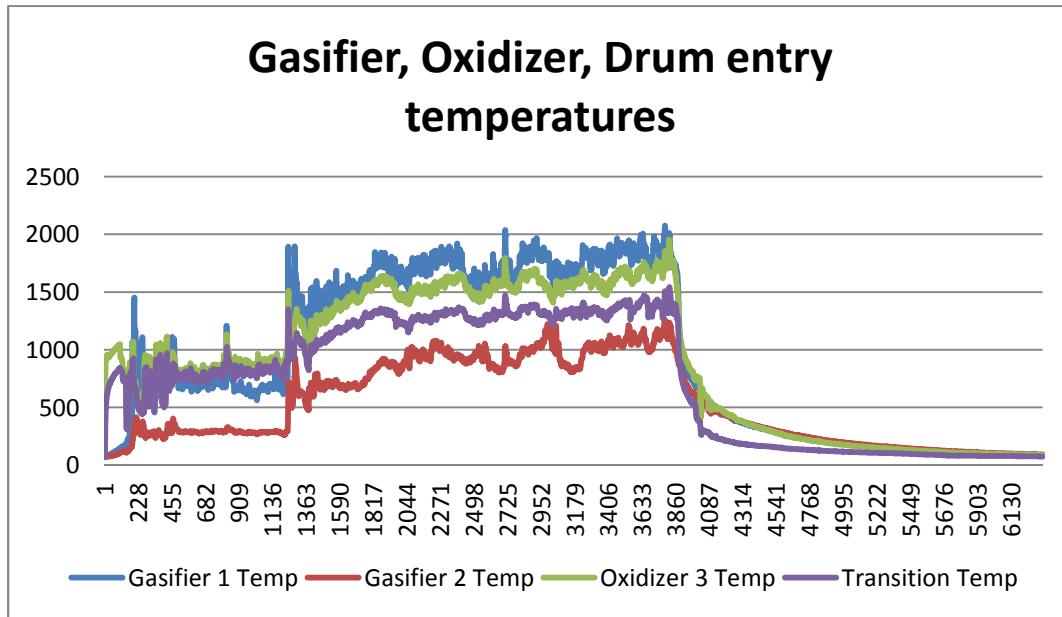


The Press Rate of 11 tons per day (TPD) corresponds to a dryer inlet feed rate of 33.14 seconds. The manual adder of 19 seconds is an increase of 57.33% (19 seconds ÷ 33.14 seconds) making the actual dryer feed rate equal to 17.31 tons per day (11 TPD x 1.5733) or 1,442 lbs/hr.

When analyzing the operational data, we learn that a dryer inlet to exhaust temperature ratio of 9:1 when operating at a Press Rate of 11 TPD is a good indicator for producing the 35% MC dried fiber. The amount of energy released during drying is a relationship between flue gas flow rate (corresponds to Press Rate) and the temperature drop from the inlet to the exhaust of the dryer.



The data clearly shows the system ran very stable at drier drum inlet temperatures of 1300F.



2. Key observation #1 confirms the input rate to the dryer exceeded the design rate of 1,400 lbs/hr. It is interesting to note the dryer output of finished dried fiber product is significantly improved over the target of 10 tons per week. The measured product production rates as noted on pages 17, 18, and 19 of the commissioning notes (Appendix A), well exceed the guaranteed hourly rate of 119 lbs/hr (10 TPW) with production at levels nearly doubling the guaranteed level. Achieved drying rates were 221.5 lbs/hr, 227.5 lbs/hr 200 lbs/hr and 145 lbs/hr respectively. The 145 lbs/hr was much dryer material which explains the lower weight per bag. To achieve this throughput, operators supplemented the press with stored pressed “wet” digestate.

Only day shift operators weighed each bag of product but the night shift operators produced the same number of bags during their shift as did the day shift crew thereby confirming the same drying rate around the clock.

3. The Proximate analysis from Geochemical Testing lab (Appendix B) confirms the on-site moisture tests of the “wet” material conducted prior to beginning the commissioning with the “wet” material entering the system being 65% MC by weight.

Interesting Observations:

In this section of the report I offer some observations that are not a part of the commissioning review but interesting to note.

1. The system appears to run in a steady state with little operator involvement. That said, I am impressed by the control of the system. The operator's ability to change the final “dried” fiber characteristics by manipulating the feed rate of “wet” digestate to the dryer is a simple control feature that works very well.
2. A water vapor plume is all that is seen emitting the stack. It appears to be free from particulate with little to no detectable odor emitted from the plant.
3. Enginuity Energy added an open drain to the ID fan housing. This addition made a significant impact to the draft on the system. The graphed data (Appendix C) clearly illustrates the installation of the open drain on the ID fan housing decreased the noise of the recorded draft curve. Before the drain was installed, the system tracked between 0.045”w.c. to 0.08”w.c. After the drain installation, the system draft was significantly more stable with draft pressure range of less than 0.01”w.c.
4. Enginuity Energy requested I comment on the use of compressed air in the filter. It is standard practice in the fabric filtration industry to use compressed air as a back pulse to purge filter media of entrained particles. The flue gas stream exiting the dryer contains more than 25% water vapor. The mass flow rate of the dryer system is orders of magnitude greater than the compressed air pulses. The use of an air knife with the rotary drum filter poses no performance or safety concern.

APPENDIX A

3710 Robinson Pike, Grandview MO 64030
913-281-6767 / fax 816-761-0201 / email gpg@gegrp.net

1/21

Procedure to capture screen shot

- ① scroll mouse to bottom toolbar
to expose time clock in task bar
- ② hit print screen on keyboard
- ③ Alt. tab to get to Word document
- ④ Control V to paste screen shot into Word doc.
- ⑤ type caption w/ keyboard defining purpose
of screen shot
- ⑥ Control S. to save Word doc w/ newest
screen shot
- ⑦ done - Save copy of Word doc every
4 hours as Backups.

We are creating one large Word document
w/ all screen shots in order.

This is to be done everytime a change is
made to the system operations.

Written notation in this notebook is to
accompany all screen shots and changes.

2/21

October 1, 2013
day 1 ~~October September~~

Time

9:02 AM

Dave + Tony collected "wet" sample labelled HAF-1 and triple bagged and placed in refrigerator.

Tony conducted % MC test witnessed by Dave. *DK* *DEW*

wet sample = 65% MC /
Dave *JK*

9:35 A.

To enable controls to perform an automatic start-up, we need a full gasifier fuel hopper. We do not have 35% MC product to start system. We mixed wet digestate and dried fiber at a 1:1 ratio and hand fed the system. Once the system is producing "dried" fiber, we will stop the hand mixing and turn to dried product for fuel.

DEW JK

11:15 A.

During startup, we recognized the ID fan was operating @ 4% on the Vfd. This is too low. Dave checked the draft setpoints and found them to be set at an order of magnitude too low. We set the draft to the desired range of 0.05"- 0.08" H₂O. ID fan is now running at 18% load which is the expected start-up point.

DEW JK

3/21

12:45 pm Gasifier reached temperature of 750°F and auto start proceeded w/o incident.

Daryl Th

1:20 pm Filter drum was sealed against side wall due to lack pressure of fabric. Matt is changing filter media so we turned propane off to cool air stream for filter change to occur. We will start auto start again once new fabric is installed.

Daryl Th

1:30 pm We paused gasifier long enough for filter media to be installed. It proved too difficult to change media while operating.

Daryl Th

1:40 pm Gasifier back online and filter media changed to ~~200 um~~ opening.

Daryl Th

2:00 pm Material exiting drum is bone dry. We changed stack temp. to set point which determines wet feed rate to dryer down to 145F from 160F. Also, press rate was changed from 7- down to 5 TPS until we sustain combustion of wet fuel. The grate was too short.

Daryl Th

4/21

2:25 pm

Stack temp still rising. ~ 175°F

Off propane - Solid fuel only

↓ removed operator override on the Press

Rate to be & so ~~#~~. wet feed rate

is full 5 TPD w/o overide. No screen shot.

Day Th

2:35 pm

Open O.F.A valve #1 to 30%, from closed to
drive temperature onto wet full pile earlier
in gasifier. No screen shot.

Day Th

2:45 pm

After 1:05 hours of running w/ new filter
media, we have established the filter system
works w/ most open media. We now are
seeking the tightest filter media that we
can run with. We decided to change
filter media to 50 ~~use~~ opening while day 1
startup temps are still relatively low.

Screen shot to ~~follow after change~~ taken
to show the pause event.

Manually stopped FA fan, wet feed, Roto drum
& gasifier grate. - IA in Manual @ 20%.

Day Th

5/21

3:20 pm

50 μm ^{opening} wood blended. we changed to the 100 μm opening. Started again inside of 3 minutes

4:27,

4:06 pm

We like the draft pressure to 10 fan speed ratio off with the filter media. We took a screen shot of operations now that we think we have found the optimum filter perforations of 100 μm .

4:33

Dny Th

4:12 pm

We are trying to increase load on gasifier by increasing U.F. air to 60% from 50% and turning off O.F.A. valve #1 which is cooling the gasifier temps. Once we see we are effectively shortening the fuel bed, we will increase speed to get more fuel into gasifier. We will accomplish this by increasing the Press Rate by 1 TPD. Increased speed now.

5:10

No screen shot

Dny H

5:24

6/21

4:27 pm

As soon as we increased load, the filter blinded. We are changing again to the 200 μm open mesh. No screen shot with this change out.

Day Th

4:33 pm

Running again w/ 200 μm filter.

Day Th

5:00 pm

increased U.F.A. to 70% of plenum pressure @ 0.4" H₂O temperature into drum increasing rapidly.

Day Th

5:10

the increased U.F.A working well, we need to inc. Press. Rate to keep fueling the gasifier. we are burning out fast which is good so we add more fuel. Now @ 6.5 TPA Press Rate.

Day Th

5:20 pm

We need to increase Press Rate again because we are burning out quickly. Increased to 7.5 TPA. no screen shot for this change.

Day Th

7/21

6:40 pm

We increased Press Rate and O.FA #1 to improve combustion and clean-up stack opacity. OFA #1 now @ 45% open and Press Rate @ 8 TPA.

- temperature in transition to den
now @ 854°F

- opacity improved.

~~Screen shot taken of new parameters.~~

DEM

JH

12:2

7:57 pm

We changed System settings to try to reach higher moisture coming out. Exit temp 120°F Burner high 125°F
Low 120°F

No screen shot needed

gd P

8:37

Tested MC 17.5%

gd P

12:3

12:10

In an effort to raise MC we increased the bias on the rate from 5 to 6. The funnel was clogging for water and the valve was turned off at the wall. Opened valve. Screen Shot

gd P

12:4

8/21

12:20 Tunnel temps kept climbing. Figured the nozzles were fouled. Knocked on them with steel rod. Temps are dropping

John JP

12:38 Manually moved grate 10" to try and get heat out of tunnel. We feel the nozzles are working but we can't drop fast enough because it was over temp for too long before valve at wall was opened. Increased nozzle duration

to 10 sec.

John JP

12:30 The tunnel temp is finally in range the down exit is now almost 150°F . Going to increase bias on rate from 6. to 7.5:

Screen shot

John JP

2:00am Discovered filter Overload: Called Matt. On his way

John JP

10/2

9/21

6:45 am

lowered temp setting in gasifier
tunnel to 180°F from 220°F and
reduced spray time to 30 sec from 60 sec
Daryl P

8:00

7:10 am

lowered water spray set temps again to
160°F and 10 sec duration, trying
to manage tunnel temp better and
avoid slugs of highly watered material.
Daryl P

8:40

7:10 am

Increasing dry feed rate to adder to
8.5 sec. and increasing Press Rate
to 8.5 TPD. We need to move fuel
front into gasifier farther and increase
fuel to unit. Our dry entry temps
have been stable @ 750°F for ~1/2 hour.
Need to increase fuel. Screen shot taken

9:20

Daryl P

7:55 Am

fuel bin is full of ^{very} ~~some~~ dry fuel. When
Press Rate was increased, the dry fuel
burned back into tunnel. We sped up grates
and ↑ water spray to move these excursions.
Dropped U.F. Air to 30% and system
seems to be settling down.

10:00

Daryl P

10/21

8:00 AM The reduced O.F.A. is gasifying the wetter fuel bed. I opened O.F.A. #1 from 45% to 55% and temps increased. Good sign.
Screen shot taken.
Daryl Th

8:40 AM We blended wet material of fuel to get wetter fuel into gasifier. Avg MC% ≈ 50%. MC. (too wet) Our gasifier bed looks good but "dried" material feels too wet. Our microwave browned up and moisture check not yet done so I increased Press rate to 9 to get more fuel in and reduced manual dryer feed rate back to 7.5 seconds.
Daryl Th

9:25 AM We did 3 moisture checks on "dried" fiber and all samples = 35.3% MC.
Conditions for running this product are ≈ ;
1050°F dryer inlet
135-140°F stack
dryer feed rate of 7.5 sec added to 9 TAD P.Rate
Screen Shot taken
Daryl Th

10:00 AM First Hopper of 35% MC fuel was filled.
Daryl Th

11/21

11:30 am

New bag. Timing fill duration w/ @
Spec product to estimate drying rate. Tony
is weighing 1st full bag of spec product.
The time and weight will provide us a ~~way~~
to estimate drying rate. BAG WT: 350 lbs

151

Dry Th

12:29 pm

(3) % MC checks on Bag #2 of Spec fuel

- 21.3% MC

2:51

The temps into dryer has increased by
+1-75°F so we will add ~~an~~ 1.0 second
to dryer feed rate \Rightarrow 8.5 seconds added

Dry Th

3:5

1:20 pm

Cleaned out filter base and removed
approximately 16 ft³ of filtrate in 20 min.

Dry Th

4:0

120 pm

Increased another 1 second on dryer
feed rate \Rightarrow 9.5 seconds total added time

Dry Th

19.3% MC

12/21

1:57 PM MAKE GUARDS SAFE PER OSHA
OR ASTM GUIDELINES FOR RPS
DO NOT TRADE BURN HAZARD FOR
SHARP EDGES. DESIGN INGENUITY'S
CHOICE Day

~~Day~~

2:50 pm Replaced dried fiber bag - 360 # \approx 20% MC
Estimated drying rate = $360 \text{ lbs} / 3 \text{ hr } 20 \text{ min}$
 $= 108 \text{ lbs/h}$
target rate = 119 lbs/hr.

Day J

69.5%
wet moisture check 71.0%.

3:50 pm Moisture check averaged 15.66% MC - for day.
We added 2.5 seconds to diec feed rate which
correlates to a 6.75% increase. Screen shot taken.
Dear J

4:05 pm The sugar fuel is causing fuel front to creep
back to gasifier entrance. We increased Press
Rate to 10 TPD and lowered tunnel temp
conditioner spraying to 130F for 10 sec duration.
Day J

time

13/21

4:20 pm

Increased O.F.A valve 4% to 65% open. Temp in Oxidizer jumped. Did this because the stack plumb had a very slight tan color in it. Burned fuel @ 4:05 but did not increase air. This change cleaned up stack to only vapor again.

~~No~~ screen shot taken.

Day Th

5:20 p.

6:10

4:47 pm

Tunnel temp is spiking over 130° due to dry fuel. I increased spray duration to 30 seconds ~~then~~ and decreased U.F. air to 45%. open from 50% open

No screen shot.

Day Th

6:40

5:08 pm

Reduced fiber % alc resulted in 16% alc. Still too dry. We will increase manual adder to 15 seconds - (10% increase). ~~for total~~ Actual drying rate = 14.94 TPA.

Also - fuel bed length is still too short. We reduced U.F.A to 40% open.

~~No~~ screen shot taken.

Day Th

7:00

14/21

5:20p. Charged bag - 2 1/2 hrs duration

285 lbs

dry rate = 114 lbs/hr ✓

6:10

19% MC still too dry

Our temp into drum is now @ 1300-1350
and we are diducting w/ damper in auto mode.
We need to get %MC higher.

We added 7 seconds to the dryer feed rate.

To get a total added time of 22 seconds.

This corresponds to a dryer rate of 17.25 TPH

6:40pm

The drum entry temp is exceeding 1350°F and
damper is trimming. We prefer to put
excess air into oxidizer using OFA valves
and control temp w/o dilution damper.

Set OFA value @ #1 - 80%, #2 - 30%.

Screen shot Taken

Dry ✓

7:08

did %MC check on new material and it is
47% MC - to wet. Reduced override
from 22 seconds to 18 seconds.

Dry ✓

15/21

9:20 T.D. fan ramped up due to plugged RPS

media. *18 Oct* Sprayed with Air Hose

6:01

12:00 AM Increased manual adder on wet bin 7 sec.

Oct 3 to 20 sec. over due to 14% MC material per moisture test. *jk*

7:35 AM

7:00 AM Decreased manual adder on wet Bin 1sec. to a 19 sec. override Due to 40% MC material per moisture Test.

jk

4:40 Lowered 2nd OF air valve to 10 from 30% because Ox temp was dropping
No odor in stack *jk*

8:00

4:45 Raise 2nd OF air valve to 30 from 10% because oxidizer Temp was dropping *jk*

8:05

4:59 Still dropping temp, bed is incresing strength raised UF to 50% *jk*

8:25a

* Need to call Jason regarding ID for auto set to 20% for no apparent reason.

16/21

6:01

Opened OF air valve #2 to 30%
for rising Trans. Table Temp.

JH

7:35 Am

J.P. and Take performed % MC checks throughout the night and recorded on a separate piece of paper. We document those measurements into this record.

7:58 pm Oct 2 - 36.7%

9:30 pm - 33%

11:30 pm - 14%

12:45 Am Oct. 3 - 23%

1:35 - 19.6%

2:25 - 39.8%

3:00 - 28%

Day JH

100%

lowered O.F.A. to 45% from 50% because bed length is short and tunnel temps increasing.

JH

8:05

Oxidizer very hot. Drier drum temp over 145°F.

Closed damper to stop sparklers from exit and ↑ O.F.A. /to cool down.. O.F.A. #2 - 50%

Day JH

8:25 am

lowered O.F.A. to 40%, O.F.A. #2 still @ 50%.
drier temp good. - Screen shot taken

Day JH

17/21

8:30 am Sample checked for MC% raised from 28.5 - 29%
Day JW

12:01

9:25 am We increased Press Rate from 10 to 11 TPD.
Day JW

1:20

Screen shot taken

9:05 am Sample checked for MC% Rased from 23 - 23.75%
Day JW

9:45 am Sample checked for MC% - 12.37. MC
Day JW

1:01

10:05 am Charged bag,
Day JW

11:00 am Holding 1600°F for dryer inlet. Opened
inlet to dryer is still between 1350-1400
so we opened OEA #3 20% to cool.
JW

1:41

11:40 Charged Bag - went to 30% on OEA #3

2:4

11:45 MC% checks were 22%. Before we increased
Press Rate and 43%. after we increased press rate,
we reduced override to dryer feed by 1 sec.
Screen shot taken.

Day JW

2:5

11:58 weight of bag was 350¹⁶⁵ lbs time = 1:35

4:14

[drying rate = 221.5 lbs/hr]

Day JW

4:14

18/21

8.5 - 29%

12:01 pm dyer inlet temp now in range so we closed OFA #3 too /20% again
Deyu Th

10.

taken

1:20 pm wetter fuel = longer bed. Increased UFA to 50%. open. Closed OFA valve #3 all the way closed.

Deyu Th

13.75%

1:07 pm Bag changed - forgot to record. Weight = 330 lbs
$$330 \text{ lbs} / 1.45 \text{ hrs.} = 227.5 \text{ lbs/hr}$$

Deyu Th

3-1800

1:40 pm bed still long and deep. Increased UFA to 55%.

Deyu Th

increased
on note,
1 sec.

Bag change weight 330 lbs

$$330 \text{ lbs} / 1 \text{ hr } 39 \text{ minutes} = 200 \text{ lbs/hr}$$

Very dry bag!

2:50

Reduced UFA to 50%.

Deyu Th

4:14

Add 2 sec to manual add. from 18 sec to 20 sec.

Th Deyu

19/21

4:54 Moisture test 10% MC

5:3

4:35 dry fuel coming tunnel temps to rise.
turned water spray on to 60 second time
and reduced OFA to 40%. from 50%

good lesson
Temp dropping rapidly in tunnel lost 25°F
in approx 2 minutes by reducing OFA only.
Dry ✓

6:00

8:10

4:35 Also ~~put~~ put 30% MC fuel from one
bag into fuel materny bin to avoid
putting over 10% MC fuel to unit.
Dry ✓

7:3

5:02 Increased Cladefine Value to 95% to
adjust to water fuel
Dry ✓

9:2

4:45 Charged Bages weight 290 lbs
Dry ✓ 145 lbs/hr for 2 hrs.

9:39

4:55 Changed OFA #3 to 30% to cool dryer inlet
temperature reading 1400°F.
Dry ✓

5:30 pm increased oven fan air to cool temps &
dryer. Temp stable @ 1325°F.
Screen shot taken
Dry ✓

10:0

OP1-80 OP2-60
OP3-40

20/
21

5:30p Also reduced dry rate override from
20 sec. to 19 secs. - moisture appears
wetter and last sample was 31.9% MC

Dear JP

6:00p Changed Bass

8:10p lowered UFA to 42% - No screen shot

Dear JP

7:38p Tuned OFA #3 to zero - Ox temp was fully

8% P

9:23 Opened OFA #3 Back to 30% because
transistor duct over 1400°F

Screen shot

JP

9:39 It dropped for a while, climbing again.
Reduced UFA to 35% to try and
reduce gasification. Left OFA alone
in hopes to dilute.

8% P

10:00p Raised UFA to 45% bed is long and
trans. still rising. Trying to burn more
below and cool above.

green not for JP

to
-60
23-40

21/21

11:40

Increase UF Air to 50% bed
has embers to the end

or Screen Shot

APPENDIX B

3710 Robinson Pike, Grandview MO 64030
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GEOCHEMICAL TESTING

Environmental and Energy Analysis

COAL ANALYSIS REPORT

2005 N. Center Ave.
Somerset, PA 15501

814/443-1671

814/445-6666

FAX: 814/445-6729

Client: ENGINIUTY ENERGY

Sampled by: Client

Sampling Date: 10/01/2013

Analyzed on: 10/08/2013

Description: HAEP - 1 Wet Digestate

LAB NO. 13-188357

Air Dry Loss..... 65.08 %

Residual Moisture..... 2.53 %

	As Received	Dry	Dry Ash-Free
Total Moisture....D3302-02.	65.96		
Ash.....D3174-04..	5.21	15.32	
Volatile Matter..D3175-07..	22.89	67.23	79.39
Fixed Carbon Calc..	5.94	17.45	20.61
	-----	-----	-----
	100.00	100.00	100.00

Sulfur.....D4239-08.. 0.09

BTU/LB.....D5865-07a. 2520

0.28

7402

8741

Lbs Sulfur/Million Btu 0.36

Lbs SO2/Million Btu 0.72

Robert L. Stull
Director of Coal Services



APPENDIX C

3710 Robinson Pike, Grandview MO 64030
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