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STORM TECHNOLOGIES, INC.
411 North Depot Street PO Box 429
www.stormeng.com
Albemarle, NC 28002
Phone: (704) 983-2040, Fax: (704) 982-9657

Heat Rate and Combustion Performance Improvement by Applying the Storm Performance Preservation Program

The successes of applying the fundamentals are growing. More plants have “Rediscovered applying the fundamentals of getting the inputs right. That is the furnace inputs of combustion air and fuel. The benefits are INTER-RELATED, COMPOUNDING and HUGE. Please note Figure No. 1 below, which shows “Typical” opportunities of the total plant. Let me explain why we say Inter-Related.

The Inter-Related and Compounding Benefits of Combustion and Performance Optimization can exceed 300Btu’s/kWh. Here are the typical opportunities.

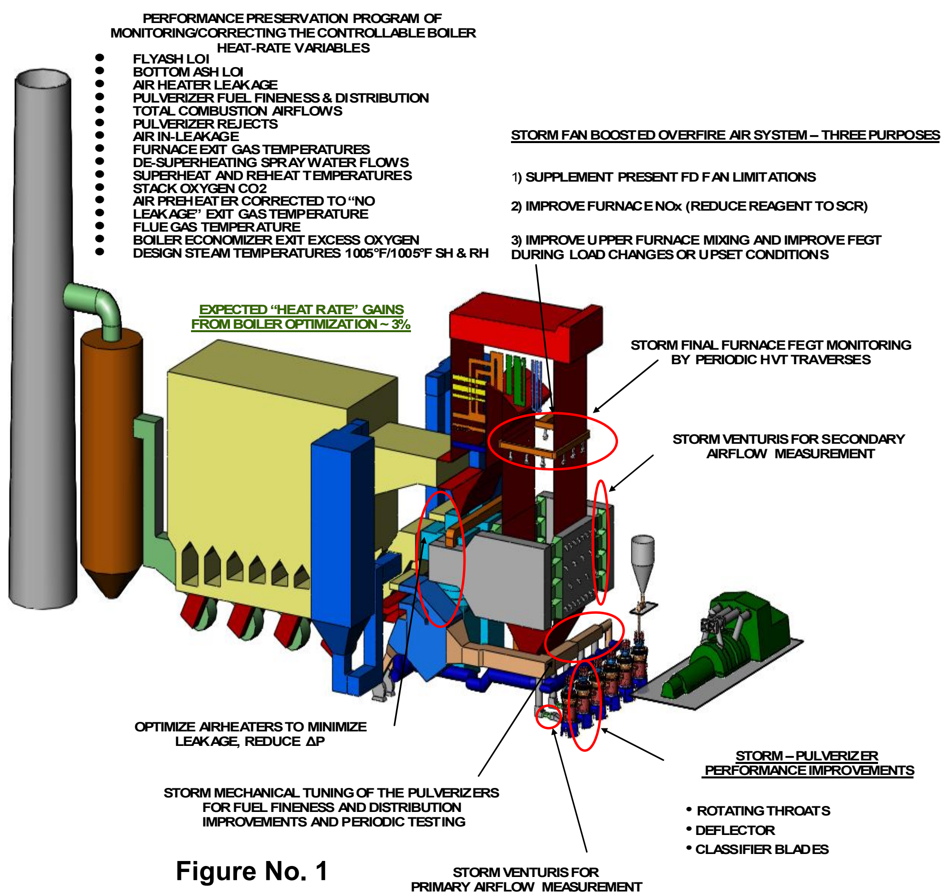


Figure No. 1

Some Inter-Related Performance Factors:

Primary airflow, when optimized, reduces tempering airflows, which then improves the airheater "X" ratio and reduces dry gas loss. Primary airflow, when reduced to optimum, also lowers NO_x by reducing the free oxygen into the fuel rich de-volatilization zone of the flames. The optimum primary airflows also reduce flame lengths on wall fired boilers and thereby reduce desuperheating spray water flows and auxiliary steam consumption by the sootblowers. Therefore, reducing the FEGT (Furnace Exit Gas Temperature). These "Heat Rate", "Reliability", Fuels Flexibility, Load Capability and NO_x factors are all inter-related and nearly all pulverizer centered. Please note Figure No. 2.

The STORM Solid Fuel Injection System Approach To Furnace Combustion Efficacy

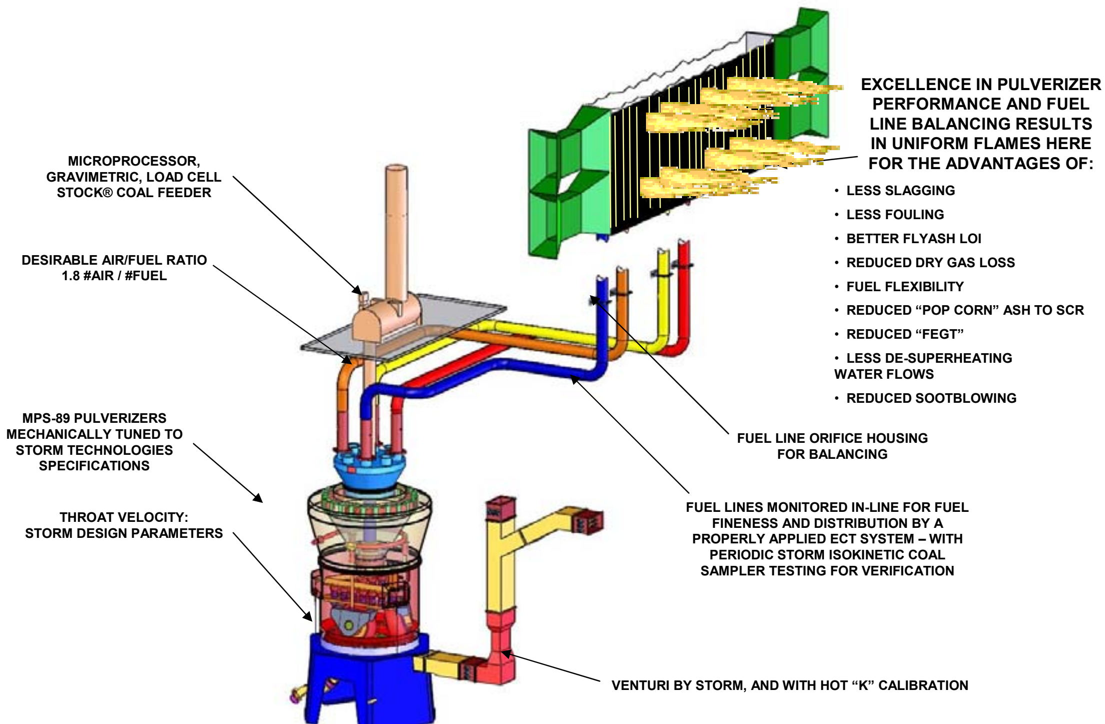


Figure No. 2

I used the word "compounding", which was intended to be used for Benefit Compounding, just as financial professionals speak of the power of Compound Interest for investments. Consider this on Benefits of Optimizing Combustion. Getting the shortest possible flames for the NO_x Limitation the unit must comply and may provide many additional benefits. This means less slagging at the upper furnace. So the compounding of benefits may apply here in at least 9 ways, lowering primary airflows (to the true and accurately measured range of 1.6 to 1.8 #air/ #Fuel) provides benefits as follow:

1. Reduced de-superheating sprays at the S.H. and R.H.
2. Less required sootblower operation to remove tenacious "sticky" cinders on the high temperature pendants.
3. Less "pop corn ash and less consequent fouling of the SCR or airheater.
4. Less draft loss as a RESULT of less fouling and therefore less…..
5. F.D. and I.D. auxiliary power.
6. Less airheater leakage due to reduced head between the F.D. discharge, and APH exit gas static.
7. With proper sized pulverizer throats, less coal rejects (wasted fuel and fire hazard).
8. Capability to lower excess air with improved fuel balance, and we could go on.
9. Less NO_x production in the furnace which, in turn, reduces the required SCR reagent requirements.

But, the inter-relationships become more fuzzy as we work down the list of benefits.

Notice anything interesting about this list? Most of these specific items are related to the 13 Essentials; and specifically to the "heart" of a pulverized coal fueled boiler, the coal pulverizers.

We call it "Mechanical Tuning of the Pulverizers, please see Figure No. 3.

STORM Recommended
Pulverizer Mechanical Tuning

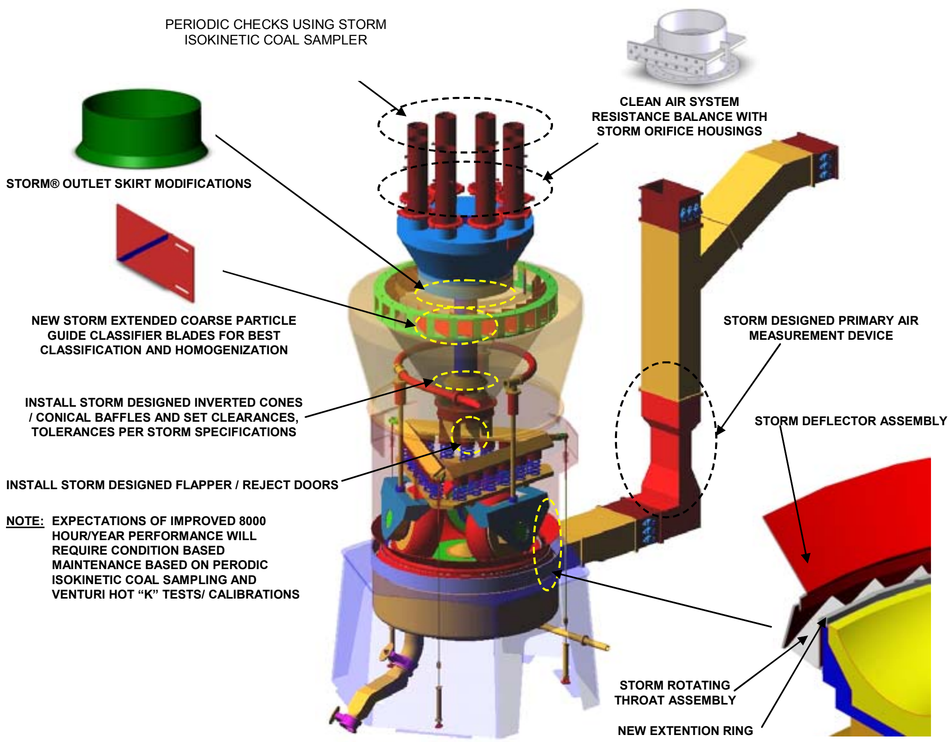


Figure No. 3

The Storm team, which has grown in numbers, now has over 75 Engineer-Years experience in optimizing coal pulverizers and coal fueled boiler combustion. Over these years we have "fine tuned" our approach to optimizing coal pulverizers.

Last month we featured the storm approach to fuel line balancing. Here comes that word "Inter-Related" once again. Fuel Line balance has a great deal to do with pulverizer optimization. Also, pulverizer optimization means a lot more than achieving > 70% passing 200 mesh fineness. We explained, or attempted to explain that in last month's edition of the newsletter.

Huge Benefits for Doing So?

That is, applying the Storm Pro-Active Approach to Combustion Optimization. You be the judge. When we write our reports or technical papers, we take the literal meaning of "words" as being important. Three key words or phrases used in the first page are:

- **Inter-Related**
- **Compounding**
- **Huge Benefits**

By the way, one thing I did not say is: These factors can be measured and controlled in the comfort of an air conditioned office. It takes pro-active testing and adjusting/tuning and more testing, to achieve and to preserve Optimum Performance. We call that **Performance Driven Maintenance**. Which was also described in last month's newsletter.

Getting back to huge benefits of getting and keeping the fuel and air inputs at optimum. Here are a few examples for a typical 325MW coal unit, that is based on $1.50/mmBtu fuel cost. Multiply by the ratio of next years expected fuel costs (would you guess $3.00/mmBtu?) and then consider Performance Driven Maintenance. Getting the inputs to the furnace right is an economically sound approach. Note: Figure No. 4 as a typical heat-rate benefit for a 325Mw unit.

What could a Total Combustion Performance Optimization Program be worth when it is applied comprehensively?

Basis:

Example Unit Load Capacity:	**325Mw**
Productions Cost Estimated:	**$20.00/Nw**
Estimated Present Heat Rate:	**9,750 BTU/kWh**
Capacity Factor:	**70%**
Hours of Operation/Year:	**8,000**
Fuel Cost/MMBTU:	**$1.50**
Estimated Fuel Costs/Year:	**$38,025,000 (100% Capacity)**
	$26,617,500 (70% Capacity)

Example:
((9,750BTU/kWh)*(25,000kWh)*(0.70)*(8,000Hrs/Year)*($1.50/MMBTU))/1,000,000=$26,617,500

Summary:
Based on the 750 BTU/kWh reduction (from 10,500 BTU/kWh to 9,750 BTU/kWh), improving reliability and increasing capacity factor it is possible to see a net gain of: $3,120,000 (lost production) + $2,047,500 (heat rate savings) = $5,167,500.00.

Figure No. 4

Figure No. 5 shows "Reliability" improvement benefits of avoiding forced outages due to tube leaks. In our experience many tube leaks are due to sootblower erosion from overblowing, from overheated metals due to high temperature flue gas lanes, or due to fireside wastage due to poor fuel fineness and/or poor fuel distribution.

What is the Cost Benefit of Increased Reliability?

Reliability and Cost Analysis Example:

If The Plant Experienced Five (5) Tube Leaks or 10 days (240 Hours) Lost Production and Production Replaced by Gas Turbines. What is the value of the lost production?

(240 Hrs) * (325 Mw's) * $40.00/Mw) = $3,120,000.00

Estimate based on:

- **325 Mw Production**
- **Approx. $60.00/Mw Oil or Gas Fueled Production Cost**
- **Approx. $20.00/Mw Coal Production Cost**
- **Approx. $40.00/Mw Delta**

Figure No. 5

How to Fix it!

Engage the services of Storm Technologies, Inc. to work with your team and to monitor early deviations from optimum. For example, lets look at critical and often not routinely measured or/sampled variables. These are examples of tests that should be conducted at least monthly so that corrections can be made before adverse performance, heat rate or reliability challenges become a reality:

Pulverizers:

- Fuel Fineness from each fuel pipe.
- Fuel distribution from each fuel pipe.
- Feeder calibration.
- Primary airflow calibration checked.
- A/F ratio optimum.
- Coal rejects NIL.
- Pulverizer drive power at optimum.
- Raw coal size < 3/4”.

Boiler:

- Superheater sprays at optimum.
- Reheater sprays at optimum (zero).
- Flyash carbon content western fuels < 0.2% carbon.
- Flyash carbon content eastern fuels < 6.0% carbon.
- Bottom ash carbon content < 1.0% carbon.
- Furnace exit excess oxygen (not economizer, furnace) 2-3% 0_2
- Stack CO < 100ppm CO

Air Heater:

- Leakage < 9% leakage

Myself and our staff have published a number of technical papers and articles in magazines of examples of successes. We know that this approach works, and it works well. The **two KEYS** to continued success are Perseverance and Commitment!

Also, sticking to the TEST, TUNE, CORRECT, TEST, ADJUST, CORRECT and TEST again approach. We never said it was fun or easy. So, after all of these years we have a new suggestion: Commit to the program with your performance testing/maintenance and/or operations & maintenance team, and then send us the data.

We can contract to do these services at our current rates for office time and therefore provide the benefits of our experience without the travel and mobilization costs. If the test data shows a need for closer attention, then we can dispatch the appropriately experienced field service engineers or technicians to your plant. We have done this to a certain extent and with good success. In fact, nearly all of the published successes did involve co-coordinated Storm/plant staff inter-actions for more than two years. The Results speak for themselves.

Here is an example of the typical benefits of implementation of a Storm Generating Plant Staff Alliance for overall coal fired generating unit performance and reliability improvement, is for improvements in Heat-Rate, Capacity Factor, Fuel Flexibility and improved environmental performance (No_x, Opacity, CO).

Basis: A Typical 400MW Boiler, 2400PSI 1005/1005°F Cycle Operating at 10,500 Btu/kWh, Designed for 9,500Btu's/kWh and 70% Capacity Factor

	Btu/kWh	Cost
Boiler and Ductwork Ambient Air In-Leakage	300	$819,000
Air Heater Exit Dry Gas Loss Potential	100	$27,3000
High Primary Airflow	75*	$204,750
Steam Temperatures off from design	75	$204,750
Periodic High Desuperheating Spray water Flows	50	$136,500
Fuel Rejects Due to Pulverizer Clearances and Settings – (Coal Spillage)	25	$68,250
Flyash Unburned Carbon	25*	$68,250
Bottom Ash Unburned Carbon	25	$68,250
Slagging and Fouling	25*	$68,250
Cycle Losses	25	$68,250
All Others Including Sootblowing and Auxiliary Power Factors	25	$68,250
Total	750	$2,047,500

* Inter-relationships can amplify this value

Figure No. 6

The Comprehensive Diagnostic Test

The Comprehensive Diagnostic Test is suggested to be conducted in full, at least twice per year. This is shown in Figure No. 7.

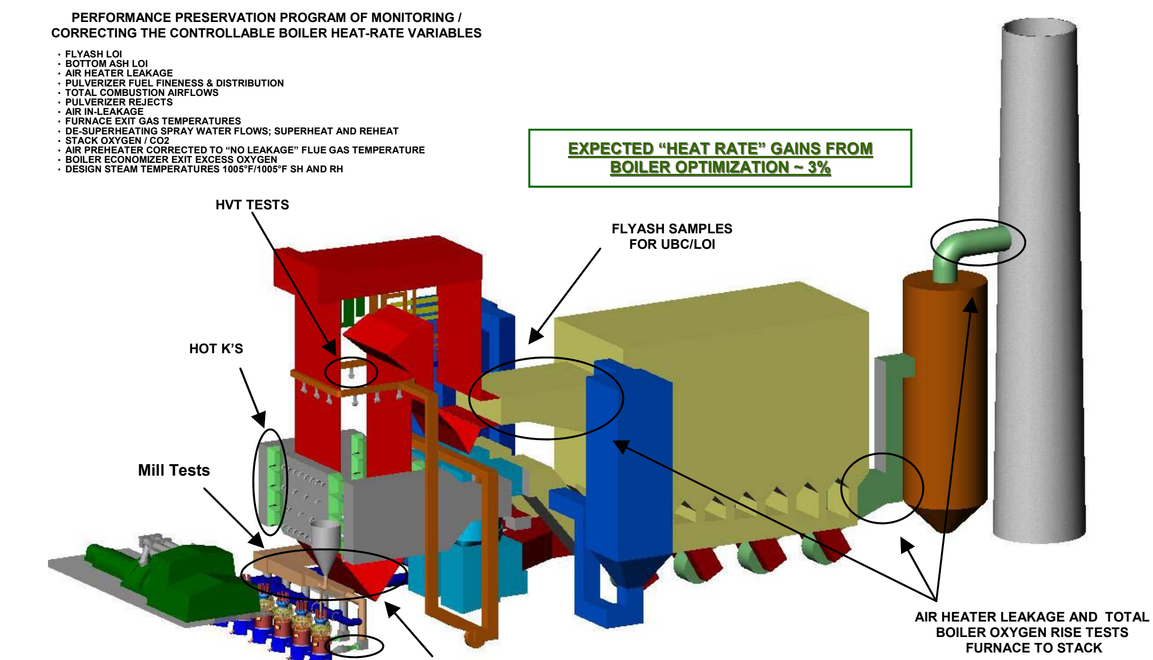


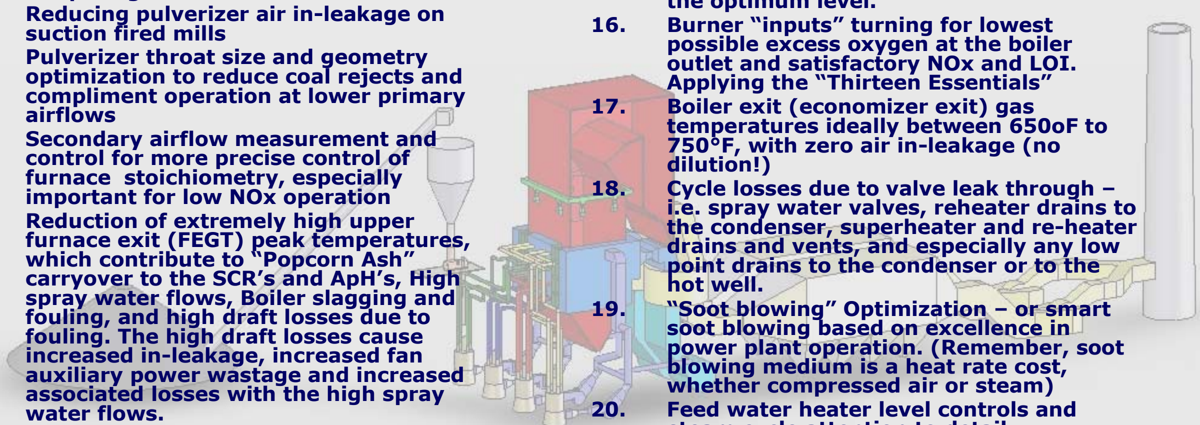
Figure No. 7

This is applying real test data to applying maintenance dollars for the maximum benefit. There is that "Benefit" word again. Yes, not only can Heat Rate, NO_x Credits, Load Factor and Reliability Benefit, so can the Maintenance Budget. Although, the first few years the maintenance budget may expand, in the long term, Performance Driven Maintenance can focus available maintenance funds for the most Benefit (RESULTS!).

In Summary:

The purpose of this newsletter is to attempt to explain "why" it is so important to optimize coal pulverizers performance. Between last month's issue, and this one, I have tried to correlate the importance of "Performance Driven Maintenance" as one component of combustion optimization. This month the intent of the newsletter is to show how achieving Optimum Pulverizer Performance can improve Heat Rate, Fuels Flexibility, Reliability, NO_x Load Factor, Capacity Factor and Competitiveness.

A Proactive Plan to Optimize the Boiler
Controllable Heat Rate Factors



1. **Flyash LOI**
2. **Bottom ash carbon content**
3. **Boiler and ductwork air in-leakage**
4. **More precise primary airflow measurement and control, by reducing tempering air**
5. **Reducing pulverizer air in-leakage on suction fired mills**
6. **Pulverizer throat size and geometry optimization to reduce coal rejects and compliment operation at lower primary airflows**
7. **Secondary airflow measurement and control for more precise control of furnace stoichiometry, especially important for low NOx operation**
8. **Reduction of extremely high upper furnace exit (FEGT) peak temperatures, which contribute to "Popcorn Ash" carryover to the SCR's and ApH's, High spray water flows, Boiler slagging and fouling, and high draft losses due to fouling. The high draft losses cause increased in-leakage, increased fan auxiliary power wastage and increased associated losses with the high spray water flows.**
9. **High de-superheating spray water flow to the superheater**
10. **High de-superheating spray water flow to the reheater**
11. **High air heater leakage (note: Ljungstrom regenerative airheaters should and can be less than 9% leakage)**
12. **Airheater Outlet Temperature**
13. **Superheater outlet temperature**
14. **Reheater outlet temperature**
15. **Airheater exit gas temperature, corrected to a "no leakage" basis, and brought to the optimum level.**
16. **Burner "inputs" turning for lowest possible excess oxygen at the boiler outlet and satisfactory NOx and LOI. Applying the "Thirteen Essentials"**
17. **Boiler exit (economizer exit) gas temperatures ideally between 650oF to 750°F, with zero air in-leakage (no dilution!)**
18. **Cycle losses due to valve leak through – i.e. spray water valves, reheater drains to the condenser, superheater and re-heater drains and vents, and especially any low point drains to the condenser or to the hot well.**
19. **"Soot blowing" Optimization – or smart soot blowing based on excellence in power plant operation. (Remember, soot blowing medium is a heat rate cost, whether compressed air or steam)**
20. **Feed water heater level controls and steam cycle attention to detail**
21. **Steam purity and the costly impact of turbine deposits on heat rate and capacity.**
22. **Auxiliary power consumption/optimization i.e., fan clearances, duct leakage, fueling primary air system optimization, etc**

Figure No. 8

Twenty-Two operations and maintenance controllable heat-rate factors. It has been my experience that the average power plant has at least 75% of these as "opportunities" for improvement.

At Storm we strive to earn, re-earn, and live up to our Reputation for RESULTS on every field assignment. Thank you for your interest in our techniques, our products and our services.

Yours very truly,

Richard F. (Dick) Storm
Consultant

FEATURED EQUIPMENT

Isokinetic Coal Sampling Kit

Includes:

Stainless steel coal sampler w/filter canister, cyclone separator, Orifice Aspirator Assembly, H.D.P. Sample Container with O ring, Extra Filter Paper, 10ft section of reinforced tubing w/clamps, 1) coal sampling probe, 1) calibrated dirty air probe, 1) temperature and static probe w/ type "K" thermocouple, 2) dustless connectors, digital manometer, 10" vertical incline manometer w/18" pitot tube and steel carrying case, 1 lot of required heavy wall 3/16" tubing, 1) 8ft type "K" thermocouple lead wire with connections, labels and spare seals.

Unit Price: $6,500.00

We accept Visa, Master Card, checks and wire transfer.

A Complete HVT Probe Kit

Includes the following:

- Standard HVT probe
- Stainless steel armored lead wire for the type "K" thermocouple
- Portable digital thermometer to accurately measure the temperature
- Clear tubing to go from the HVT probe to the gas sample conditioner
- STORM custom gas sample conditioner
- ECOM-AC Gas Analyzer that measures O_2

Unit Price: $12,500.00

We accept Visa, Master Card, checks and wire transfer.

Contact us at:
Storm Technologies, Inc.
PO Box 429
Albemarle, NC 28002
Phone: 704-983-2040
Fax: 704-982-9657
Web-site: www.stormeng.com