PHASE I:

BIOMASS ENHANCED REFINED LIGNITE DEMONSTRATION PROJECT

NORTH DAKOTA INDUSTRIAL COMMISSION

CONTRACT NUMBER R005-012

FINAL STATUS REPORT

Submitted to:

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1.0 PROJECT SUMMARY

Objectives of Phase I of the Biomass Enhanced Refined Lignite Demonstration Project were to: development of a compacting machine, to produce a blended fuel from lignite and biomass, characterize the fuel through laboratory analysis and emissions testing and perform test burns on the fuel blends. All project goals were met.

Production of the blended fuel required the designing and engineering of a compaction machine and integration of the material handling systems with the compaction machine. Engineers from ComPAKco designed, manufactured and assembled the compaction machine (ComPAKer). Most of the materials handling equipment was purchased and Federal Machine performed integration design and engineering.

The ComPAKer has successfully processed a complete range of blended fuels from 20-100% biomass percentage blends. Energy inputs for the equipment are significantly less than competing compaction equipment. The equipment is mobile and compaction rates for the product can be varied to meet the desired production applications. Production rates were less than targeted; however, the design can be scaled up to produce compacted material at higher rates.

Test burns were conducted at the Federal Machine site. Emission(s) testing was conducted in April. A second test burn, of 30/70 lignite/biomass blend was produced and burned in July. Production runs demonstrated that blends containing higher proportions of biomass formed Paks with better integrity. These dense paks meant a more porous charge in the furnace enabling a larger load to burn with more consistent heat output and less smoke. PAKs with higher biomass blends also had lower BTU content.

The biomass blends have been tested and characterized in the laboratory. Short Proximate, physical characteristic analysis (Pellet Durability Index), Ultimate testing and mercury analysis were performed on the fuel. Ash minerals were performed on PAKs produced in July.

The targeted market for the lignite/biomass Paks is rural institutions and homes that use propane, oil, and natural gas for heating. ComPAKco's machine can provide a low cost, high value solid fuel as an alternative that should be especially attractive to farmers that can grow much of their own fuel for home heating and for drying crops.

2.0 ENGINEERING, RESEARCH & DEVELOPMENT

ComPAKco began development of compaction technology 2 ½ years ago. Four technology and equipment provisional patents have been applied for. Advantages of the Federal Machine design are:

- Energy Inputs are as low as 1/10 of conventional designs.
- The machine is mobile and easily configurable
- Pressures are able to be varied to produce a variety of product densities

The ComPAKco developed compaction machine proves the concept of rotary compaction. ComPAKco researched a variety of raw product blends for use in the new compaction machine. Laboratory scale data suggested that blends of biomass and lignite had the potential for producing a high value fuel.

ComPAKco learned a great deal through the development of the first generation of compaction technology; however, it was clear that a larger, more powerful machine was required to produce a commercially viable fuel product. The newly designed machine would be similar in overall concept yet significantly different than the original design.

The new design, funded by this project, was targeted to prove commercial viability for a rotary compaction machine. Specifically, a machine that could make a blended coal/biomass fuel in large quantity. The new design work was considerable: The number of compaction dies as well as the horsepower applied were doubled. The power train was made much more rigid by using a direct drive mechanism as opposed to the former chain-and-sprocket configuration. Further, the orientation of the compaction rings was changed to allow better throughput, serviceability, and integration with a conveyor system. The product conveyor had to be able to move and lift product away from the compaction machine while sifting out fines generated during compaction. Ancillary equipment also had to be modified for use specific to this project.

Initial laboraoty research indicated that a bioblend of straw, grass and alfalfa would be optimum to blend with refined lignite. Targeted blends were 60 – 80% lignite and 20-40% biomass. Results from full scale production runs demonstrated that blends containing higher proportions of biomass formed Paks with better integrity. Material flow and compaction capability dropped with higher lignite percentages. In July, blends of 20-30% lignite and 70-80% biomass were produced; this blend compacted and flowed through the ComPAKer with ease. Test burns have shown that the higher percentage more dense biomass PAKs allow better air flow enabling a larger loads to be banked in the furnace. This results in more consistent heat output and less smoke. PAKs produced for the July test burn eliminated problems experienced during the April test burn, specifically with high air flows and incomplete combustion. The material also demonstrated better handling properties.

The integration of the material handling equipment was part of the Project design.

3.0 CONSTRUCTION

Once design work was completed, engineering specifications for the new ComPAker were developed by ComPAKco engineers. The ComPAKer was manufactured by Federal Machine. Pictures below show machining and manufacturing activities. A prototype ComPAKer run was performed prior to integration of the material handling components. There were some difficulties experienced when feeding higher blends of lignite as material did not flow easily through the machine. Material for the April test run and burn was produced with no modifications to the ComPAKer following the prototype run.

Following the April production runs, the main shaft of the compacting machine was revised and rebuilt. The original shafts failed through fatigue and required a minor redesign. Two new shafts were machined and the units were reassembled.

The outgoing conveyor was revised and rebuilt to better handle material flow. The first version of the conveyor had a slope that was too steep and material would roll back and not leave the conveyor.

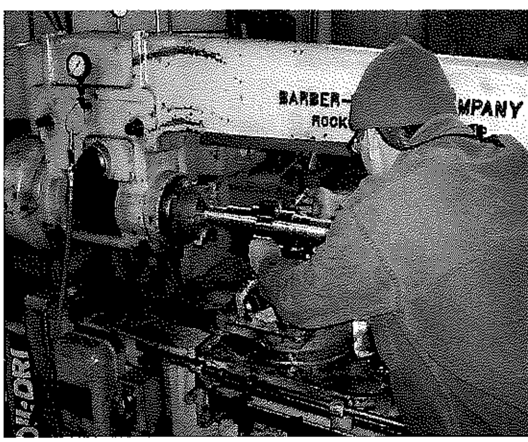


Figure 1: Cutting Mainshaft Gear Box

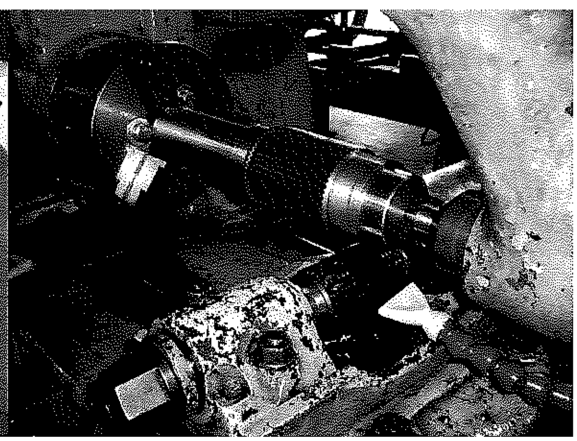


Figure 2: Hobbling splines on gear box transmission shafting

4.0 COMPAKER PERFORMANCE

The performance of the newly designed ComPAKer has met expectations and through operation of the compacting machine, ComPAKco has accomplished the Project goals. The photos below show compacted material as it leaves the compaction machine. Figures 3 and 4 are not shown due to confidentiality.

Laboratory analysis of the prototype runs of the ComPAKer can be found in Table 3b. The prototype lignite/biomass PAKs experienced molding issues during storage, a phenomenon not previously observed in pilot production or with 100% biomass PAKs. During prototype PAK production, some problems were experienced moving the lignite through the machine. Water was added as a aid to facilitate material flow through the machine.

It became clear that making a good coal/biomass mix was a tradeoff in a number of different categories. Compacted alfalfa Paks have been tested to yield 7,500 BTU per pound; the same as the compressed wood pellets used in home heating applications. Lignite coal has a (dry) BTU content of nearly 10,000 BTUs per pound, making blends higher in coal also higher in energy density, however, lignite coal is not very compressable and tends to crumble rather than form a bond between particles. Further, water is required to adequately lubricate the coal through the compression dies. The higher the coal content, the greater the water content would be in the coal Pak as it exits the machine. Paks with high coal content are fragile and require drying to prevent mold when storing, negating the energy advantage of the additional lignite. An optimal point was found at roughly 25% coal, wherein the machine was able to push through the Paks without additional water, and the fiberous biomass was able to hold the Paks together.

In July, PAKs were produced with 100%, 80% and 70% biomass. These PAKs flowed through the machine easily and did not require additional lubrication. The PAKs have not exhibited any degredation upon storage.

5.0 TEST BURNS & EMISSION TESTING

April 2010 Test Burn

Production runs and test burns were conducted in April and July of 2010. Runs in April consisted of three fuel blends, an 80/20, 70/30 and 60/40 lignite/biomass fuel blends. PAKs were produced prior to the test burns. Material flow problems through the ComPAKer were experienced. A malfunction of the hay grinder, a part of the raw product processing equipment combined with the material flow problems experienced with high lignite content feed stock for the PAKS resulted in the PAKs that did not meet the desired quality specificaiton . Since emissions testing was scheduled and significant notification and scheduling is required to secure a test team, a decision was made to proceed with testing.

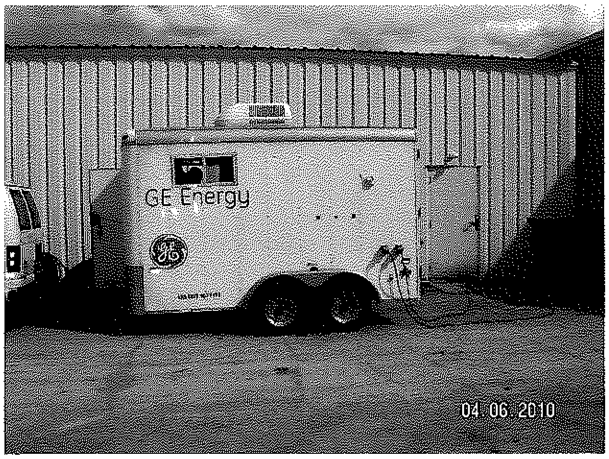
Lessons learned revolve around production of high lignite PAKs and production quality control. These lessons learned were applied to the July Pak production and test burns.

Production runs demonstrated that blends containing higher proportions of biomass formed Paks with higher density. One outcome of April production and test burns was the determination that PAK density was very important to complete combustion. PAKs produced in July contained higher biomass percentage than previously produced PAKs. Higher biomass fuels produced a more dense Pak enabling the furnace to burn with more consistent heat output and less smoke.

The hay grinder reduces the size of the alfalfa and straw to approximately 1-2 inches. Malfunction of the hay grinder resulted in oversized raw biomass feedstock. The oversized feedstock in addition to the high percentage of lignite resulted in flow problems through the compaction equipment. To help alleviate the flow problems additional lubrication, water, was required resulting in a wetter than desired final product. In addition, the final product was more friable.

Figure 5: High percentage lignite PAKs with oversized straw

Emission Testing was performed by GE Infra, Energy during the April test runs, below is a picture of the testing trailer and the test team performing emissions testing. Analysis of emissions included measurement of the flue gas concentrations of Nitrogen Oxides (NOx), Sulfur Dioxide (SO_2), Carbon Dioxide (CO_2) and Oxygen (O_2) in the flue gas. Combustion characteristics of the 60/40 blend were insufficient for emission testing, the product was too moist for compete combustion. No testing was performed during the July test runs as indicator parameters were established to monitor test burns to compare with the April test results. See the temperature montoring picture below.



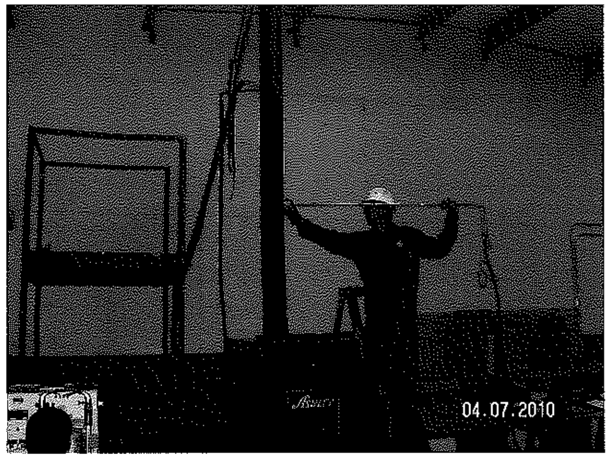


Figure 6: GE Test Trailer

Figure 7: GE Testing Emissions

Lessons learned from the test burn include:

1. Production of high lignite percentage PAKs will be discontinued in favor of higher biomass percentages.
    a. Material flow problems are experienced with high percentage lignite PAKs.
        i. To make the material flow through the ComPAKer water was added as a lubricant. The final product contained excessive moisture.
        ii. Wet fuel resulted in incomplete combustion
        iii. Mold developed on the fuel during storage and transportation
    b. Too many fines were produced during PAK production. Fines affected the fuel to air ratio and combustion properties of the fuel.
        i. Fines impeded air flow through the furnace requiring higher air flow. These higher air flows resulted in carry over of particulate matter. Higher NOx emissions were generated as a presumably as a result of incomplete combustion.
        ii. There were more handling problems due to fines and higher PAK friability

2. Quality control of the product is extremely important. The malfunction of the hay grinder resulted in:

   a. Too many fines

      i. Longer than desired biomass stalks resulting in a product that contained fines from the breakage of PAKs

      ii. Fines affected the fuel air ratios and combustion properties of the fuel

         - Additional particulate matter was carried over as a result of higher fuel air ratios

         - Higher NOx emissions were generated, presumably, as a result of incomplete combustion

Graphs from Test Run 1 are included in Tables 2a and 2b. Some conclusions from test results are:

1. Higher percentages of lignite resulted in a higher lb/mmBtu sulfur content.

2. Higher percentages of biomass resulted in higher Nitrogen Oxide emissions which may be a result of the combustion characteristics of the fuel rather than fuel quality

3. Higher percentages of biomass resulted in higher levels of particulate, again this may be a result of the air to fuel ratio required for combustion of the lower ranked fuel

4. Emissions spiked when fuel was added to the furnace.

5. Higher percentages of lignite resulted in higher BTU contents

July 2010 Test Burn

PAKs produced for the July test burn were 70% and 80% biomass. No problems were experienced with PAK production. PAK quality met all design criteria. Observations from the run include:

1. No molding issues were experienced with the PAKs during storage.

2. Stack emissions of particulate were not visible as opposed to the April test where stack emissions were noticeably evident

3. Few fines were contained in the final product

4. Lower air flows were needed for complete combustion, which means that the fuel was more efficiently burned

5. The product banked well and held it's shape during the test burn

6. Temperature in the furnace was maintained during the test run as opposed the first test when temperature swings were experienced whenever fuel was added.

Figure 8: July test burn showing banked PAKs intact during burn

Figure 9: Measuring Temperature – July

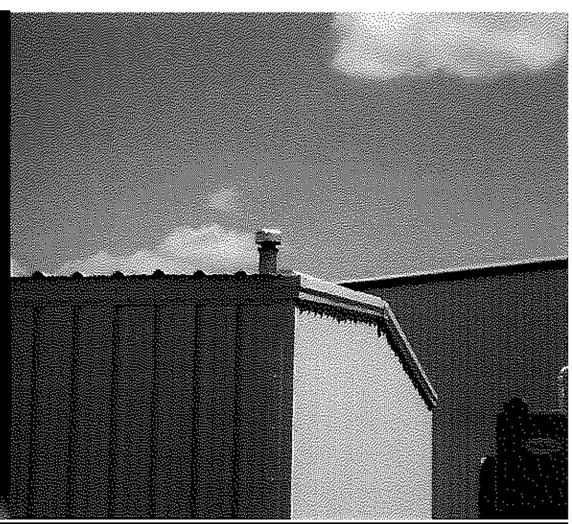


Figure 10: No visible emissions – July burn

6.0 LABORATORY TESTING AND FUEL SPECIFICATION

Laboratory analysis has been an important aspect of the research and development of the lignite/biomass fuel. All analysis was performed at the Coal Creek Station Testing Laboratory. Testing was performed per methodology described in Table 3a. Short Proximate Analysis parameters consisted of moisture, ash, BTUs, and sulfur and can be found in Table 3b. Ultimate Analysis consisted of carbon, nitrogen, hydrogen and oxygen. Some PAKs were analyzed for density and heavy metals, analysis can be found in Table 3c.

Dry BTUs are the comparison basis of heating value for all bioblended fuels. Dry BTUs are corrected for moisture; moisture in the PAKs has been an undesirable variable that was caused by equipment operational issues and blend percentages.

Bioblend Laboratory Analysis observations are:

1. Sulfur content varies proportionally to the percentage of lignite in the PAK
2. Dry BTUs vary proportionally to the percentage of lignite in the PAK
3. Ash is inversely proportional to the percentage of lignite in the PAK
4. Moisture varies proportionally to the percentage of lignite in the PAK
5. Carbon intensity varies proportionally to the percentage of lignite in the PAK

Results of the laboratory testing will be the basis for the development of a fuel specification. The fuel specification will be variable based on the application.

PAKs produced for the test burns were tested for Pellet Durabilty Index. Pellet Durability Index is a measurement of the amount of material that stays intact during testing. There are proposed standards for material; a Premium Grade Rating would be material that has a Pellet Durability Index of >= 97.5% and a Standard or Utility Grade Rating has a Pellet Durability Index of >= to 95%. PAKs produced for the lst test run were much lower than Premium or Standard Grade rating due to the malfunction of the raw material processing equipment. Pellet Durability Index for the PAks produced in July showed marked improvement.

7.0 BUDGET AND EXPENDITURES

	Projected	Actual
NDIC Renewable Energy Grant	$275,000	$249,938
Federal Machine GAE Match	$295,000	$278,584
Total Project	$ 570,000	$528,522

Table 1: Project Expenditures Overview

Table 1 contains a spreadsheet of North Dakota Renewable Energy funds spent and in-kind expenditures and purchases by Federal Machine, ComPakco, Falkirk Mine and Great River Energy. Explanations of cost variations from the projected budget are noted in the spreadsheet.

8.0 TIMELINE

In November 2009, ComPAKco and GAE requested an extension to the Biomass Enhanced Refined Lignite Demonstration Project Grant timeline. The primary reason for an extension request was that permitting the Project building was more time consuming and complicated than initially anticipated. The building permit from the City of Fargo was not received until December. The delay in securing a permit set back the start of construction; that set back combined with weather delays and contractor availability pushed completion of the building into February. Equipment could not be permanently placed until construction of the building was complete. A final report for the Project was due April 30, a second extension request for the Project was sought to perform additional testing of the lignite/biomass fuel products as previous test burns were hampered by PAK quality . This document represents a final report for the Project.

9.0 PROJECT APPLICATION

The targeted market for the lignite/biomass Paks is rural institutions and homes that use propane, oil, and natural gas for heating. ComPAKco's machine can provide a low cost, high value solid fuel as an alternative that should be especially attractive to farmers that can grow much of their own fuel for home heating and for drying crops.

- Home Heating Market - ComPAKco has been in contact with state of the art home heating furnace and gasifer manufactures. Manufacturers are very interested in a consistently available, quality-controlled fuel. Several are urging us to speed up commercial production, as there is a shortage of consistent quality fuel. Materials of stove construction will dictate fuel specifications. Marketing efforts should concentrate on stoves with specifications that meet current PAK fuel specifications.

- Small and Large Commercial/Industrial Boiler Market - Several small and large commercial/industrial heating and/or process boilers are interested in the product for a variety of reasons. Some see the potential availability of the product as a plus while others are looking to reduce emissions of pollutants such as CO_2.

- Grain Drying Market - ComPAKco has held several meetings with large agricultural producers that currently dry grain with other fuels. Economics and utilization of local products are driving interest in the bioblend coal fuel.

TABLE 2a: Emissions Summary GE

Instrumental Reference Method
Calibration and Moisture Corrected Field Data

Project Number:	ZTN00086	Test Date(s):	4/7/2010 and 4/8/2010
Customer:	Great River Energy	Facility:	Federal Machine Company
Unit Identification:	Furnace	Recorded by:	GL
Sample Location:	Stack	Fc Factor:	N/A
RM Probe Type:	Extractive (Dry)	Fd Factor:	N/A
Load Level:	6/20%, 70%/30% and 40%/60% Mixt	Condition:	

Calibration Corrected Test Run Averages on RM Probe Moisture Basis

Run #	Start Time	End Time	NO_x ppmvd	SO_2 ppmvd	CO ppmvd	CO_2 % v/v dry	O_2 % v/v dry
1	12:00	15:00	42.08	88.96	1839.5	2.66	18.09
2	8:20	11:57	66.37	56.49	2733.59	2.12	18.79
3	13:30	14:30	52.95	[redacted]	5535.46	1.13	19.74

Summary Test Run Averages on a Corrected Moisture Basis

Run #	Start Time	End Time	NO_x ppmvw	SO_2 ppmvw	CO ppmvw	CO_2 % v/v wet	O_2 % v/v wet	Moisture Bws
1	12:00	15:00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.039
2	8:20	11:57	[illegible]	54.14	[illegible]	[illegible]	[illegible]	0.042
3	13:30	14:30	[illegible]	[redacted]	[illegible]	1.09	[illegible]	0.032

Emission Rate Calculation Summary

Run #	Start Time	End Time	NO_x lb/MMBtu	SO_2 lb/MMBtu	CO lb/MMBtu	NO_x lb/hr	SO_2 lb/hr	CO lb/hr	Flow SCFM
1	12:00	15:00				0.03	0.08	0.73	9433
2	8:20	11:57	-	-	-	0.04	0.05	0.98	86
3	13:30	14:30	-	-	-	0.04	0.00	2.41	104

Emission Rate Test Results Summary
lb/hr Emission Rate Determined Using lb/MMBtu Emission Factor and Heat Input

Run #	Start Time	End Time	Heat Input MMBtu/Hr	NO_x lb/hr	SO_2 lb/hr	CO lb/hr
1	12:00	15:00				
2	8:20	11:57		-	-	-
3	13:30	14:30		-	-	-

Test Run Averages Corrected to a Reference O_2 Concentration

Run #	Start Time	End Time	NO_x ppmvd corrected to 15% Oxygen	SO_2 ppmvd corrected to 15% Oxygen	CO ppmvd corrected to 15% Oxygen
1	12:00	15:00	[illegible]	166.77	[illegible]
2	8:20	11:57	[illegible]	[illegible]	[illegible]
3	13:30	14:30	[illegible]	[redacted]	[illegible]

Table 2b: Emisions Testing 80/20 Test Run

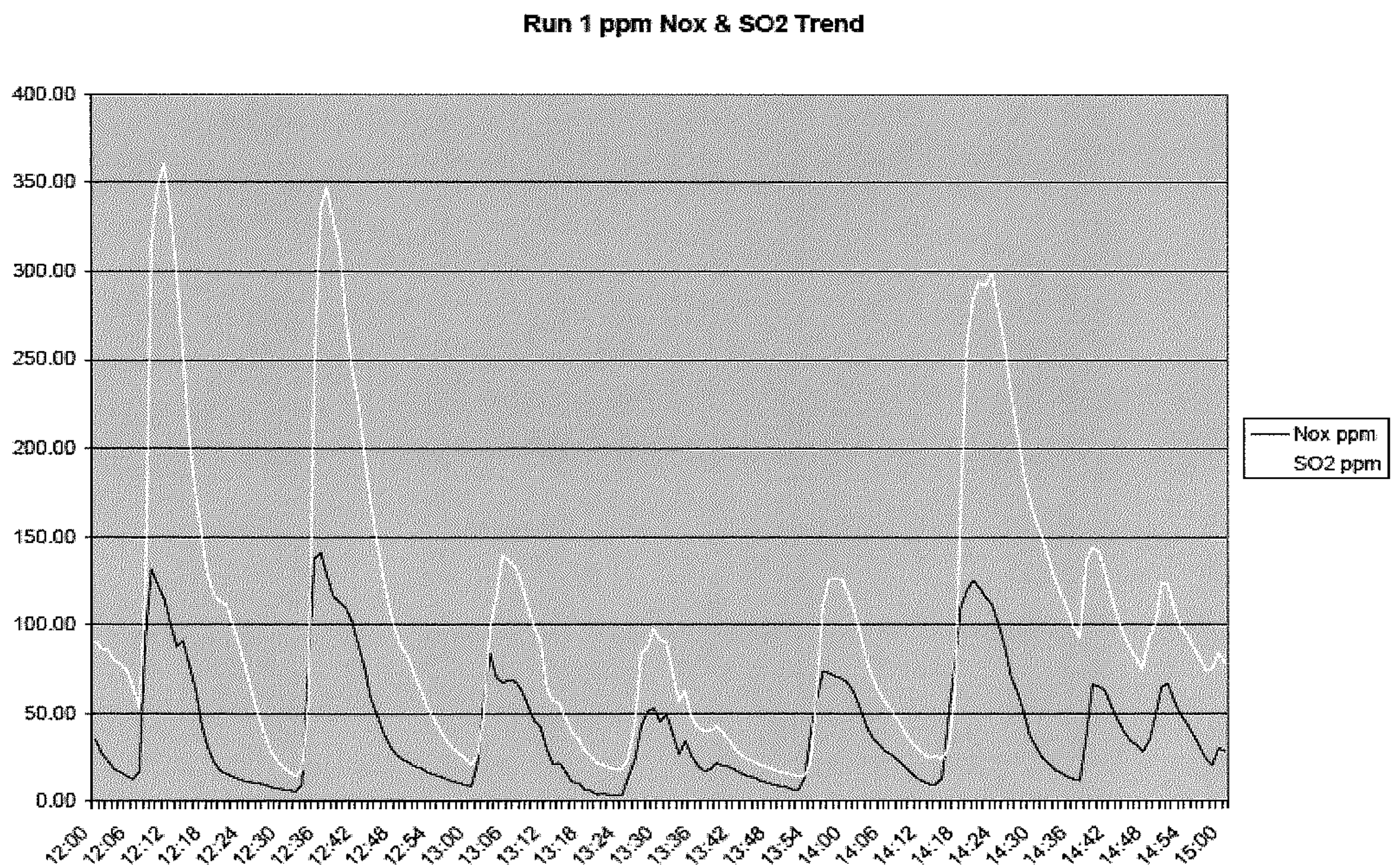


Table 2c: Emisions Testing 70/30 Test Run

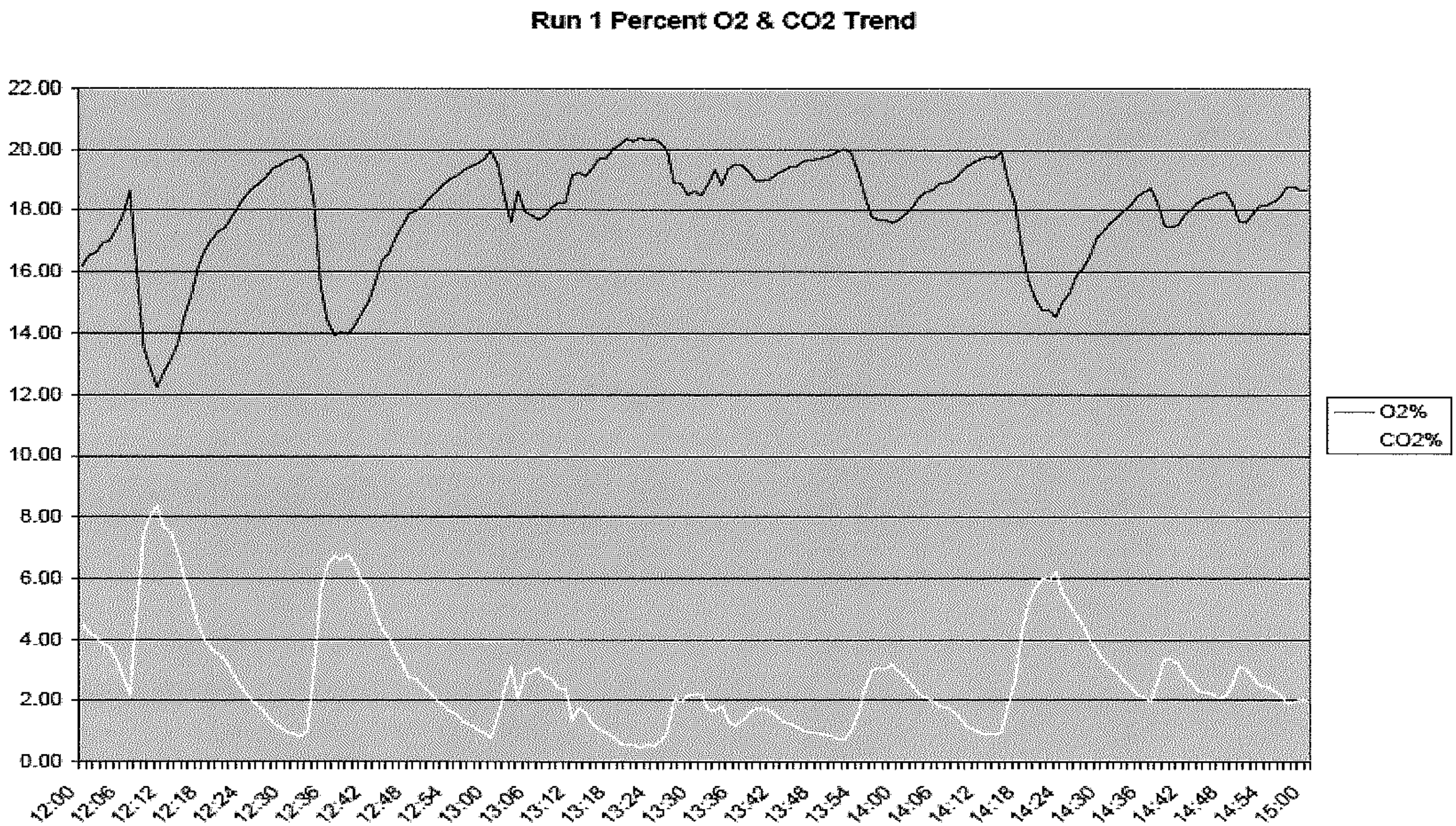


Table 3a: Laboratory Testing Methodology

Laboratory Parameter	Methodology
Moisture	ASTM D 5142
Ash wt%	ASTM D 5142
Volatile wt%	ASTM D 5142
Btu/lb	ASTM D 5865
Total Carbon wt%	ASTM D 5373
Hydrogen wt%	ASTM D 5373
Nitrogen wt%	ASTM D 5373
Total Sulfur wt%	ASTM 4239
Mercury μg/g	ASTM D 6722
Pellet Durability Index	ASAE S-269.3
Bulk Density	ASTM E 873

Table 3b: Compacted Fuel Analysis

Lab ID	Sample ID	Date	Total Moisture	Dry Ash	As-rec Ash	Dry BTU	As-rec BTU	Dry Sulfur	As-rec Sulfur	lbs SO_2/MMBTU
Raw Material										
4064-09	FM-SSC1 (lignite)	04/06/2009	27.50	16.59	12.03	9,949	7,213	0.88	0.64	1.77
4065-09	FM-SSC2 (lignite)	04/06/2009	27.61	18.32	13.26	9,759	7,065	0.95	0.69	1.95
4066-09	FM-SSC3 (lignite)	04/06/2009	27.64	16.05	11.61	10,008	7,242	0.96	0.69	1.92
6799-10	FM-Straw	03/09/2010	7.04	6.72	6.25	7,827	7,276	0.17	0.16	0.43
6801-10	FM-Misc. Material	03/09/2010	23.84	7.73	5.89	9,547	7,271	0.48	0.36	1.00
Research PAKs										
4278-09	FM-Coal Pak	05/04/2009	8.13	12.65	11.62	11,142	10,236	0.69	0.63	1.24
4279-09	FM-Coal Pak(dup)	05/04/2009	8.10	13.17	12.10	11,122	10,221	0.63	0.58	1.14
4280-09	FM-Coal/Corn Stover(2)Pak	05/04/2009	7.10	15.14	14.07	8,748	8,128	0.83	0.77	1.89
4281-09	FM-Coal/CornStover(2)Pak (dup)	05/04/2009	7.06	15.12	14.05	8,758	8,140	0.84	0.78	1.93
4282-09	FM-Coal/BioBlend 3 Pak	05/04/2009	8.66	19.75	18.04	8,719	7,964	0.95	0.87	2.19
4283-09	FM-coal/BioBlend 3 Pak (dup)	05/04/2009	8.61	20.07	18.34	8,672	7,925	0.96	0.88	2.21
4284-09	FM-Corn Stover Pak	05/04/2009	6.04	8.27	7.77	7,573	7,115	0.07	0.06	0.18
4285-09	FM-Corn Stover Pak (dup)	05/04/2009	6.02	7.92	7.44	7,524	7,071	0.05	0.05	0.14
Prototype PAK Production										
6802-10	FM-Coal PAKs	03/09/2010	15.44	13.81	11.68	9,133	7,723	0.70	0.59	1.54
6800-10	FM-Straw PAKs	03/09/2010	7.36	7.77	7.20	7,856	7,278	0.17	0.16	0.44
Test Burn PAK Production* - Full Scale										
7062.1-10	FM 40/60 PAKs	04/14/2010	55.00	13.79	6.20	8,617	3,877	0.50	0.22	1.15
7062.2-10	FM 70/30 PAKs	04/14/2010	47.28	14.50	7.65	9,245	4,874	0.80	0.42	1.73
7062.3-10	FM 80/20 PAKs	04/14/2010	28.72	14.83	10.57	9,150	6,523	0.87	0.62	1.91
7608-09	FM 0/100 PAKs	05/24/2010	7.85	17.85	16.45	7,090	6,534	0.24	0.22	0.68

Lab ID	Sample ID	Date	Total Moisture	Dry Ash	As-rec Ash	Dry BTU	As-rec BTU	Dry Sulfur	As-rec Sulfur	lbs SO_2/MMBTU
7607-09	FM 0/100 PAKs (dup)	05/24/2010	7.82	17.95	16.55	7,119	6,562	0.24	0.23	0.69
7610-09	FM 25/75	05/24/2010	12.79	13.97	12.18	8,630	7,526	0.39	0.34	0.89
7609-09	FM 25/75 (dup)	05/24/2010	12.89	14.17	12.34	8,696	7,575	0.42	0.37	0.97
8450-09	FM 20-80	07/26/2010	9.80	13.43	12.11	8,419	7,594	0.35	0.31	0.83
8449-09	FM 30-70	07/26/2010	8.14	13.69	12.58	8,068	7,411	0.40	0.37	1.00

TABLE 3c: Ultimate Analysis

Sample ID	Date	As-Rec C (wt.%)	Dry C (wt.%)	As-Rec H (wt.%)	Dry H (wt.%)	As-Rec N (wt.%)	Dry N (wt.%)	As-Rec O2 by Diff (wt.%)	Dry O2 by Diff (wt.%)	As-Rec Hg (ug/g)	Dry Hg (ug/g)
FM 40/60 PAKs	04/14/2010	23.16	54.37	8.5	4.87	0.73	1.71	61.79	25.38	<0.02	<0.047
FM 70/30 PAKs	04/14/2010	29.42	57.82	7.73	4.39	0.66	1.3	53.88	20.16	<0.02	<0.039
FM 80/20 PAKs	04/14/2010	41.09	58.39	6.41	4.4	0.85	1.21	40.61	20.32	0.04	0.057
FM 20/80 PAKs	07/26/2010	42.34	47.39	5.82	5.18	2.35	2.63	31.95	25.17	0.020	0.022
FM 30/70 PAKs	07/26/2010	43.60	47.80	5.61	5.07	2.27	2.49	35.06	29.89	<0.02	<0.022

*Note that the Sample ID of the Test Burn PAKs indicates the % lignite / % Biomass

TABLE 3d: Pellet Durability Index

Sample ID	Date	Pellet Durability Index ug/g
FM 70/30 PAKs	04/14/2010	57.2
FM 80/20 PAKs	04/14/2010	48.2
FM 20-80 PAKs	07/26/2010	90.4
FM 30-70 PAKs	07/26/2010	87.4

TABLE 3e: Bulk Density

Lab ID	Sample ID	Date	Bulk Density
7062.1-10	FM 40/60 PAKs	04/14/2010	0.27
7062.2-10	FM 70/30 PAKs	04/14/2010	0.62
7062.3-10	FM 80/20 PAKs	04/14/2010	0.51

TABLE 3f: Ash Minerals

Analyte (% by wt.)	FM 30-70 (8449-10)	FM 20-80 (8450-09)
Na_2O	0.87	0.87
MgO	4.68	5.14
Al_2O_3	9.68	9.68
SiO_2	34.04	35.73
P_2O_5	4.50	3.96
SO_3	5.49	5.37
K_2O	19.97	18.70
CaO	17.91	17.27
TiO_2	0.32	0.33
Fe_2O_3	3.67	4.31
SrO	0.11	0.11
BaO	0.11	0.12

Table 4: Project Timeline

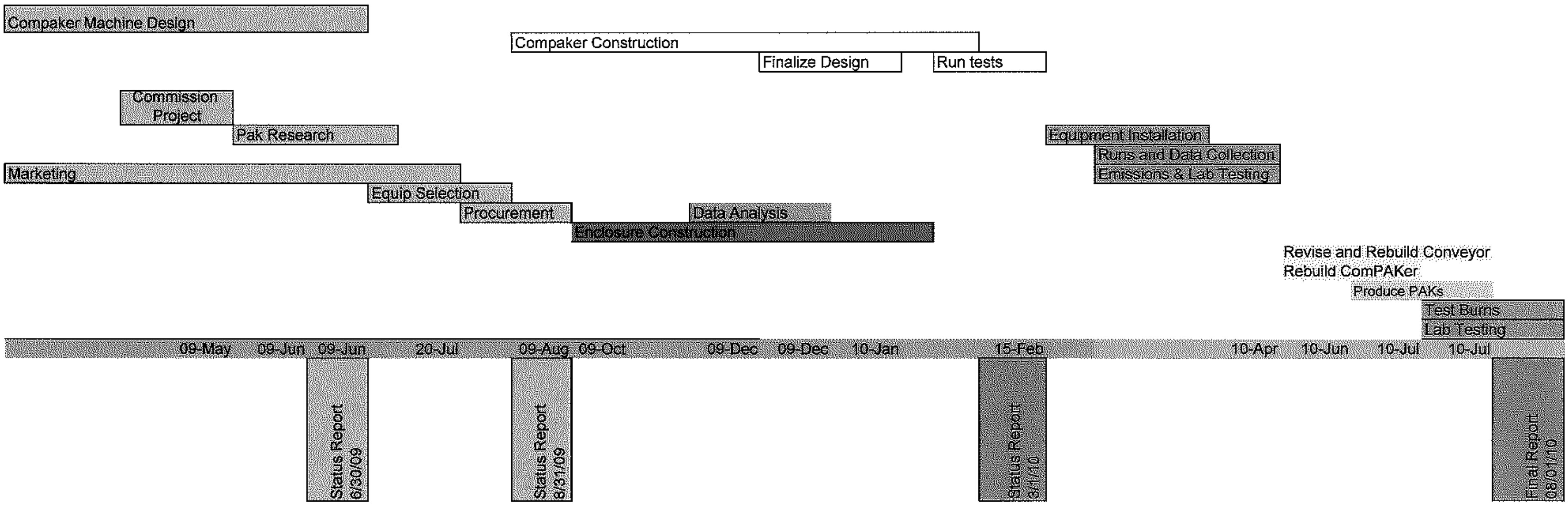


Table 5: Project Final Expenses

Description	North Dakota Renewable Energy Council *funds spent*	In Kind Expenses ComPakco	In Kind Expenses Federal Machine	In Kind Expenses Great American Energy
Project Design				
1 Building plans (structural, electrical) and permitting	487	15,000		
Equipment Design [1]				
2 Engineering overhead	10,507	4,000		
3 Engineering, conveyor	210	4,000		
4 Compactor design, compaction R&D	37,972	45,250		
5 Design modification		3,500		
Construction				
6 Compactor, conveyor construction	61,362			
7 Manufacturing overhead	30,680		6,800	
8 Materials, compactor and conveyor	13,400		16,200	
9 Building electrical	4,127			
10 Testing building	51,589			
11 Concrete for test building	2,900			16,000
Operation				
12 Floor space and coal storage			10,800	
13 Land rental for building			4,100	
14 Administrative expenses	12,892		800	
15 Labor			16,376	
Biomass Specs and Testing				
16 Blend development		2,500		600
17 Product testing		4,000		2,170
18 Emissions testing		250		12,922
19 Analysis and Evaluation of Results				1,846
Equipment [2]				
20 Test stove	2,032			
21 Fork lift	14,630			
22 Hay grinder	4,350			
23 Ribbon blender	2,800			
Refined Lignite [3]				
24 Material				1,750
25 Labor				2,386
26 Shipping				617
Biomass Material				
27 Raw material procurement		1,100		
Additives				
28 Raw material procurement		500		
Project Management				
29 General Plant Project Management		57,950	19,225	18,233
30 Travel Expenses				1,522
31 Quality Control Management of Testing Team				1,573
32 Preparation of Reports				6,614
	249,938	**138,050**	**74,301**	**66,233**
Total Renewable Energy Council Funds Expended	249,938			
Total In-Kind Expenses	278,584			
	528,522			

1. Engineering expenses have been more than anticipated for the following reasons:
   a. Additional research and development was required for material binding including selection of and testing of binders.
   b. Additional R&D was added to the conveyor system to separate and recycle material "fines". We did not anticipate doing this originally, thinking we could use an off-the-shelf system.
   c. Additional engineering expenses were incurred for locating, repairing and adapting used equipment to our needs. The used equipment route has saved us a great deal of time (some machines could take months to deliver) and money; however, additional engineering time was devoted to procuring and modifying the equipment.
   d. A redesign of the main shaft of the compacting machine was performed following the Ist test runs.
2. Equipment expenses have been less than projected as used equipment has been purchased whenever possible.
3. Refined liginite expenses are less than project; however all costs have not been accounted for in this spreadsheet.