Progress Energy

June 25, 2007

Jonathan Holtom, P.E.
North Permitting Section
Florida Department of Environmental Protection
Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Re: Request for Additional Information Regarding BART Application For Crystal River Power Plant
Construction Permit Project No. 0170004-017-AC

Dear Mr. Holtom,

Progress Energy Florida (PEF) is in receipt of the Department's February 27, 2007 request for additional information (RAI) related to the January 31, 2007 Best Available Retrofit Technology (BART) Determination Application for Crystal River Units 1 and 2. In addition, in a letter dated May 16, 2007, the Department granted an additional 30 days (by June 27, 2007) to submit the requested information. The following responses (in bold italic type) are provided to the comments in the order in which they were received.

1. Section 5.3: of the "BART Analysis for PM Emissions From Unit Nos. 1 and 2" contains a statement that "PEF does not believe that Units 1 and 2 can continuously achieve levels lower than the actual historical PM emissions used in this analysis". Please explain why PEF believes this to be true.

PEF believes that the previously submitted summary of actual PM test results over the last 5-year period provides an adequate demonstration of why lower proposed PM levels cannot be consistently achieved. Operations and coal types are highly variable. This variability is even more pronounced due to the annual snapshot-in-time nature of the PM compliance demonstration.

2. Emission Rates: Considering the results from past compliance tests, please identify and justify what PEF believes to be the lowest, continuously achievable emission rate from the existing ESPs.

It is difficult to characterize a "lowest, continuously achievable" emission rate, as emissions are not continuously monitored. Due to the lack of data that addresses the potential variability in operations and fuels that are currently allowed under the Title V operating permit, PEF believes that the existing PM emission limit is appropriate and continuously achievable.

3. Compliance Test Data: A review of the past compliance tests shows that Unit 2 has been consistently testing fairly low (0.002 - 0.027 lb/MMBtu). For Unit 1, the results show a gradual increase from

0.03 lb/MMBtu in 1995 to 0.0774 lb/MMBtu in 2000. From 2001 - 2006, the results dropped and are now in the range of 0.02 - 0.037 lb/MMBtu. Please explain what happened to cause this decrease.

The timeframe mentioned (i.e., approximately 2000 to 2001) coincides with an increased emphasis at Crystal River on continuous performance improvement. Additional resources were devoted to plant operations that affected the frequency and scope of plant outages and maintenance activities. In addition, the timing of scheduled annual testing with respect to maintenance activities may have had an affect. PEF does not schedule testing to take advantage of improved performance resulting from scheduled maintenance, however, due to numerous factors, some of the pre-2001 tests may have been scheduled prior to maintenance and some of the more recent testing may have coincided with operations shortly after maintenance had been conducted.

There are other numerous factors that may have contributed to the perceived performance improvement. These include the coal characteristics, performance of the coal pulverizers, particle size distribution, resistivity, air inleakage, temperature of the flue gas, the gas distribution within the ESP, and the test method itself. With respect to the test method and the total particulate measured, the amount of front half wash was significant compared to the filterable particulate. This may indicate that a significant amount of the particulate allocated to total emissions was captured in the probe. If this is the case, it would generally indicate that the flue gas was reacting with the probe or that the acid gases condensed out in the probe during testing. Greater attention to detail in the testing procedures may have had an affect on lowering the reported PM emissions in these more recent tests.

4. Analysis/Cost Evaluation for Existing ESPs: Please provide an analysis and cost evaluation for physical refinements/refurbishments to the existing ESPs. For example, you have recently proposed modifications to the existing ESPs for Units 4 and 5 to achieve an emissions level of 0.03 lb/MMBtu.

The extent of the Units 4 and 5 precipitator scope of work has not yet been confirmed, so any reliance on those potential upgrades with respect to the performance of Units 1 and 2 would be premature.

GE Energy was contacted regarding the Units 1 and 2 precipitators and has offered several options for PEF's consideration. Attachment 1 provides GE Energy's Engineering Review and Budgetary Proposal. Page 11 states that "The information in this document is provided for budgetary estimating purposes only. It does not constitute an offer or acceptance by Contractor or GE, nor does it create any obligation of any kind, whether express or implied, on the part of Contractor or GE, to enter into any agreement of any kind or to provide any particular goods or services at any particular price. Any such obligations can only arise upon completion and signature of a final, agreed Contract between the parties. The pricing is estimated only and is not based upon complete information about the details of the facility and equipment, the proposed operations and other factors that may affect the ultimate final price to be established by the signed Contract. No warranty or representation is given, either expressed or implied, concerning the information in this Budgetary Quotation. All information is subject to change." Nevertheless, information provided in this report was used as the basis for several assumptions in the ESP upgrade analysis. When pressed further for emission guarantees, rather than estimates, GE Energy provided an email response (Attachment 1) with a range of guarantees based on various assumptions and design coals. For purposes of this analysis, PEF relied on the upper range of the guarantees provided. Analyses of the various options are summarized below.

GE Energy has proposed a rebuild with rigid electrodes for Unit 1. This rebuild is described on page 5 of the attached Unit 1 and Unit 2 Engineering Review Document (Attachment 1). GE provided a

Mr Holtom
June 25, 2007
Page 3

performance estimate of 0.015 lb/MMBtu for the Unit 1 rebuild. The rebuild does include replacement of the ESP roofs and insulator compartments along with other repairs so that the remaining useful life will be extended, but would not have an equivalent useful life comparable to the installation of a new ESP. Based on the supplied vendor data, PEF calculated a cost-effectiveness of approximately $7,500 per ton of PM removed. The cost and cost-effectiveness data spreadsheets are provided in Tables 1 through 8 of Attachment 4 to this letter.

GE Energy has also proposed modifications incorporating additional fields (sectionalization) and improved gas distribution. The budget for this work is estimated at slightly less than $1,000,000, however, a firm budget determination requires gas flow studies and redesign work. The average emissions performance estimate for the improved gas distribution is 0.035lb/MMBtu. When compared with the 0.0376 lb/MMBtu value of the highest actual PM source test data, an emissions reduction of 13.8 lbs/hr or 60 tons per year is obtained. Therefore, these modifications produce only a minimal improvement with a probable high dollar per ton cost, and therefore are not considered to be BART.

GE Energy has also proposed a rebuild for a section of Unit 2. The rebuild includes a rigid electrode design and repair of the casing internals along with gas distribution improvements (See pages 10&11 of Attachment 1). GE provided a guaranteed performance estimate of 0.015 lb/MMBtu for Unit 2 after this rebuild. Based on this data, PEF calculated a cost effectiveness of $8,500 per ton of PM removed (Table 2 of Attachment 4).

5. <u>Analysis/Cost Evaluation for Replacing Old ESPs:</u> Please provide an analysis and cost evaluation for replacing the old electrostatic precipitators (ESPs) with new, higher-efficiency ESPs.

Outlet emissions for new ESPs are considered equivalent to the 0.01 lb/MMBtu lowest guaranteed performance value for the Unit 1 & 2 rebuilds. However, the calculated cost-effectiveness (approximately $27,000/ton for Unit 1 and $34,000/ton for Unit 2) would be considered prohibitive. In addition, the cost-effectiveness does not include the cost of removal of the old ESPs, which will be necessary, since the open space required for additional ESPs is not available at the Crystal River facility. These cost analyses are provided in Tables 3 and 4 of Attachment 4.

6. <u>Analysis/Cost Evaluation for Baghouses:</u> Please provide an analysis and cost evaluation for adding baghouses following the existing ESPs.

PEF has received an outlet emissions guarantee of 0.012 lb/MMBtu from Hamon-Research Cottrell for a "polishing" baghouse scenario for both Units 1 and 2 at Crystal River (Attachment 2). The emissions from the polishing baghouses (which would be installed after each existing ESP) are assumed to be 100 percent PM$_{10}$ For the analysis, it was assumed that the inlet to each polishing baghouse would be equivalent to the actual previous source test data. For instance, for Unit 1, the highest actual PM source test data from the ESP was 0.0376 lb/MMBtu. The installation of the polishing baghouse on Unit 1 would remove an additional 420 tons/year of PM$_{10}$from the stack gases. The cost-effectiveness analysis indicates that the cost per ton of pollutant removed would be approximately $22,000 per ton, which is prohibitive (Table 5 of Attachment 4). Similarly, for Unit 2, values of 288 tons/year of PM$_{10}$ removed and approximately $34,000/ton were obtained (Table 6 of Attachment 4). It should be noted that this analysis assumed it would be physically feasible and not unusually expensive to install the polishing baghouses at the Crystal River site. For example, the costing spreadsheet assumes installation costs reflective of a greenfield installation and did not apply an extra cost factor for a retrofit situation. In reality, it is likely that it would be extraordinarily difficult and expensive to install the polishing baghouses at the existing facility.

An additional more technically feasible baghouse alternative was also explored. This alternative would be to convert the existing ESP housings to fabric filters. This alternative, which was offered by Buell (the manufacturer of the existing ESPs, see Attachment 3) would be able to meet an outlet emissions level of 0.006 lb/MMBtu. However, this approach would not be cost effective. The cost per ton of pollutant removed would be greater than $17,200/ton for Unit 1, and $24,800 for Unit 2 (Tables 7 and 8 of Attachment 4, respectively).

7. <u>Analysis/Cost Evaluation for Cyclones:</u> Please provide an analysis and cost evaluation for installing cyclones prior to the ESPs.

Installation of cyclones would not reduce PM_{10} emissions significantly and, in addition, would be *expensive (approximately $1.7 million). Communications with vendors, including Buell (the manufacturer of the existing ESPs) and review of the literature indicate that the installation of cyclones would not produce an improvement in emissions performance worth pursuing (see Attachment 3 comments).*

8. <u>Bid Specifications:</u> For each cost analysis, please provide the bid specification/vendor estimate or other supporting documentation.

As indicated in the previous responses above, vendor data is provided in Attachments 1 through 3 and the cost spreadsheets for the described options are provided in Attachment 4 to this letter.

9. <u>Visibility Modeling:</u> For each of the above options, please provide the visibility impact modeling results for the expected level of lowered emissions related to each of the proposed changes.

PEF has conducted additional modeling runs consistent with the results of the control technology assessments summarized above. Specifically, attached are the runs that reflect the base case (i.e., highest actual PM source test data), the controlled case with the ESP upgrades and ESP replacement (i.e., 0.015 lb/MMBtu and 0.010 lb/MMBtu, respectively) and the controlled case with the baghouses in both a polishing mode and as a refurbishment to the existing ESPs (ie., 0.012 lb/MMBtu and 0.006 lb/MMBtu, respectively). The PM speciation profile for each modeled option, as well as the modeled impacts are presented in Attachment 5 to this letter. In all cases, the visibility improvement was minimal and the resulting $/dV reduced was prohibitive. A summary table of the four options and the resulting $/dV reduced is provided in Attachment 5.

10. <u>Model Results:</u> Please explain why the modeled results (Table 5-8) show an increase in visibility impacts when modeling the BACT equivalent emissions of 56.25 lb/hr for Unit 1 and 71.93 lb/hr for Unit 2 (based on the BACT equivalent rate of 0.015 lb PM/MMBtu, as shown in Table 5-8) compared to the current actual emissions of 140.82 lb/hr for Unit 1 and 115.22 lb/hr for Unit 2 (based on tested emissions rates of 0.037 lb PM/MMBtu for Unit 1 and 0.027 lb PM/MMBtu, as shown in Table 3-1).

The BACT equivalent emissions showed a slight increase for several reasons. One contributing factor was because the allowable heat input limit was used for the future controlled case, while the actual (lower) heat input during testing was used for the highest actual PM test data. However, the most significant reason for the slightly higher values was because the spreadsheet used was based on an equation from AP-42 that artificially inflated the condensable fraction of the PM when the filterable was reduced to correspond to BACT levels. This resulted in overall emissions (ie., the filterables plus

the condensables) being higher for the controlled case than the baseline case, even though filterable PM levels were reduced.

This submittal reflects a different, more representative method of calculation for the condensable PM fraction that is accepted for TRI calculations (the Southern Company Method) and was used as the basis for SAM emissions estimates for the recent PSD permitting for Crystal River Units 4 and 5. The accuracy of this method was corroborated by EPA Reference Method 8 testing. This calculation method further assumes that the SAM emissions comprise 80 percent of the total condensable PM emissions (referenced to AP-42, Section 1.1-5 and other recent literature). In other words, the SAM emissions were calculated for Units 1 and 2. Given that these emissions (the inorganic as H_2SO_4) comprise approximately 80 percent of the total condensable PM, the total condensable was back-calculated. The organic fraction was then determined as the difference between the total condensable PM and the inorganic fraction.

The various PM control levels were then determined from the baseline established above. For example, enhanced PM control to reach a level of 0.015 lb/MMBtu was assumed to affect the filterable PM, while the condensable would remain unaffected. This is because ESPs and baghouses are passive control devices. Therefore, an upgrade in their performance wouldn't necessarily translate into an improvement in performance (i.e., efficiency) for SAM or other condensables. The exception would be if there were an active control component, such as an alkali injection system, that would then make the ESP or baghouse more effective. The introduction of a sorbent to adsorb the acid or sulfate would then create a fine particle that could then be collected as a filterable particulate in the ESP, for example.

11. Excel Worksheets: Please provide the active Excel Worksheets with formulas for Tables 5-2 through 5-4 of the Air Modeling Report and Tables 2-3 through 2-7 of the Modeling Protocol.

As discussed above, the calculation method for both the baseline and for the four proposed PM reduction scenarios, is different from that submitted to the Department in January 2007. Hard copies of all calculation tables are provided in Attachment 5 to this letter. In addition, the active Excel worksheets for these tables are provided in a separate submittal.

12. Emission Information: Table 5-4 shows that H_2SO_4 emissions increase for Unit 2 to 184.40 lb/hr from 94.0 lb/hr given in Table 2-7 for Unit 2. Table 5-3 shows that these emissions increase for Unit 1 to 80.0 lb/hr from 78.0 Ib/hr given in Table 2-6 for Unit 1. Please explain why these emissions are expected to increase for the controlled case.

Please refer to the response to Item 10 above.

13. CALPUFF Files: Please send the CALPUFF files for all of the NEW IMPROVE results.
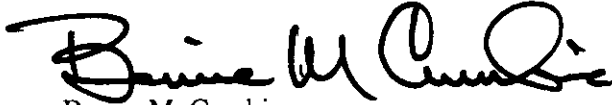
The requested CALPUFF files are provided in a CD that is attached to this letter.

As noted earlier, PEF received the Department's letter on May 16, 2007, granting additional time, until June 27, 2007, to submit this requested information. As these responses are providing additional information of an engineering nature, a State of Florida professional engineering certification has also been provided, in accordance with Rule 62-4.050(3), F.A.C. In addition, the appropriate Responsible Official certification page has been signed and included in this submittal.

Should you have any question regarding these responses or need additional information, please contact Dave Meyer at (727) 820-5295 or Scott Osbourn at (813) 287-1717.

Sincerely,

Bernie M. Cumbie
Plant Manager/Responsible Official

Attachments

cc: Dave Meyer, Progress Energy Florida, Inc. (Dave.Meyer@pgnmail.com)
Scott Osbourn, P.E., Golder Associates (sosbourn@golder.com)
Ms. Cindy Zhang-Torres, P.E., DEP - SWD (cindy.zhang-torres@dep.state.fl.us)
Gregg Worley, EPA Region 4 (worley.gregg@epa.gov)
Dee Morse, National Parks Service (Dee_Morse@nps.gov)

APPLICATION INFORMATION

Owner/Authorized Representative Statement

Complete if applying for an air construction permit or an initial FESOP.
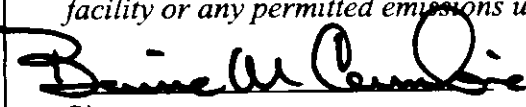
1. Owner/Authorized Representative Name : **Bernie Cumbie, Plant Manager**	

2. Owner/Authorized Representative Mailing Address...
Organization/Firm: **Progress Energy**
    Street Address: **100 Central Ave CN 77**
        City: **St. Petersburg**   State: **Florida**   Zip Code: **33701**

3. Owner/Authorized Representative Telephone Numbers... Telephone: **(352) 563 - 4484**   ext. Fax: **(352) 563 - 4496**

4. Owner/Authorized Representative Email Address: **Bernie.cumbie@pgnmail.com**

5. Owner/Authorized Representative Statement: *I, the undersigned, am the owner or authorized representative of the facility addressed in this air permit application. I hereby certify, based on information and belief formed after reasonable inquiry, that the statements made in this application are true, accurate and complete and that, to the best of my knowledge, any estimates of emissions reported in this application are based upon reasonable techniques for calculating emissions. The air pollutant emissions units and air pollution control equipment described in this application will be operated and maintained so as to comply with all applicable standards for control of air pollutant emissions found in the statutes of the State of Florida and rules of the Department of Environmental Protection and revisions thereof and all other requirements identified in this application to which the facility is subject. I understand that a permit, if granted by the department, cannot be transferred without authorization from the department, and I will promptly notify the department upon sale or legal transfer of the facility or any permitted emissions unit.* Signature _____   Date __6/26/07__

Professional Engineer Certification

1.	Professional Engineer Name: **Scott Osbourn** Registration Number: **57557**
2.	Professional Engineer Mailing Address... Organization/Firm: **Golder Associates Inc.**** Street Address: **5100 Lemon Street, Suite 114** City: **Tampa** State: **FL** Zip Code: **33609**
3.	Professional Engineer Telephone Numbers... Telephone: **(813) 287 - 1717** ext. 211 Fax: **(813) 287 - 1716**
4.	Professional Engineer Email Address: **sosbourn@golder.com**

5. Professional Engineer Statement:

I, the undersigned, hereby certify, except as particularly noted herein*, that:

(1) To the best of my knowledge, there is reasonable assurance that the air pollutant emissions unit(s) and the air pollution control equipment described in this application for air permit, when properly operated and maintained, will comply with all applicable standards for control of air pollutant emissions found in the Florida Statutes and rules of the Department of Environmental Protection; and

(2) To the best of my knowledge, any emission estimates reported or relied on in this application are true, accurate, and complete and are either based upon reasonable techniques available for calculating emissions or, for emission estimates of hazardous air pollutants not regulated for an emissions unit addressed in this application, based solely upon the materials, information and calculations submitted with this application.

(3) If the purpose of this application is to obtain a Title V air operation permit (check here ☐, if so), I further certify that each emissions unit described in this application for air permit, when properly operated and maintained, will comply with the applicable requirements identified in this application to which the unit is subject, except those emissions units for which a compliance plan and schedule is submitted with this application.

(4) If the purpose of this application is to obtain an air construction permit (check here ☒, if so) or concurrently process and obtain an air construction permit and a Title V air operation permit revision or renewal for one or more proposed new or modified emissions units (check here ☐, if so), I further certify that the engineering features of each such emissions unit described in this application have been designed or examined by me or individuals under my direct supervision and found to be in conformity with sound engineering principles applicable to the control of emissions of the air pollutants characterized in this application.

(5) If the purpose of this application is to obtain an initial air operation permit or operation permit revision or renewal for one or more newly constructed or modified emissions units (check here , if so), I further certify that, with the exception of any changes detailed as part of this application, each such emissions unit has been constructed or modified in substantial accordance with the information given in the corresponding application for air construction permit and with all provisions contained in such permit.
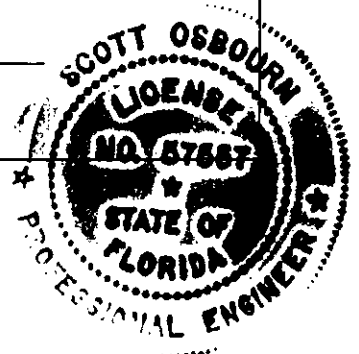
_____ Signature	1/26/07 Date
(seal)	

* Attach any exception to certification statement.
** **Board of Professional Engineers Certificate of Authorization #00001670**

ATTACHMENT 1

GE Energy Response

Osbourn, Scott

From:	Osbourn, Scott
Sent:	Friday, June 22, 2007 6:12 PM
To:	Osbourn, Scott
Subject:	FW: Progress- Crystal River Units 1 & 2 BART Analysis
Importance:	High

GE Energy Information for Cost Estimates-- Attachment 1 to BART RAI Response Letter

Scott Osbourn, P.E.
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ATTORNEY/CLIENT COMMUNICATION OR WORK PRODUCT
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From: Eckhoff, Shannon (GE Infra, Energy) [mailto:Shannon.Eckhoff@ge.com]
Sent: Tuesday, June 19, 2007 10:20 AM
To: Stevens, J. Patrick; Osbourn, Scott; Phillips, Warren
Subject: RE: Progress- Crystal River Units 1 & 2 BART Analysis
Importance: High

Per our discussion yesterday:

Here are ranges for guarantees that could be offered at Crystal River.

Performance Guarantee Range for Crystal River Unit 1 & 2	
Unit 1	**Guarantee Range, lb/mmBTU**
Gas distribution modifications	0.03 to .04
Electrical sectionalization	.035 to .045
Rebuild	.01 to .015
Unit 2	
Gas distribution modifications	.025 to .03
Rebuild A/B Old	.01 to .015

The guarantees are based on design coals which generally reflect the worst case operating conditions. The range will be refined as the impact of each successive upgrade is known.

New ESP construction can be looked at as ~$10 to $12/acfm for materials/engineering and them add ~2.5x that number for greenfield construction. The numbers represent flange-to-flange construction. To evaluate ESP replacement, we would need to have an accurate picture as to the space available on site. Another thought would be to reduce the ESP load through slipstream fabric filters. We did not have time to analyze these options at this point, but would look forward to discussing them further with you.

Regards,
Shannon Eckhoff
GE Infra, Energy
PCS - ESP Engineering Manager

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6/22/2007

GE Energy

Progress Energy – Crystal River
Crystal River, FL
Unit 1 and 2 ESP Engineering Review
And Budgetary Proposal
May 23, 2007

To assist in definition of long term upgrades to the particulate matter control systems at Crystal River, we have completed a preliminary review of the Unit 1 and 2 electrostatic precipitators. The recommendations reflect high level opinions of the types of upgrades that will improve reliability and effectiveness of the existing electrostatic precipitators.

Unit 1 Electrostatic Precipitator
Background
Currently, a Buell weighted-wire design electrostatic precipitator is utilized to remove particulate suspended in the Unit 1 boiler outlet gas stream. The flue gas conditions utilized to evaluate performance of the Unit 1 electrostatic precipitator were derived from the June 2005 stack test data. The conditions are as shown below:

Crystal River Unit 1 ESP Inlet Conditions		
Description	Value	Units
Process description	Pulverized Coal Boiler	(None)
Gas volume	1,514,389	Actual ft³/min (June 2005 stack test data)
Heat input, rated	3,750	mmBTU/hr
Gas temperature	349	°F
Gas pressure	-6 to -8	Inches w.c.
Gas moisture content	8.5	% by volume
Inlet dust loading	7.54	Lb/mmBTU (estimated)
Outlet dust loading measured	0.04	Lb/mmBTU (June 2005 Normal)
Heat input, test period	3,651	mmBTU/hr (June 2005 Normal)
Outlet dust loading measured	0.02	Lb/mmBTU (June 2005 Soot)
Heat input, test period	3,642	mmBTU/hr (June 2005 Soot)
Outlet dust loading limit	0.1	Lb/mmBTU (Normal)
Outlet dust loading limit	0.3	Lb/mmBTU (3 hr in 24 hr)
Outlet emission requirement	20	%, six minute average

As indicated, the original electrostatic precipitator is a Buell weighted wire design, BA1.6X40K343-12.2P. A plan view sketch of the Unit 1 electrostatic precipitator is shown below.
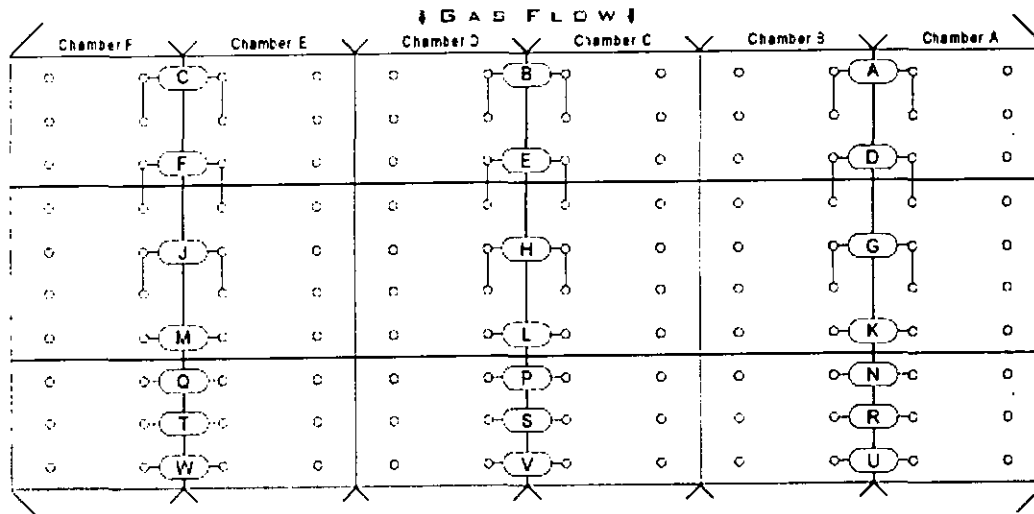
Twenty-one (21) transformer rectifiers are utilized to serve the electrical fields contained in the Unit 1 electrostatic precipitator.

T/R Set	Volts-AC	Amps-AC	kV-DC	mA-DC	kVA
1A – 1J	480	187	45	1400	90
1K – 1W	480	146	45	1100	70

Transformer rectifiers A, B, C, D, E, F, G, H, and J serve four (4) electrical sections each. Transformer rectifiers K, L, M, N, P, Q, R, S, T, U, V, and W serve two (2) electrical sections each. One (1) electrical section contains approximately 7,420 ft² of collecting plate area.

The physical configuration of the Unit 1 electrostatic precipitator is shown in the following table:

Existing Unit 1 Electrostatic Precipitator		
Description	**Value**	**Units**
Number of casings	1	Each
Number of chambers per casing	6	Each
Gas passage width	9	Inches
Number of passages per chamber	40	Each
Number of mechanical fields	3	Each
Field 1	9.0 wide by 30.917 tall	Feet
Field 2	12.0 wide by 30.917 tall	Feet
Field 3	9.0 wide by 30.917 tall	Feet
Collecting system rapping type	Impact rappers	
High voltage rapping type	Impact rappers	
Number of energized fields	7 per casing	Each
T/R sets A, B, C, D, E, F, G, H, & J	45 kV, 1400 ma	
Current density	47 µA/ft.²	
T/R sets K, L. M. N, P, Q, R. S, T, U, V, & W	45 kV, 1100ma	
Current density	74 µA/ft.²	

The existing electrostatic precipitator exhibits the following critical operating parameters when treating the gas volume defined above:

Critical ESP Parameters		
Existing Unit 1 Electrostatic Precipitator		
Total collecting plate area	445,205	Ft.²
Treatment length	30.00	Ft.
Aspect ratio	0.9	
Specific collecting area, SCA	293	Ft.²/1000 ACFM (9" basis)
Specific collecting area, SCA	220	Ft.²/1000 ACFM (12" basis)
Gas velocity	4.54	Ft./sec.
Treatment time	6.6	Sec.

Evaluation

Stack test results indicate that the existing electrostatic precipitator is capable of meeting current emission standards for filterable particulate. Improving collection efficiency will allow the existing electrostatic precipitator to accommodate expanded fuel flexibility, upset conditions, soot blowing, and the potential for future sorbent injection activities while maintaining emission compliance. A quick overview of the major systems is shown in the table below:

Crystal River Unit 1 Critical Operating Parameters			
Parameter	Actual	Design Target	Unit
Total collecting plate area	445,205	N/A	ft²
Treatment length	30	N/A	ft
Aspect ratio	0.9	>0.8	
Specific collecting area, SCA			
Specific collecting area, SCA			
Gas velocity			
Treatment time	6.6	8 to 10	sec.
Number of electrical fields	7	>4	Each
Size of electrical fields			
Size of electrical fields	14,840	<20,000	ft² (K,L,M,N,P,Q,R,S,T,U,V,W)
Current density	47	35 to 70	µA/ft² (A,B,C,D,E,F,G,H,J)
Current density	74	35 to 70	µA/ft² (K,L,M,N,P,Q,R,S,T,U,V,W)
Applied voltage	10	>10	kV/inch

The table indicates that, when compared to current design targets, the Unit 1 electrostatic precipitator aspect ratio is within standard. Aspect ratio is treatment length divided by treatment height. A larger ratio value indicates lower propensity of for dust re-entrainment due to rapping and flow distribution.

The number of electrical fields and the secondary current rating of the transformer rectifier units installed are within acceptable limits.

Unit 1 Recommendations

From the preliminary equipment analysis, the following recommendations can be offered. Implementing the recommendations will result in reduced dust emissions and improved equipment availability.

Improve Gas Distribution

In a single casing electrostatic precipitator with six (6) chambers, uniform gas distribution is difficult to achieve. As indicated, collection efficiency is exponentially related to SCA. If a chamber or gas passages within a chamber are treating a disproportionate amount of gas volume, the overall collection efficiency will be degraded. The portions of the electrostatic precipitator treating lower than expected gas volumes will not compensate for those sections treated elevated gas volume levels.

It is recommended that a flow model study should be undertaken for Unit 1. The purpose of the study is to define current conditions and to make recommendations for gas distribution upgrades. Proper distribution of gas will be extremely beneficial to optimal precipitator operation. Significant reductions in outlet emissions can be achieved as a result of implementing the gas flow study recommendations.

Budgetary Price for a CFD model study on Unit 1: $67,000.00

Improving Temperature and Dust Distribution

Electrostatic precipitators with multiple chambers perpendicular to gas flow are prone to mal-distribution of dust and temperature gradients in the inlet electrical fields. These conditions are different from gas flow mal-distribution. Uniform gas distribution can generally be achieved with minimal impact on overall system pressure drop. Correcting a temperature gradient or moving distribution requires significantly more pressure drop to achieve and still cannot always be accomplished successfully.

It is most effective to increase the number of electrical fields perpendicular to gas flow. Presently there are three (3) electrical fields perpendicular to gas flow in each field. Adding three (3) transformer rectifiers to each of the first two (2) electrical fields would improve the ability of the existing electrostatic precipitator to accommodate mal-distribution of inlet conditions.

Dividing the inlet two (2) fields into six (6) independently energized electrical fields will reduce the impact of localized sparking on overall operation. Any changes that can be introduced to minimize the inlet temperature gradient or introduce more uniform dust burden would help performance, but the most effective method to accomplish improved performance is to increase the number of electrical fields perpendicular to gas flow. This activity would also reduce the size of the plate area served by the first two (2) electrical field transformer rectifiers.

Budgetary material price to add thermal and dust mixing to CFD model above: $33,500.00

Budgetary material price to add (3) T/R sets, VI-CLR's, cabinets, controls and bus: $128,900.00

Increase Specific Collecting Plate Area

The obvious method of increasing SCA is to increase treatment length or collecting plate height. This is not the most cost effective initial improvement that can be implemented. There are interim measures that can be undertaken to increase SCA without adding collecting plate area.

Reduce gas volume treated

As indicated, collection efficiency is exponentially related to SCA. Gas volume is a portion of the SCA value that can be controlled. Stack test data indicates stack gas volume of approximately 1,550,000 ACFM versus an original design value of 1,450,000 ACFM. It is likely that in-leakage is responsible for the majority of the increased gas volume treated. If the stack test volume was reduced to the design level, the measured outlet emissions would decrease from 0.02 lb/mmBTU to approximately 0.018 lb/mmBTU without any other changes. This represents a reduction in outlet emissions of about 10%.

Improve Dust Resistivity

The June 2005 stack tests indicate that stack emissions are lower during soot blowing than those experienced during normal operation. This is typically not the case since the electrostatic precipitator will experience an increased dust burden during soot blowing. A possible explanation for this phenomenon relates to improved resistivity of the dust.

If the soot blowers installed on Unit 1 utilize steam rather than compressed air, they may contribute to improving dust resistivity. Steam soot blowers increase the moisture available in the flue gas to condition the dust. The fact that outlet emissions decrease during soot blowing indicates that the electrostatic precipitator would perform better if dust resistivity was reduced.

Flue gas temperature at the stack is about 350°F. This is near the peak dust resistivity of most coals. Dust resistivity would decrease if the gas temperature was reduced to near 300°F. When dust resistivity decreases, outlet emissions will decrease as well.

Gas temperature reduction can be achieved by increased cleaning of the convection and air heater surfaces, evaporative gas conditioning, and dilution air. Of these methods, only the improved cleaning and EGC make sense. Introduction of dilution air for the purpose of reducing gas temperature will only tax an already over burdened electrostatic precipitator.

Rebuild With Rigid Electrodes

Most of the problems noted above would be resolved as a result of a rebuild incorporating a weighted wire to rigid electrode conversion. The gas passage spacing would increase from nine (9) inches to eleven (11) inches. This would allow the existing transformer rectifiers to be reused in the outlet electrical fields. It is recommended that new transformer rectifiers should be installed for the first four (4) electrical fields. The secondary voltage ratings of these transformer rectifiers should be 60kV.

The rigid rebuild would incorporate a gas flow model so distribution devices can be designed and installed during the rebuild.

The rebuild would include new insulator compartments. The hot and cold roofs would also be replaced to expedite installation. During the rebuild, the inlet and outlet lower bottom end frames should also be replaced.

All penetrations such as access doors and rapper shafts would be upgraded to utilize new gas tight seals. Rapping densities would be improved to reduce build up and dust re-entrainment.

Budgetary Material Price for a rebuild as noted: $3,631,300.00

Unit 2 Electrostatic Precipitator
Background

Currently, multiple Buell weighted-wire design electrostatic precipitators are utilized to remove particulate suspended in the Unit 2 boiler outlet gas stream. The three (3) electrostatic precipitators were constructed in phases to improve particulate collection efficiency. The units are characterized as Unit 2 A & B Old, Unit 2 A & B New, and Unit 2C. A plan view sketch of the three (3) units is shown below:
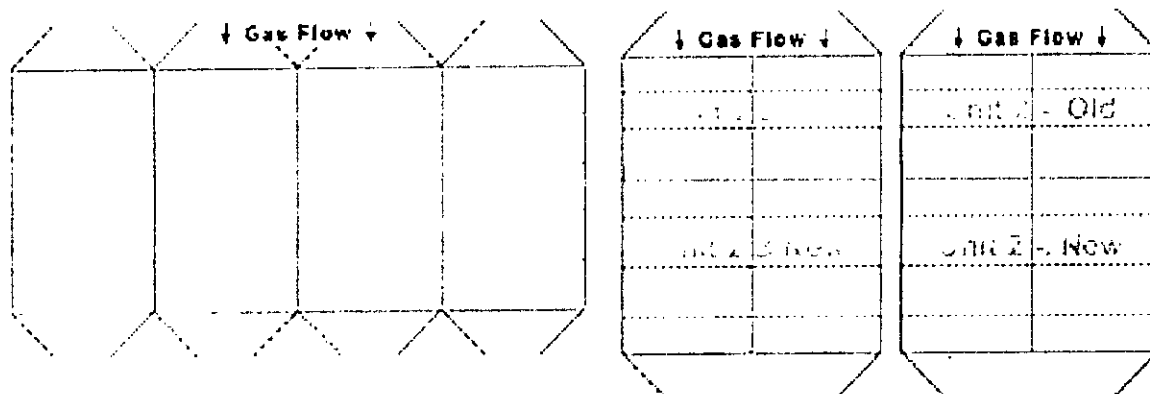
To evaluate performance of the Unit 2 electrostatic, design inlet flue gas conditions were established. The flue gas conditions utilized to evaluate performance of the Unit 2 electrostatic precipitator were based on data taken during the May 2004 stack test. The design conditions are as shown below:

Crystal River Unit 2 ESP Inlet Conditions		
Description	Value	Units
Process description	Pulverized Coal Boiler	(None)
Gas volume	1,700,000	Actual ft³/min (May 2004 stack test data)
Heat input, rated	4,795	mmBTU/hr
Gas temperature	290	°F
Gas pressure	-6 to -8	Inches w.c.
Gas moisture content	8.0	% by volume
Inlet dust loading	6.44	Lb/mmBTU (estimated)
Outlet dust loading measured	0.027	Lb/mmBTU (May 2004 Normal)
Heat input, test period	4,390	mmBTU/hr (May 2004 Normal)
Outlet dust loading measured	0.021	Lb/mmBTU (May 2004 Soot)
Heat input, test period	4,384	mmBTU/hr (May 2004 Soot)
Outlet dust loading limit	0.1	Lb/mmBTU (Normal)
Outlet dust loading limit	0.3	Lb/mmBTU (3 hr in 24 hr)
Outlet emission requirement	20	%, six minute average

2B Old	Primary		Secondary	
T/R Set	Volts	Amps	kV	mA
2B-1 · 2B-4	480	102	45	770
2B-5 · 2B-6	480	146	45	1100
2B-7 · 2B-9	480	187	45	1400

2A Old	Primary		Secondary	
T/R Set	Volts	Amps	kV	mA
2A-1 · 2A-4	480	102	45	770
2A-5 · 2A-6	480	146	45	1100
2A-7 · 2A-9	480	187	45	1400
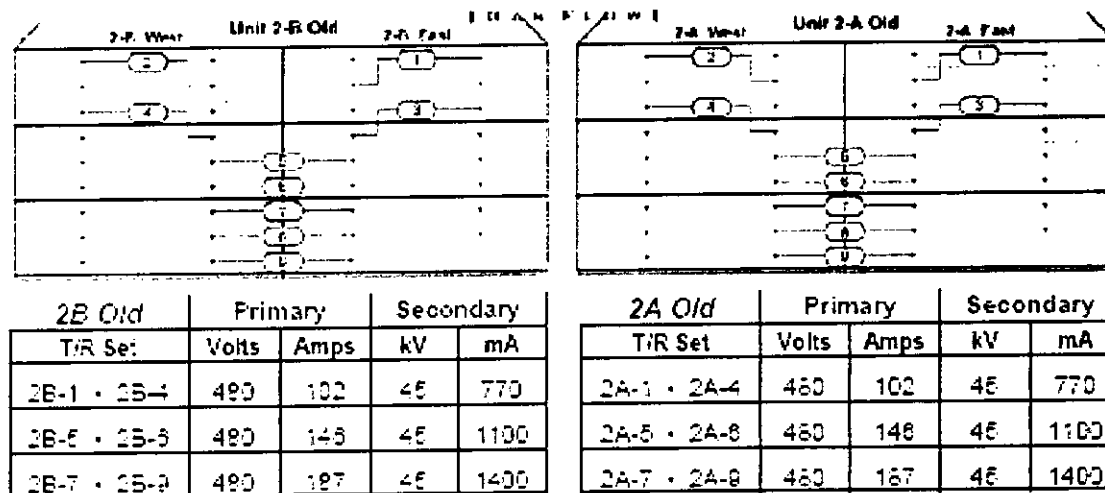
A total of eighteen (18) transformer rectifiers serve the Unit 2 A & B Old electrostatic precipitator.

The Unit 2 A & B New electrostatic precipitators are installed in series with the A & B Old electrostatic precipitator. A Plan view sketch is shown below:

2B New	Primary		Secondary	
T/R Set	Volts	Amps	kV	mA
2B-10	480	146	45	1100
2B-11 · 2B-15	480	104	45	770
2B-18 · 2B-22	480	146	45	1100

2A New	Primary		Secondary	
T/R Set	Volts	Amps	kV	mA
2A-10	480	146	45	1100
2A-11 · 2A-15	480	104	45	770
2A-19 · 2A-22	480	146	45	1100
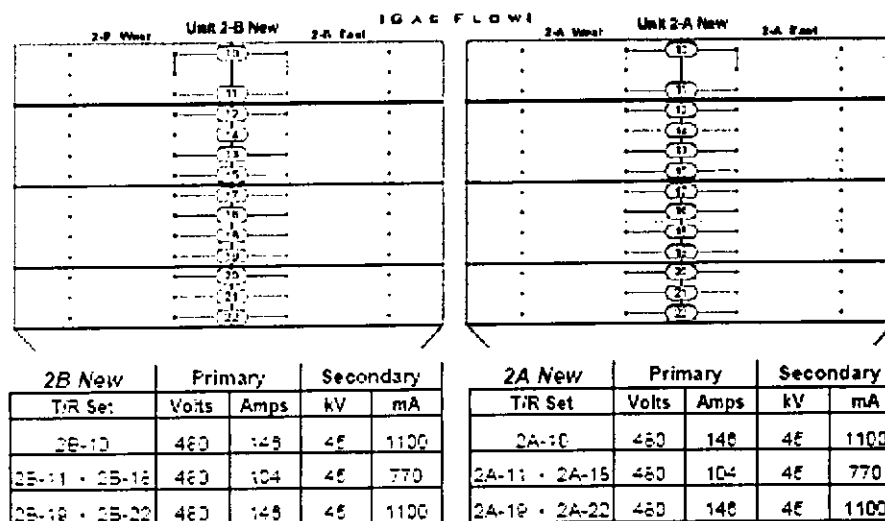
A total of twenty-six (26) transformer rectifiers serve the Unit 2 A & B New electrostatic precipitator.

The most recent addition to the Unit 2 particulate removal equipment is the Unit 2C ESP which is installed in parallel with the Unit 2 A & B (Old and New) casings. A sketch of the Unit 2C electrostatic precipitator is shown below:
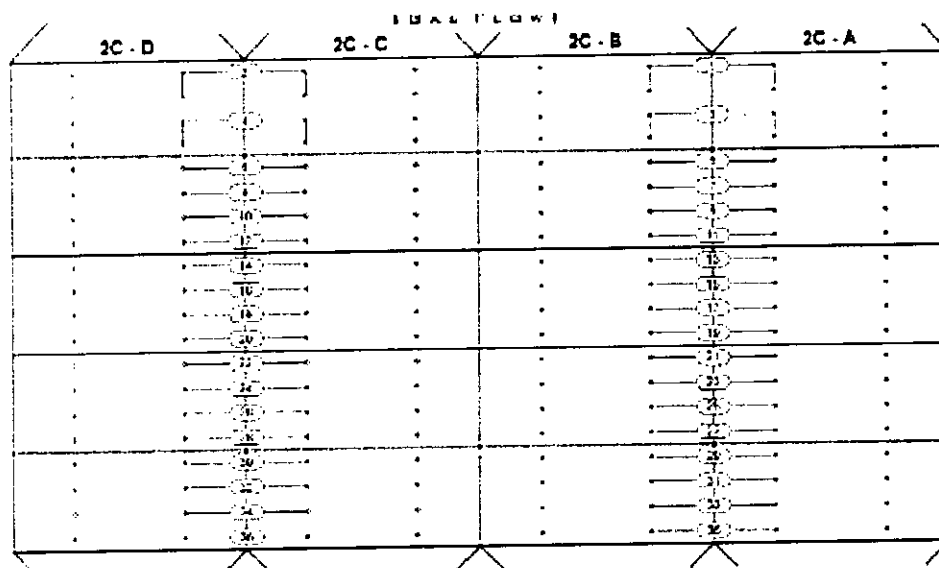
2C	Primary		Secondary	
T/R Set	Volts	Amps	kV	mA
2C-1 · 2C-4	460	187	45	1400
2C-5 · 2C-30	460	156	45	1100
2C-31 · 2C-36	460	187	45	1400

Unit 2C has a total of thirty-six (36) transformer rectifiers.

Based on the multiple electrostatic precipitators that comprise the Unit 2 particulate removal equipment, we will treat the units as two (2) parallel gas trains.

Existing Unit 2 Electrostatic Precipitator			
Description	Unit 2 A & B (old & new)	Unit 2C	Units
Number of casings	2	1	Each
Number of chambers per casing	2	4	Each
Gas passage width	9	9	Inches
Number of passages per chamber	43	48	Each
Number of mechanical fields	7	5	Each
Field 1	9 x 30.92	12 x 30.92	Feet
Field 2	9 x 30.92	12 x 30.92	Feet
Field 3	9 x 30.92	12 x 30.92	Feet
Field 4	9 x 30.92	12 x 30.92	Feet
Field 5	12 x 30.92	12 x 30.92	Feet
Field 6	12 x 30.92	N / A	Feet
Field 7	9 x 30.92	N / A	Feet
Collecting system rapping type	Impact	Impact	
High voltage rapping type	Impact	Impact	

Existing Unit 2 Electrostatic Precipitator			
Description	Unit 2 A & B (old & new)	Unit 2C	Units
Number of energized fields	20	18	Each
Area per T/R Set			
Collecting area per electrical section	7,798	8,905	ft²
Two electrical sections served	15,596	17,809	ft²
Four electrical sections served	31,912	35,619	ft²
Secondary voltage rating	45	45	kV
Current density 2 sections, 770 mA	49	N / A	μA/ft.²
Current density 2 sections, 1100 mA	71	62	μA/ft.²
Current density 4 sections, 1100 mA	34	N / A	μA/ft.²
Current density 2 sections, 1400 mA	90	78	μA/ft.²
Current density 4 sections, 1400 mA	N / A	39	μA/ft.²

The existing electrostatic precipitator exhibits the following critical operating parameters when treating the gas volume defined above. For the purpose of the evaluation, we assumed total gas flow was divided equally between the Unit 2 A & B and Unit 2C casings:

Critical ESP Parameters		
Existing Unit 2 Electrostatic Precipitator		
Parameter	Unit 2A & B (old & new)	Unit 2C
Total collecting plate area	733,914 ft²	712,397 ft²
Treatment length	69 ft	60 ft
Aspect ratio	2.23	1.94
Specific collecting area, SCA @ 9" GP	863	838
Specific collecting area, SCA @ 12" GP	648	629
Gas velocity	3.55 ft/sec	3.2 ft/sec
Treatment time	19.43 sec.	18.75 sec.

Evaluation
The table below provides a comparison of current design standards to the existing equipment.

Crystal River Unit 2 Critical Operating Parameters			
Parameter	Unit 2 A & b	Unit 2 C	Design Target
Total collecting plate area	733,914 ft²	712,397 ft²	N/A
Treatment length	69 ft	60 ft	N/A
Aspect ratio	2.23	1.94	>0.8
Specific collecting area	863 ft²/1000 acfm Actual	838 ft²/1000 acfm Actual	N/A
Specific collecting area	648 ft²/1000 acfm @12"GP	629 ft²/1000 acfm @12"GP	>320
Gas velocity	3.55 ft/sec	3.2 ft/sec	<3.5
Treatment time	19.43 sec	18.75 sec	8 to 10
Number of electrical fields	20 (44)	18 (36)	>4
Inlet fields	49 - 71 µA/ft²	39 - 62 µA/ft²	25 - 45 µA/ft²
Middle fields	34 - 90 µA/ft²	62 µA/ft²	40 - 60 µA/ft²
Outlet fields	49 - 71 µA/ft²	62 - 78 µA/ft²	55 - 90 µA/ft²
Two electrical section size	15,596 ft²	17,809 ft²	20,000 ft²
Four electrical section size	31,912 ft²	35,619 ft²	40,000 ft²
Secondary voltage	10 kV/inch	10 kV/inch	10 kV/inch

As shown in the table, the existing equipment meets most of the current design standards for a modern electrostatic precipitator. The only design concerns relate to the available current density of the Unit 2 A & B New inlet fields. The transformer rectifiers designated 2A-10 and 2B-10 an installed current density of 34 micro amps per square foot of plate area. This is a low current density for the position of the transformer rectifiers in the combined Old and New casings. We would expect a minimum current density in this field of about 45 to 50 micro amps per square foot of plate area. Based on the large number of electrical fields provided however, the low current density is not the factor limiting performance of the Unit 2 electrostatic precipitator.

The table also points out that the electrical fields comprised of four (4) sections exceed our recommended size. When large electrical fields are utilized, the impact of sparking in one field has a disproportionate impact on overall performance. Once again though, the size of the electrical fields is not the main factor limiting performance of the Unit 2 electrostatic precipitator.

Unit 2 A/B (old & new) & 2C Recommendations
From the preliminary equipment analysis, the following recommendations can be offered. Implementing the recommendations will result in reduced dust emissions and improved equipment availability.

Rebuild the Unit 2 A & B Old Electrostatic Precipitator
The rebuild should be configured to utilize eleven inch (11") gas passage spacing and rigid electrodes. The transformer rectifiers in the first four (4) sections should be replaced with units rated at 60kV. The balance of the fields can reuse existing transformer rectifier sets.

High voltage rapping would be improved as a result of the rebuild. In addition, rapping densities on the collecting system would be brought up to current design standards.

Budgetary Material Price for a rebuild as noted: $2,212,000.00

It is recommended that a flow model study be completed for the Unit 2 A & B electrostatic precipitator prior to the rebuild project. This will allow corrective flow distribution devices to be installed as part of the rebuild.

Budgetary Material Price for a CFD model study: $55,000.00

Improve Gas Distribution

The combination of two parallel flow paths provided by Unit 2 A & B and the Unit 2C create flow distribution problems. It is very difficult to obtain equal distribution between the parallel paths.

It is recommended that a flow model study should be undertaken for Unit 2 A, B & C. The model should incorporate existing distribution duct work between parallel casing and flow within each casing. The purpose of the study is to define current conditions and to make recommendations for gas distribution upgrades. Significant reductions in outlet emissions can be achieved as a result of implementing gas flow study recommendations.

Budgetary Material Price for a CFD model study: $105,000.00

Improving Temperature

The large number of electrical fields both in the direction of flow and perpendicular to flow provides sufficient sectionalization to accommodate expected mal-distribution in gas and temperature. To confirm this, electrical data from adjacent transformer rectifiers should be compared. If there is a significant difference in electrical conditions observed in adjacent fields, then there may be insufficient sectionalization.

A more important consideration relates to the normal operating temperature of the Unit 2 electrostatic precipitators. Stack test data indicates flue gas temperature at 275°F. Historical data indicates inlet gas temperatures of less than 265°F. This temperature level is at or near the calculated acid dew point for the fuel burned. Based on the nature of temperature measurements and the large volume within which the temperature is measured, it is likely that portions of the electrostatic precipitator operate in the acid dew point on a regular basis.

General Maintenance

Condition of the Unit 2 A & B New and the Unit 2C electrostatic precipitators does not appear to warrant a rebuild at this time. A detailed internal inspection should be accomplished for each unit for the purpose of defining internal maintenance activities. Our recommendation for Unit 2 A & B Old, however, is that it be rebuilt as noted above.

Budgetary Quotation

The information in this document is provided for budgetary estimating purposes only. It does not constitute an offer or acceptance by Contractor or GE, nor does it create any obligation of any kind, whether express or implied, on the part of Contractor or GE, to enter into any agreement of any kind or to provide any particular goods or services at any particular price. Any such obligations can only arise upon completion and signature of a final, agreed Contract between the parties. The pricing is estimated only and is not based upon complete information about the details of the facility and equipment, the proposed operations and other factors that may affect the ultimate final price to be established by the signed Contract. No warranty or representation is given, either expressed or implied, concerning the information in this Budgetary Quotation. All information is subject to change.

Summary

We look forward to further discussions concerning this work and appreciate this opportunity to quote. If you should have any questions or comments, please feel free to contact us at 800-821-2222.

Sincerely,

GE ENERGY

ATTACHMENT 2

Hamon-Research Cottrell Response

From: Phillips, Warren
Sent: Thursday, May 10, 2007 5:18 PM
To: 'BARRY.STOLZMAN@HAMONUSA.COM'
Cc: 'BILL.ELSTER@HAMONUSA.COM'; Stevens, J. Patrick
Subject: PEF-GOLDER ASSOCIATES
Barry Stolzman
Harmon - Research Cottrell
Reference: PEF - Crystal River, Florida

Barry,
As you may recall from our recent phone conversation, Golder Associates
is conducting a BART Analysis for PEF's plant at Crystal River. We would
like to consider HRC's COHPAC technology as a technically feasible
control alternative for the emissions from each of two fossil fuel steam
generators. These units are pulverized coal dry bottom boilers, each
with emissions controlled by a Buell high efficiency electrostatic
precipitator. Unit 1 is rated at 440.5 MW, 3,750 MMBTU/hr. Unit 2 is
rated at 523.8MW, 4,795 MMBTU/hr. Both units are burning bituminous
coal. Enclosed are PM emission test report data for both units. Golder
will need the projected PM emissions for each of these units after
COHPAC baghouse retro-fits. In addition, please include a 30,000' budget
for provision and installation of each new baghouse. Hopefully, this is
adequate information for you to prepare the budgetary quotes. If
additional data is required please call or email your request. We are in
the process of obtaining existing equipment arrangement information, and
expect this will be available to you if necessary.

Please treat the attached test reports as confidential information.

Sincerely,
Warren Phillips
Sr. Design Engineer
Golder Associates
503-607-1820

From: ELSTER Bill [mailto:bill.elster@hamonusa.com]
Sent: Friday, June 01, 2007 6:22 AM
To: Phillips, Warren
Cc: STOLZMAN Barry
Subject: FW: PEF-GOLDER ASSOCIATES

Warren,

Based on the information provided, HRC would recommend the installation
of a "polishing baghouse" sized at a 6:1 net A/C ratio. The material
cost for this size unit would be approximately $8.5 million for Unit 1
and $9.0 million for Unit 2. The particulate emissions would be
guaranteed at .012 Lbs/MMBTu. Emissions would be independent of normal
or sootblowing operation. It would be helpful if you could provide the
actual size of the existing ESP's.

From: Phillips, Warren [mailto:Warren_Phillips@golder.com]
Sent: Friday, June 01, 2007 3:54 PM
To: ELSTER Bill
Subject: RE: PEF-GOLDER ASSOCIATES

Bill,

Thanks for the quick reply. I've attached files which will give you the
size information for both of PEF's ESP units.

*   Are you utilizing a high efficiency (laminated ptfe
membrane) fabric? Alternatively, your test data on the COHPAC Systems
could provide some emissions data which is correlated to particulate
size.
Answer: We would anticipate the particulate emissions to be <= 10 micron
in size.

        The bag material we would supply is PPS.

*   Do you have any "rule of thumb" estimates for installation costs
for the baghouse (flange to flange)?

Answer: Normally we would expect the labor in a non-union area to be
approximately 1 to 1. However, with the continued shortage of labor in
Florida we would recommend that you apply a 1.4 to 1 ratio.

*   ·Does the material cost include allowances for foundations?

Answer: No, the cost of foundations is not included. Also, the material
price quoted to you did not include wire and conduit, or heat insulation
and would be included in the labor adjustment provided above. The 1.4
factor does not cover the cost of foundations, as that is very site
specific.
Thanks again for the help.
Regards,
Warren

From: Phillips, Warren [mailto:Warren_Phillips@golder.com]
Sent: Sunday, June 10, 2007 8:51 PM
To: ELSTER Bill
Subject: RE: PEF-GOLDER ASSOCIATES

Bill,
I have a few more questions relating to our cost analysis for the polishing baghouse option at Progress Energy -
Crystal River:

1. What is the approximate footprint of the baghouse? (Unit 1 case is adequate) – 71' wide x 100' long
2. What is the estimated bag life between filter changes? – 3.5 years
3. What is the estimated cost of the replacement bags? - $1,410,000
4. What is the normal/average operating delta P, (flange to flange) of the collector? – 7.5" in Gross condition; 8.0" in NET
condition
Thanks again for the help.

Regards,
Warren
-----Original Message-----
From: ELSTER Bill [mailto:bill.elster@hamonusa.com]

ATTACHMENT 3

Buell Response

Buell Division of

Fisher-Klosterman, Inc .®

200 North Seventh Street
Suite 2
Lebanon, PA 17046-5006
Phone: 717-274-7110
Fax: 717-274-7342
E-mail: twl@fkinc.com
www.fkinc.com

June 11, 2007

To: Warren Phillips
        Golder Associates

From: Tom Lugar
        Buell Division of Fisher-Klosterman, Inc.

Subject: Bart Analysis Input
          Progress Energy Florida Crystal River Unit 1 & 2

Mr. Phillips:

The following is in response to your request for information as stated in your June 4 email concerning the subject Crystal River ESPs.

1. The budgetary estimate to supply cyclones for Unit 1 & 2 is $1.7 million (material & construction). Adding cyclones will have a minimal impact on reducing fine particulate emissions. In fact, in many cases, ESPs replaced multi-clones to decrease particulate emissions in response to the original Clean Air Act. As seen on the attached Buell Fractional Efficiency Curve (cyclone removal efficiency versus particle size), cyclones are poor performers in removing less the 8 micron in diameter and especially for particulate less than PM 2.5 which is responsible for haze and will remain the lungs if breathed in. These fines pass through the cyclones and must be dealt with by the ESP. Thus the minimal impact statement concerning adding cyclones. In an ESP, fine particulate require more time for charging and collection. For high removal efficiency of fines an ESP must be designed to have large collecting plate area and an aspect ratio of 1.0 and greater to allow more treatment time.

2. Attached is a typical ESP inlet particle size analysis for a PC fired boiler (see Fig 11). The mean particle size is in the 10 to 12 micron size range and particulate 2.5 micron diameter and less make up 11.5% of the total mass. Also attached is a typical ESP fractional penetration as a function of particle size for various overall ESP removal efficiencies (see Fig. 24).

3. A budgetary estimate to convert Unit #1 and Unit #2 precipitator casings to a pulse jet, long bag, PTFE membrane fabric filter is $35 million (material & construction). This is the total to convert both units. Attached is a satellite view of the site. As shown, the ESP casings are large enough that a conversion could be made in the far left casing for Unit #2 boiler and use the center ESP to convert to pulse jet for Unit #1 boiler. The ESP (now used for Unit #1) would not be required and would be decommissioned.

4. An ESP has a reduction in collection efficiency in the 0.1 to 0.5 micron diameter range. Typical ESP fractional efficiencies are approximately 95% for this range of particle size. A fabric filter

also has a reduction in removal efficiency in this range but typical collection efficiencies in this range are higher, around 99.5%.

Typical pulse jet fabric filters applied to coal-fired boilers achieve an outlet emission between 0.01 to 0.02 lb/MMBTU. With the use of a PTFE membrane filter bag, outlet emissions are in the range of 0.001 grain/acf or 0.003 to 0.006 lb/MMBTU.

Very truly yours,

Tom Lugar
Product Manager, APC Products
Buell Division Fisher-Klosterman, Inc.

BUELL Fractional Efficiency Curve
Curve No. 28.154 PF.3
Based on A.S.M.E. P.T.C. 28
Calibration of Bahco Microparticle Classifier
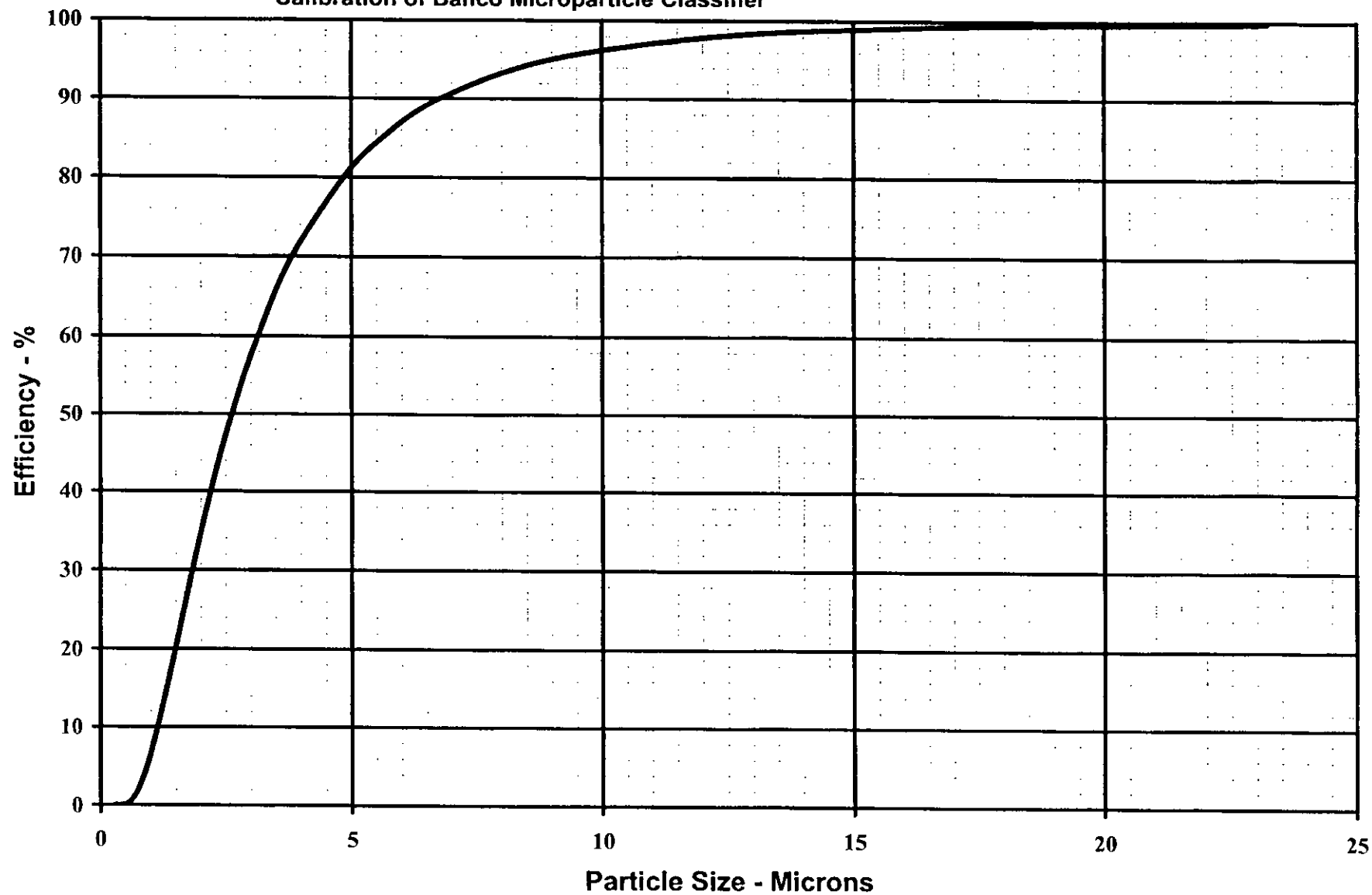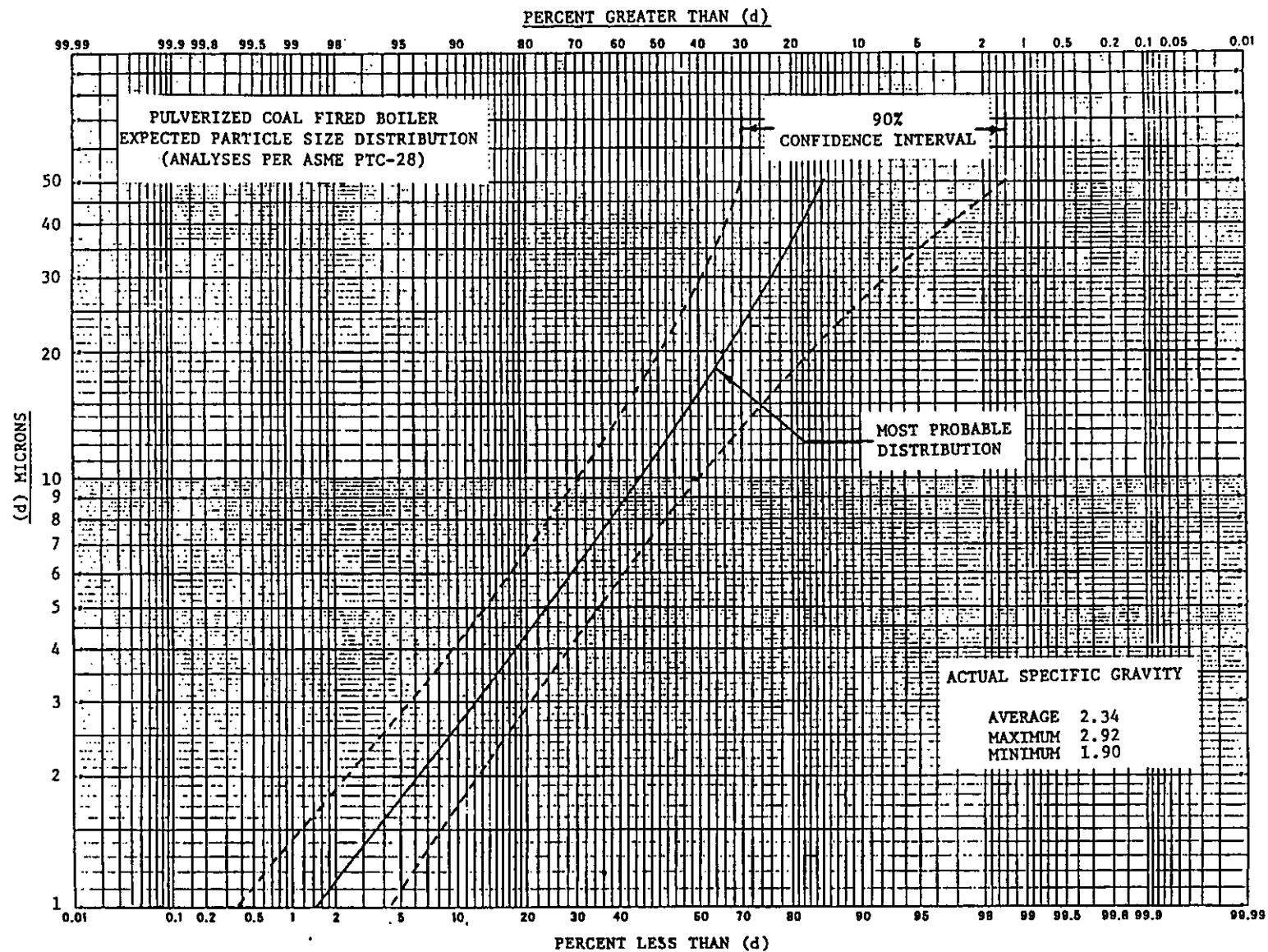
Figure 11. Expected Particle Size Distribution for Pulverized Coal-Fired Boiler

Reference: 28
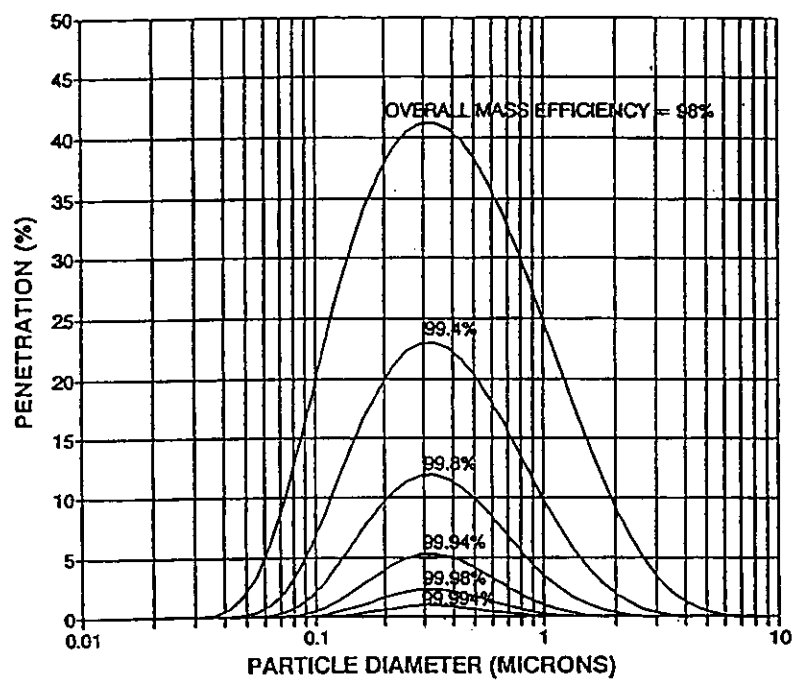
Figure 24. ESP Fractional Penetration as Function of Particle Size for
Various Overall Efficiencies

Reference: 56

ATTACHMENT 4

Cost and Cost-Effectiveness Tables 1 through 8

TABLE 1 -ELECTROSTATIC PRECIPITATOR COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion Unit 1 - Rebuild ESP	Electrostatic Precipitator	PM10

TOTAL CAPITAL COST FOR ELECTROSTATIC PRECIPITATOR-REBUILD

DIRECT COSTS (capital investment)

(1) Purchased Equipment Costs:

(a) Basic Equipment and Auxiliaries (A)	$3,631,300
(b) Instrumentation (0.10 A)	$363,130
(c) Freight and Taxes (0.08 A)	$290,504
Total Equipment Cost (B):	$4,284,934

(2) Direct Installation Costs:

(b) Erection and Handling (2.50 B)	$10,712,335
(b) Deconstruction (0.01 B)	$42,849
Total Installation Cost (C)	$10,755,184

Total Direct Costs of Capital Investment (DCCI) = (B + C)	$15,040,118

INDIRECT COSTS (capital investment):

(1) Engineering Costs (0.20 B)	$856,987
(2) Construction and Field Expenses (0.20 B)	$856,987
(3) Contractor Fees (0.10 B)	$428,493
(4) Startup (0.01 B)	$42,849
(5) Performance Test (0.01 B)	$42,849
(6) Contingencies (0.03 B)	$128,548
Total Indirect Costs of Capital Investment (ICCI)	$2,356,714

TOTAL CAPITAL INVESTMENT (TCI) = (DCCI + ICCI):	$17,396,832

ANNUALIZED COST OF CAPITAL INVESTMENT

(1) Interest Rate	10.0%
(2) Control System Economic Life (years)	(10)
(3) Capital Recovery Factor (CRF)	(0.163)
(4) Capital Recovery Cost (CRC) = (CRF X TCB)	$2,831,300

TABLE 1 -ELECTROSTATIC PRECIPITATOR COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion Unit 1 - Rebuild ESP	Electrostatic Precipitator	PM10

TOTAL ANNUAL O&M COST FOR ELECTROSTATIC PRECIPITATOR – REBUILD

DIRECT COSTS (O&M):

  (1) Variable Costs

    (a) Utilities

(a1) Electricity -	Cost:	0.0000	$/kW	(No additional electricity consumpton)	
	Rate:	0	kW/yr		

          $0

    (b) Landfill Costs

(b1) Dust	Volume:	370.4	ton/yr	
	Cost:	28.50	$/ton	(Estimate)

          $10,557

Total Direct Variable Costs (D) $10,557

  (2) Semivariable Costs (considered equivalent to semivariable costs without rebuild)=0

(a) Labor	O = $26.00	M = $34.00	

        (a1) Operating (O) = (2 hrs/shift X 3 shifts/day X day/24hrs X 8,500 hrs/yr X $26.00/hr) $0

        (a2) Supervisory (0.15 O) $0

        (a3) Maintenance (M) = (2 hrs/shift X 3 shifts/day X day/24hrs X 8,500 hrs/yr X $34.00/hr) $0

    (b) Maintenance Materials (M) (1% of Purchased Equipment Costs) $0

    (c) Replacement Parts

        (c1) Initial cost of replacement parts (Cp) = (0.05 B) $0

        (c2) Cost of parts replacement labor (Cpl) = (0.01 B) $0

        (c3) Interest rate (i)   10%

        (c4) Replacement parts Economic Life (n) (years)   5

        (c5) Capital recovery factor of replacement parts (CRFp)   0.26

        (c6) Capital Recovery Cost of replacement parts ([Cp+Cpl] X CRFp) $0

Total Semivariable Costs (E) $0

Total Annual Direct Cost of O&M (DCO&M) = (D + E) $10,557

INDIRECT COSTS (O&M):(Equivalent without rebuild)=0

  (1) Overhead (60% of Sum of Operating, Supervisory, & Maintenance Labor) $0

  (2) Property Tax (0.01 TCI) $0

  (3) Insurance (0.01 TCI) $0

  (4) Administration (0.02 TCI) $0

Total Annual Indirect Costs of O&M (ICO&M) $0

TOTAL ANNUAL COSTS of O&M (TAO&M) = (DCO&M + ICO&M): $10,557

COST EFFECTIVENESS OF ELECTROSTATIC PRECIPITATOR REBUILD

Capital Recovery Cost of Equipment (CRC)		$2,831,300	
Total Annual Costs of O&M (TAO&M)		$10,557	
Total Annualized Cost (TAC) = (CRC + TAO&M)		$2,841,857	
Control Device Loading Rate (F)	tons/yr	119,929.2	
Control Device efficiency improvement (G)		0.3%	To meet 0.015
Pollutant Removed (H) = (F X G)		378.3	
COST EFFECTIVENESS (TAC / H):	$/ton of pollutant removed	$7,512.17	

TABLE 2 - ELECTROSTATIC PRECIPITATOR COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion Unit 2 - Rebuild ESP	Electrostatic Precipitator	PM10

TOTAL CAPITAL COST FOR ELECTROSTATIC PRECIPITATOR-REBUILD

DIRECT COSTS (capital investment)

(1) Purchased Equipment Costs:	
(a) Basic Equipment and Auxiliaries (A)	$2,372,000
(b) Instrumentation (0.10 A)	$237,200
(c) Freight and Taxes (0.08 A)	$189,760
Total Equipment Cost (B):	$2,798,960
(2) Direct Installation Costs:	
(b) Erection and Handling (2.50 B)	$6,997,400
(b) Deconstruction (0.01 B)	$27,990
Total Installation Cost (C)	$7,025,390
Total Direct Costs of Capital Investment (DCCI) = (B + C)	$9,824,350

INDIRECT COSTS (capital investment):

(1) Engineering Costs (0.20 B)	$559,792
(2) Construction and Field Expenses (0.20 B)	$559,792
(3) Contractor Fees (0.10 B)	$279,896
(4) Startup (0.01 B)	$27,990
(5) Performance Test (0.01 B)	$27,990
(6) Contingencies (0.03 B)	$83,969
Total Indirect Costs of Capital Investment (ICCI)	$1,539,428

TOTAL CAPITAL INVESTMENT (TCI) = (DCCI + ICCI):	$11,363,778

ANNUALIZED COST OF CAPITAL INVESTMENT

(1) Interest Rate	10.0%
(2) Control System Economic Life (years)	(10)
(3) Capital Recovery Factor (CRF)	(0.163)
(4) Capital Recovery Cost (CRC) = (CRF X TCB)	$1,849,400

TABLE 2 - ELECTROSTATIC PRECIPITATOR COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion Unit 2 - Rebuild ESP	Electrostatic Precipitator	PM10

TOTAL ANNUAL O&M COST FOR ELECTROSTATIC PRECIPITATOR – REBUILD

<u>DIRECT COSTS (O&M)</u>:

(1) Variable Costs

  (a) Utilities

    (a1) Electricity -   Cost: 0.0000 $/kW   (No additional electricity consumption)

                   Rate: 0   kW/yr

                                                                   $0

  (b) Landfill Costs

    (b1) Dust   Volume: 189.6   ton/yr

                    Cost: 28.50 $/ton   (Estimate)

                                                        $5,404

Total Direct Variable Costs (D) $5,404

(2) Semivariable Costs (considered equivalent to semivariable costs without rebuild)=0

  (a) Labor   O = $26.00   M = $34.00

    (a1) Operating (O) = (2 hrs/shift X 3 shifts/day X day/24hrs X 8,500 hrs/yr X $26.00/hr) $0

    (a2) Supervisory (0.15 O) $0

    (a3) Maintenance (M) = (2 hrs/shift X 3 shifts/day X day/24hrs X 8,500 hrs/yr X $34.00/hr) $0

  (b) Maintenance Materials (M) (1% of Purchased Equipment Costs) $0

  (c) Replacement Parts

    (c1) Initial cost of replacement parts (Cp) = (0.05 B) $0

    (c2) Cost of parts replacement labor (Cpl) = (0.01 B) $0

    (c3) Interest rate (i)   10%

    (c4) Replacement parts Economic Life (n) (years)   5

    (c5) Capital recovery factor of replacement parts (CRFp)   0.26

    (c6) Capital Recovery Cost of replacement parts ([Cp+Cpl] X CRFp)   <u>$0</u>

Total Semivariable Costs (E) $0

Total Annual Direct Cost of O&M (DCO&M) = (D + E) $5,404

INDIRECT COSTS (O&M):(Equivalent without re-build)=0

  (1) Overhead (60% of Sum of Operating, Supervisory, & Maintenance Labor) $0

  (2) Property Tax (0.01 TCI) $0

  (3) Insurance (0.01 TCI) $0

  (4) Administration (0.02 TCI)   <u>$0</u>

Total Annual Indirect Costs of O&M (ICO&M) $0

TOTAL ANNUAL COSTS of O&M (TAO&M) = (DCO&M + ICO&M): $5,404

COST EFFECTIVENESS OF ELECTROSTATIC PRECIPITATOR REBUILD

Capital Recovery Cost of Equipment (CRC)		$1,849,400
Total Annual Costs of O&M (TAO&M)		<u>$5,404</u>
Total Annualized Cost (TAC) = (CRC + TAO&M)		$1,854,804
Control Device Loading Rate (F)	tons/yr	123,660.4
Control Device efficiency improvement (G)		0.18% To meet 0.015
Pollutant Removed (H) = (F X G)		216.6
COST EFFECTIVENESS (TAC / H):	$/ton of pollutant removed	$8,561.90

TABLE 3 - ELECTROSTATIC PRECIPITATOR COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion Unit 1	Electrostatic Precipitator	PM10

TOTAL CAPITAL COST FOR REPLACEMENT ELECTROSTATIC PRECIPITATOR

DIRECT COSTS (capital investment)

(1) Purchased Equipment Costs:
    (a) Basic Equipment and Auxiliaries (A) $18,172,668
    (b) Instrumentation (0.10 A) $1,817,267
    (c) Freight and Taxes (0.08 A) $1,453,813
Total Equipment Cost (B): $21,443,748

(2) Direct Installation Costs:
    (a) Foundations and Supports (0.04 B) $857,750
    (b) Erection and Handling $41,571,795
    (c) Electrical (0.08 B) $1,715,500
    (d) Piping (0.01 B) $214,437
    (e) Insulation for ductwork (0.02 B) $428,875
    (f) Painting (0.02 B) $428,875
    (g) Building and Site Preparation (0.01 B) $214,437
Total Installation Cost (C) (2.5A) $45,431,670

Total Direct Costs of Capital Investment (DCCI) = (B + C) $66,875,418

INDIRECT COSTS (capital investment):

(1) Engineering Costs (included in A)
(2) Construction and Field Expenses (included in C)
(3) Contractor Fees (included in C)
(4) Startup (0.01 B) $214,437
(5) Performance Test (0.01 B) $214,437
(6) Contingencies (0.03 B) $643,312
Total Indirect Costs of Capital Investment (ICCI) $1,072,187

TOTAL CAPITAL INVESTMENT (TCI) = (DCCI + ICCI): $67,947,606

ANNUALIZED COST OF CAPITAL INVESTMENT
(1) Interest Rate   10.0%
(2) Control System Economic Life (years)   (10)
(3) Capital Recovery Factor (CRF)   (0.163)
(4) Capital Recovery Cost (CRC) = (CRF X TCB) $11,058,200

TABLE 3 - ELECTROSTATIC PRECIPITATOR COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion Unit 1	Electrostatic Precipitator	PM10

TOTAL ANNUAL O&M COST FOR ELECTROSTATIC PRECIPITATOR

DIRECT COSTS (O&M):

(1) Variable Costs

    (a) Utilities

        (a1) Electricity -   Cost: 0.0000 $/kW   (Estimate)

                       Rate: 0   kW/yr   (No Additional Electricity Consumption)

                                                                        $0

    (b) Landfill Costs

        (b1) Dust   Volume: 452.5   ton/yr

                      Cost: 28.50 $/ton   (Estimate)

                                                          $12,897

Total Direct Variable Costs (D) $12,897

(2) Semivariable Costs (Equivalent to replaced unit)=0

    (a) Labor   O = $26.00   M = $34.00

        (a1) Operating (O) = (2 hrs/shift X 3 shifts/day X day/24hrs X 8,500 hrs/yr X $26.00/hr) $0

        (a2) Supervisory (0.15 O) $0

        (a3) Maintenance (M) = (2 hrs/shift X 3 shifts/day X day/24hrs X 8,500 hrs/yr X $34.00/hr) $0

    (b) Maintenance Materials (M) (1% of Purchased Equipment Costs) $0

    (c) Replacement Parts

        (c1) Initial cost of replacement parts (Cp) = (0.05 B) $0

        (c2) Cost of parts replacement labor (Cpl) = (0.01 B) $0

        (c3) Interest rate (i)   10%

        (c4) Replacement parts Economic Life (n) (years)   5

        (c5) Capital recovery factor of replacement parts (CRFp)   0.264

        (c6) Capital Recovery Cost of replacement parts ([Cp+Cpl] X CRFp) $0

Total Semivariable Costs (E) $0

Total Annual Direct Cost of O&M (DCO&M) = (D + E) $12,897

INDIRECT COSTS (O&M):

(1) Overhead (60% of Sum of Operating, Supervisory, & Maintenance Labor) $0

(2) Property Tax (0.01 TCI) $679,500

(3) Insurance (0.01 TCI) $679,500

(4) Administration (0.02 TCI)(Equivalent cost)=0 $0

Total Annual Indirect Costs of O&M (ICO&M) $1,359,000

TOTAL ANNUAL COSTS of O&M (TAO&M) = (DCO&M + ICO&M): $1,371,897

COST EFFECTIVENESS OF ELECTROSTATIC PRECIPITATOR

Capital Recovery Cost of Equipment (CRC)		$11,058,200
Total Annual Costs of O&M (TAO&M)		$1,371,897
Total Annualized Cost (TAC) = (CRC + TAO&M)		$12,430,097
Control Device Loading Rate (F)	tons/yr	123,893.8
Control Device efficiency improvement (G)		0.4% To meet 0.010
Pollutant Removed (H) = (F X G)		452.5
COST EFFECTIVENESS (TAC / H):	$/ton of pollutant removed	$27,467.30

TABLE 4 -ELECTROSTATIC PRECIPITATOR COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion Unit 2	Electrostatic Precipitator	PM10

TOTAL CAPITAL COST FOR REPLACEMENT ELECTROSTATIC PRECIPITATOR

DIRECT COSTS (capital investment)

(1) Purchased Equipment Costs:
  (a) Basic Equipment and Auxiliaries (A) — $20,400,000
  (b) Instrumentation (0.10 A) — $2,040,000
  (c) Freight and Taxes (0.08 A) — $1,632,000
Total Equipment Cost (B): — $24,072,000

(2) Direct Installation Costs:
  (a) Foundations and Supports (0.04 B) — $962,880
  (b) Erection and Handling — $46,667,040
  (c) Electrical (0.08 B) — $1,925,760
  (d) Piping (0.01 B) — $240,720
  (e) Insulation for ductwork (0.02 B) — $481,440
  (f) Painting (0.02 B) — $481,440
  (g) Building and Site Preparation (0.01 B) — $240,720
Total Installation Cost (C) (2.5A) — $51,000,000

Total Direct Costs of Capital Investment (DCCI) = (B + C) — $75,072,000

INDIRECT COSTS (capital investment):

(1) Engineering Costs (included in A)
(2) Construction and Field Expenses (included in C)
(3) Contractor Fees (included in C)
(4) Startup (0.01 B) — $240,720
(5) Performance Test (0.01 B) — $240,720
(6) Contingencies (0.03 B) — $722,160
Total Indirect Costs of Capital Investment (ICCI) — $1,203,600

TOTAL CAPITAL INVESTMENT (TCI) = (DCCI + ICCI): — $76,275,600

ANNUALIZED COST OF CAPITAL INVESTMENT
(1) Interest Rate — 10.0%
(2) Control System Economic Life (years) — (10)
(3) Capital Recovery Factor (CRF) — (0.163)
(4) Capital Recovery Cost (CRC) = (CRF X TCB) — $12,413,500

TABLE 4 -ELECTROSTATIC PRECIPITATOR COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion Unit 2	Electrostatic Precipitator	PM10

TOTAL ANNUAL O&M COST FOR ELECTROSTATIC PRECIPITATOR

DIRECT COSTS (O&M):

  (1) Variable Costs

    (a) Utilities

(a1) Electricity -	Cost:	0.0000	$/kW	(Estimate)	
	Rate:	0	kW/yr	(No Additional Electricity Consumption)	

                                                                                   $0

    (b) Landfill Costs

(b1) Dust	Volume:	406.8	ton/yr	
	Cost:	28.50	$/ton	(Estimate)

                                                                                   $11,594

Total Direct Variable Costs (D) $11,594

  (2) Semivariable Costs (Equivalent to replaced unit)=0

    (a) Labor   O = $26.00   M = $34.00

        (a1) Operating (O) = (2 hrs/shift X 3 shifts/day X day/24hrs X 8,500 hrs/yr X $26.00/hr) $0

        (a2) Supervisory (0.15 O) $0

        (a3) Maintenance (M) = (2 hrs/shift X 3 shifts/day X day/24hrs X 8,500 hrs/yr X $34.00/hr) $0

    (b) Maintenance Materials (M) (1% of Purchased Equipment Costs) $0

    (c) Replacement Parts

        (c1) Initial cost of replacement parts (Cp) = (0.05 B) $0

        (c2) Cost of parts replacement labor (Cpl) = (0.01 B) $0

        (c3) Interest rate (i)   10%

        (c4) Replacement parts Economic Life (n) (years)   5

        (c5) Capital recovery factor of replacement parts (CRFp)   0.264

        (c6) Capital Recovery Cost of replacement parts ([Cp+Cpl] X CRFp) $0

Total Semivariable Costs (E) $0

Total Annual Direct Cost of O&M (DCO&M) = (D + E) $11,594

INDIRECT COSTS (O&M):

  (1) Overhead (60% of Sum of Operating, Supervisory, & Maintenance Labor) $0

  (2) Property Tax (0.01 TCI) $762,800

  (3) Insurance (0.01 TCI) $762,800

  (4) Administration (0.02 TCI)(Equivalent cost)=0 $0

Total Annual Indirect Costs of O&M (ICO&M) $1,525,600

TOTAL ANNUAL COSTS of O&M (TAO&M) = (DCO&M + ICO&M): $1,537,194

COST EFFECTIVENESS OF ELECTROSTATIC PRECIPITATOR

Capital Recovery Cost of Equipment (CRC)		$12,413,500
Total Annual Costs of O&M (TAO&M)		$1,537,194
Total Annualized Cost (TAC) = (CRC + TAO&M)		$13,950,694
Control Device Loading Rate (F)	tons/yr	135,253.5
Control Device efficiency improvement (G)		0.3% To meet 0.01
Pollutant Removed (H) = (F X G)		406.8
COST EFFECTIVENESS (TAC / H):	$/ton of pollutant removed	$34,296.22

TABLE 5 - BAGHOUSE COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion - Unit 1 ESP Outlet	Polishing Baghouse	PM10

TOTAL CAPITAL COST FOR BAGHOUSE

DIRECT COSTS (capital investment)

(1) Purchased Equipment Costs:	
(a) Basic Equipment and Auxiliaries (A)	$10,596,210
(b) Instrumentation (0.10 A)	(Included in 1A)
(c) Freight and Taxes (0.08 A)	$847,697
Total Equipment Cost (B):	$11,443,907
(2) Direct Installation Costs:	
(a) Foundations and Supports (0.04 B)	$457,756
(b) Erection and Handling (1.4 B)	$16,021,470
(c) Electrical (0.08 B)	$915,513
(d) Piping (0.01 B)	$114,439
(e) Heat Insulation (0.07 B)	$801,073
(f) Painting (0.04 B)	$457,756
(g) Demolition and Site Preparation (0.01 B)	$114,439
Total Installation Cost (C)	$18,882,446
Total Direct Costs of Capital Investment (DCCI) = (B + C)	$30,326,353

INDIRECT COSTS (capital investment):

(1) Engineering Costs (0.10 B)	$1,144,391
(2) Construction and Field Expenses (0.20 B)	$2,288,781
(3) Contractor Fees (0.10 B)	$1,144,391
(4) Startup (0.01 B)	$114,439
(5) Performance Test (0.01 B)	$114,439
(6) Contingencies (0.03 B)	$343,317
Total Indirect Costs of Capital Investment (ICCI)	$5,149,758

TOTAL CAPITAL INVESTMENT (TCI) = (DCCI + ICCI):	$35,476,111

ANNUALIZED COST OF CAPITAL INVESTMENT (BAGS)

(1) Interest Rate	10.0%
(2) Control System Economic Life (years)	3.50
(3) Total Price of Full Set of Bags (including taxes, freight and labor) (TCB)	$1,410,000
(3) Capital Recovery Factor (CRF)	0.353
(4) Capital Recovery Cost (BCRC) = (CRF X TCB)	$497,100

ADJUSTED CAPITAL INVESTMENT (ATCI) = (TCI) - (TCB)	$34,066,111

ANNUALIZED COST OF CAPITAL INVESTMENT (ALL EQUIPMENT)

(1) Interest Rate	10.0%
(2) Control System Economic Life (years)	10
(3) Capital Recovery Factor (CRF)	0
(4) Capital Recovery Cost (CRC) = (CRF X ATCI)	$5,544,100

TABLE 5 - BAGHOUSE COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion - Unit 1 ESP Outlet	Polishing Baghouse	PM10

TOTAL ANNUAL O&M COST FOR BAGHOUSE

DIRECT COSTS (O&M):
  (1) Variable Costs
    (a) Utilities

(a1) Electricity -	Cost:	0.0700	$/kW		
	Rate:	#########	kW/yr		
					$1,363,800

    (b) Landfill Costs

(b1) Dust	Mass:	420	ton/yr		
(	Cost:	28.50	$/ton	(Estimate)	
					$11,984

Total Direct Variable Costs (D) $1,375,784

  (2) Semivariable Costs
    (a) Labor   O = $26.00   M = $34.00

(a1) Operating (O) = (1 hrs/shift X 3 shifts/day X day/24hrs X 8,760 hrs/yr X $26/hr)	$28,470
(a2) Supervisory (0.15 O)	$4,300
(a3) Maintenance (M) = (1 hrs/shift X 3 shifts/day X day/24hrs X 8,760 hrs/yr X $34/hr)	$37,230
(b) Maintenance Materials (M)	$37,230
(c) Replacement Parts	
(c1) Initial cost of replacement parts (Cp) = (0.05 B)	$572,200
(c2) Cost of parts replacement labor (Cpl) = (0.01 B)	$114,400
(c3) Interest rate (i)	10%
(c4) Replacement parts Economic Life (n) (years)	5
(c5) Capital recovery factor of replacement parts (CRFp)	0.26
(c6) Capital Recovery Cost of replacement parts ([Cp+Cpl] X CRFp)	$181,100
Total Semivariable Costs (E)	$288,330

Total Annual Direct Cost of O&M (DCO&M) = (D + E) $1,664,114

INDIRECT COSTS (O&M):

(1) Overhead (60% of Sum of Operating, Supervisory, & Maintenance Labor)	$42,000
(2) Property Tax (0.01 ATCI)	$340,700
(3) Insurance (0.01 ATCI)	$340,700
(4) Administration (0.02 ATCI)	$681,300
Total Annual Indirect Costs of O&M (ICO&M)	$1,404,700

TOTAL ANNUAL COSTS of O&M (TAO&M) = (DCO&M + ICO&M): $3,068,814

COST EFFECTIVENESS OF BAGHOUSE

Capital Recovery Cost Of Bags (BCRC)	$497,100	
Capital Recovery Cost of Equipment (CRC)	$5,544,100	
Total Annual Costs of O&M (TAO&M)	$3,068,814	
Total Annualized Cost (TAC) = (CRC + TAO&M)	$9,110,014	
Control Device Loading Rate (F) tons/yr	617.6	To Meet 0.012
Control Device efficiency (G)	68.1%	
Pollutant Removed (H) = (F X G)	420.5	
COST EFFECTIVENESS (TAC / H): $/ton of pollutant removed	$21,666	

TABLE 6 - BAGHOUSE COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion - Unit 2 ESP Outlet	Polishing Baghouse	PM10

TOTAL CAPITAL COST FOR BAGHOUSE

DIRECT COSTS (capital investment)

(1) Purchased Equipment Costs:
    (a) Basic Equipment and Auxiliaries (A) $11,247,184
    (b) Instrumentation (0.10 A)   (Included in 1A)
    (c) Freight and Taxes (0.08 A) $899,775
Total Equipment Cost (B): $12,146,959

(2) Direct Installation Costs:

    (a) Foundations and Supports (0.04 B) $485,878
    (b) Erection and Handling (1.4 B) $17,005,742
    (c) Electrical (0.08 B) $971,757
    (d) Piping (0.01 B) $121,470
    (e) Heat Insulation (0.07 B) $850,287
    (f) Painting (0.04 B) $485,878
    (g) Demolition and Site Preparation (0.01 B) $121,470
Total Installation Cost (C) $20,042,482

Total Direct Costs of Capital Investment (DCCI) = (B + C) $32,189,441

INDIRECT COSTS (capital investment):

    (1) Engineering Costs (0.10 B) $1,214,696
    (2) Construction and Field Expenses (0.20 B) $2,429,392
    (3) Contractor Fees (0.10 B) $1,214,696
    (4) Startup (0.01 B) $121,470
    (5) Performance Test (0.01 B) $121,470
    (6) Contingencies (0.03 B) $364,409
Total Indirect Costs of Capital Investment (ICCI) $5,466,131

TOTAL CAPITAL INVESTMENT (TCI) = (DCCI + ICCI): $37,655,572

ANNUALIZED COST OF CAPITAL INVESTMENT (BAGS)
    (1) Interest Rate   10.0%
    (2) Control System Economic Life (years)   3.50
    (3) Total Price of Full Set of Bags (including taxes, freight and labor) (TCB) $1,598,000
    (3) Capital Recovery Factor (CRF)   0.353
    (4) Capital Recovery Cost (BCRC) = (CRF X TCB) $563,400

ADJUSTED CAPITAL INVESTMENT (ATCI) = (TCI) - (TCB) $36,057,572

ANNUALIZED COST OF CAPITAL INVESTMENT (ALL EQUIPMENT)
    (1) Interest Rate   10.0%
    (2) Control System Economic Life (years)   10
    (3) Capital Recovery Factor (CRF)   0.163
    (4) Capital Recovery Cost (CRC) = (CRF X ATCI) $5,868,200

TABLE 6 - BAGHOUSE COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Coal Combustion - Unit 1 ESP Outlet	Polishing Baghouse	PM10

TOTAL ANNUAL O&M COST FOR BAGHOUSE

DIRECT COSTS (O&M):
(1) Variable Costs
  (a) Utilities
    (a1) Electricity -   Cost: 0.0700 $/kW
        Rate: ######## kW/yr
                                  $1,545,300

  (b) Landfill Costs
    (b1) Dust   Mass: 288 ton/yr
(Cost: 28.50 $/ton (Estimate)
                                  $8,220

Total Direct Variable Costs (D) $1,553,520

  (2) Semivariable Costs
    (a) Labor   O = $26.00   M = $34.00

(a1) Operating (O) = (1 hrs/shift X 3 shifts/day X day/24hrs X 8,760 hrs/yr X $26/hr)	$28,470
(a2) Supervisory (0.15 O)	$4,300
(a3) Maintenance (M) = (1 hrs/shift X 3 shifts/day X day/24hrs X 8,760 hrs/yr X $34/hr)	$37,230
(b) Maintenance Materials (M)	$37,230
(c) Replacement Parts	
(c1) Initial cost of replacement parts (Cp) = (0.05 B)	$607,300
(c2) Cost of parts replacement labor (Cpl) = (0.01 B)	$121,500
(c3) Interest rate (i)	10%
(c4) Replacement parts Economic Life (n) (years)	5
(c5) Capital recovery factor of replacement parts (CRFp)	0.264
(c6) Capital Recovery Cost of replacement parts ([Cp+Cpl] X CRFp)	$192,300

Total Semivariable Costs (E) $299,530

Total Annual Direct Cost of O&M (DCO&M) = (D + E) $1,853,050

INDIRECT COSTS (O&M):

(1) Overhead (60% of Sum of Operating, Supervisory, & Maintenance Labor)	$42,000
(2) Property Tax (0.01 ATCI)	$360,600
(3) Insurance (0.01 ATCI)	$360,600
(4) Administration (0.02 ATCI)	$721,200

Total Annual Indirect Costs of O&M (ICO&M) $1,484,400

TOTAL ANNUAL COSTS of O&M (TAO&M) = (DCO&M + ICO&M): $3,337,450

COST EFFECTIVENESS OF BAGHOUSE

Capital Recovery Cost Of Bags (BCRC)	$563,400	
Capital Recovery Cost of Equipment (CRC)	$5,868,200	
Total Annual Costs of O&M (TAO&M)	$3,337,450	
Total Annualized Cost (TAC) = (CRC + TAO&M)	$9,769,050	
Control Device Loading Rate (F)	tons/yr	519.2	To Meet 0.012
Control Device efficiency (G)		55.6%
Pollutant Removed (H) = (F X G)		288.4
COST EFFECTIVENESS (TAC / H):	$/ton of pollutant removed	$33,871

TABLE 7 - BAGHOUSE COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Unit 1 ESP - Convert to PTFE Baghouse	Converted ESP Baghouse	PM10

TOTAL CAPITAL COST FOR BAGHOUSE

DIRECT COSTS (capital investment)

(1) Purchased Equipment Costs:	
(a) Basic Equipment and Auxiliaries (A)	$18,408,294
(b) Instrumentation (0.10 A)	(Included in 1A)
(c) Freight and Taxes (0.08 A)	$1,472,664
Total Equipment Cost (B):	$19,880,958
(2) Direct Installation Costs:	
(a) Foundations and Supports (0.04 B)	$795,238
(b) Erection and Handling (in A above)	$0
(c) Electrical (0.08 B)	$1,590,477
(d) Piping (0.01 B)	$198,810
(e) Heat Insulation (0.07 B)	$1,391,667
(f) Painting (0.04 B)	$795,238
(g) Demolition and Site Preparation (0.01 B)	$198,810
Total Installation Cost (C)	$4,970,239
Total Direct Costs of Capital Investment (DCCI) = (B + C)	$24,851,197

INDIRECT COSTS (capital investment):

(1) Engineering Costs (0.10 B)	$1,988,096
(2) Construction and Field Expenses (0.20 B)	$3,976,192
(3) Contractor Fees (0.10 B)	$1,988,096
(4) Startup (0.01 B)	$198,810
(5) Performance Test (0.01 B)	$198,810
(6) Contingencies (0.03 B)	$596,429
Total Indirect Costs of Capital Investment (ICCI)	$8,946,431
TOTAL CAPITAL INVESTMENT (TCI) = (DCCI + ICCI):	$33,797,628

ANNUALIZED COST OF CAPITAL INVESTMENT (BAGS)

(1) Interest Rate	10.0%
(2) Control System Economic Life (years)	4.00
(3) Total Price of Full Set of Bags (including taxes, freight and labor) (TCB)	$2,246,400
(3) Capital Recovery Factor (CRF)	0.315
(4) Capital Recovery Cost (BCRC) = (CRF X TCB)	$708,700
ADJUSTED CAPITAL INVESTMENT (ATCI) = (TCI) - (TCB)	$31,551,228

ANNUALIZED COST OF CAPITAL INVESTMENT (ALL EQUIPMENT)

(1) Interest Rate	10.0%
(2) Control System Economic Life (years)	10
(3) Capital Recovery Factor (CRF)	0.163
(4) Capital Recovery Cost (CRC) = (CRF X ATCI)	$5,134,800

TABLE 7 - BAGHOUSE COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Unit 1 ESP - Convert to PTFE Baghouse	Converted ESP Baghouse	PM10

TOTAL ANNUAL O&M COST FOR BAGHOUSE

DIRECT COSTS (O&M):
  (1) Variable Costs
    (a) Utilities

(a1) Electricity -	Cost:	0.0700	$/kW		
	Rate:	########	kW/yr		$1,363,800

    (b) Landfill Costs

(b1) Dust	Mass:	519	ton/yr		
	Cost:	28.50	$/ton	(Estimate)	$14,792

Total Direct Variable Costs (D) $1,378,592

  (2) Semivariable Costs
    (a) Labor   O = $26.00   M = $34.00

(a1) Operating (O) = (1 hrs/shift X 3 shifts/day X day/24hrs X 8,760 hrs/yr X $26/hr)	$28,470
(a2) Supervisory (0.15 O)	$4,300
(a3) Maintenance (M) = (1 hrs/shift X 3 shifts/day X day/24hrs X 8,760 hrs/yr X $34/hr)	$37,230
(b) Maintenance Materials (M)	$37,230
(c) Replacement Parts	
(c1) Initial cost of replacement parts (Cp) = (0.05 B)	$994,000
(c2) Cost of parts replacement labor (Cpl) = (0.01 B)	$198,800
(c3) Interest rate (i)	10%
(c4) Replacement parts Economic Life (n) (years)	5
(c5) Capital recovery factor of replacement parts (CRFp)	0.264
(c6) Capital Recovery Cost of replacement parts ([Cp+Cpl] X CRFp)	$314,700
Total Semivariable Costs (E)	$421,930

Total Annual Direct Cost of O&M (DCO&M) = (D + E) $1,800,522

INDIRECT COSTS (O&M):

(1) Overhead (60% of Sum of Operating, Supervisory, & Maintenance Labor)	$42,000
(2) Property Tax (0.01 ATCI)	$315,500
(3) Insurance (0.01 ATCI)	$315,500
(4) Administration (0.02 ATCI)	$631,000
Total Annual Indirect Costs of O&M (ICO&M)	$1,304,000

TOTAL ANNUAL COSTS of O&M (TAO&M) = (DCO&M + ICO&M): $3,104,522

COST EFFECTIVENESS OF BAGHOUSE

Capital Recovery Cost Of Bags (BCRC)		$708,700	
Capital Recovery Cost of Equipment (CRC)		$5,134,800	
Total Annual Costs of O&M (TAO&M)		$3,104,522	
Total Annualized Cost (TAC) = (CRC + TAO&M)		$8,948,022	
Control Device Loading Rate (F)	tons/yr	617.6	To Meet 0.006
Control Device efficiency (G)		84.0%	
Pollutant Removed (H) = (F X G)		519.0	
COST EFFECTIVENESS (TAC / H):	$/ton of pollutant removed	$17,240	

TABLE 8 - BAGHOUSE COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Unit #1 ESP - Convert to Baghouse	Converted ESP Baghouse	PM10

TOTAL CAPITAL COST FOR BAGHOUSE

DIRECT COSTS (capital investment)

(1) Purchased Equipment Costs:
    (a) Basic Equipment and Auxiliaries (A) $20,685,168
    (b) Instrumentation (0.10 A)   (Included in 1A)
    (c) Freight and Taxes (0.08 A) $1,654,813
Total Equipment Cost (B): $22,339,981

(2) Direct Installation Costs:

    (a) Foundations and Supports (0.04 B) $893,599
    (b) Erection and Handling (in A above) $0
    (c) Electrical (0.08 B) $1,787,198
    (d) Piping (0.01 B) $223,400
    (e) Heat Insulation (0.07 B) $1,563,799
    (f) Painting (0.04 B) $893,599
    (g) Demolition and Site Preparation (0.01 B) $223,400
Total Installation Cost (C) $5,584,995

Total Direct Costs of Capital Investment (DCCI) = (B + C) $27,924,976

INDIRECT COSTS (capital investment):

    (1) Engineering Costs (0.10 B) $2,233,998
    (2) Construction and Field Expenses (0.20 B) $4,467,996
    (3) Contractor Fees (0.10 B) $2,233,998
    (4) Startup (0.01 B) $223,400
    (5) Performance Test (0.01 B) $223,400
    (6) Contingencies (0.03 B) $670,199
Total Indirect Costs of Capital Investment (ICCI) $10,052,991

TOTAL CAPITAL INVESTMENT (TCI) = (DCCI + ICCI): $37,977,968

ANNUALIZED COST OF CAPITAL INVESTMENT (BAGS)
    (1) Interest Rate   10.0%
    (2) Control System Economic Life (years)   4.00
    (3) Total Price of Full Set of Bags (including taxes, freight and labor) (TCB) $2,545,920
    (3) Capital Recovery Factor (CRF)   0.315
    (4) Capital Recovery Cost (BCRC) = (CRF X TCB) $803,200

ADJUSTED CAPITAL INVESTMENT (ATCI) = (TCI) - (TCB) $35,432,048

ANNUALIZED COST OF CAPITAL INVESTMENT (ALL EQUIPMENT)
    (1) Interest Rate   10.0%
    (2) Control System Economic Life (years)   10
    (3) Capital Recovery Factor (CRF)   0.163
    (4) Capital Recovery Cost (CRC) = (CRF X ATCI) $5,766,400

TABLE 8 - BAGHOUSE COST DATA
CONTROL EQUIPMENT ANALYSIS
Progress Energy, Crystal River, Florida

Source	Control Device	Pollutant
Unit #1 ESP - Convert to Baghouse	Converted ESP Baghouse	PM10

TOTAL ANNUAL O&M COST FOR BAGHOUSE

DIRECT COSTS (O&M):
  (1) Variable Costs
    (a) Utilities

(a1) Electricity -	Cost:	0.0700	$/kW	
	Rate:	########	kW/yr	
				$1,545,300

    (b) Landfill Costs

(b1) Dust	Mass:	404	ton/yr	
	Cost:	28.50	$/ton	(Estimate)
				$11,508

Total Direct Variable Costs (D) $1,556,808

  (2) Semivariable Costs
    (a) Labor   O = $26.00   M = $34.00

(a1) Operating (O) = (1 hrs/shift X 3 shifts/day X day/24hrs X 8,760 hrs/yr X $26/hr)	$28,470
(a2) Supervisory (0.15 O)	$4,300
(a3) Maintenance (M) = (1 hrs/shift X 3 shifts/day X day/24hrs X 8,760 hrs/yr X $34/hr)	$37,230
(b) Maintenance Materials (M)	$37,230
(c) Replacement Parts	
(c1) Initial cost of replacement parts (Cp) = (0.05 B)	$1,117,000
(c2) Cost of parts replacement labor (Cpl) = (0.01 B)	$223,400
(c3) Interest rate (i)	10%
(c4) Replacement parts Economic Life (n) (years)	5
(c5) Capital recovery factor of replacement parts (CRFp)	0.264
(c6) Capital Recovery Cost of replacement parts ([Cp+Cpl] X CRFp)	$353,600
Total Semivariable Costs (E)	$460,830

Total Annual Direct Cost of O&M (DCO&M) = (D + E) $2,017,638

INDIRECT COSTS (O&M):

(1) Overhead (60% of Sum of Operating, Supervisory, & Maintenance Labor)	$42,000
(2) Property Tax (0.01 ATCI)	$354,300
(3) Insurance (0.01 ATCI)	$354,300
(4) Administration (0.02 ATCI)	$708,600
Total Annual Indirect Costs of O&M (ICO&M)	$1,459,200

TOTAL ANNUAL COSTS of O&M (TAO&M) = (DCO&M + ICO&M): $3,476,838

COST EFFECTIVENESS OF BAGHOUSE

Capital Recovery Cost Of Bags (BCRC)		$803,200	
Capital Recovery Cost of Equipment (CRC)		$5,766,400	
Total Annual Costs of O&M (TAO&M)		$3,476,838	
Total Annualized Cost (TAC) = (CRC + TAO&M)		$10,046,438	
Control Device Loading Rate (F)	tons/yr	519.2	To Meet 0.006
Control Device efficiency (G)		77.8%	
Pollutant Removed (H) = (F X G)		403.8	
COST EFFECTIVENESS (TAC / H):	$/ton of pollutant removed	$24,880	

ATTACHMENT 5

PM Speciation Profiles and Modeled Impacts for Control Options

Attachment 5. Control Option Summary Table

Control Option	Modeled dV Level	Units 1 and 2 Total Annualized Cost ($)	$/dV Reduced
Baseline	0.71	N/A	N/A
0.015 lb/MMBtu ESP Upgrades	0.61	4,696,661	46,966,610
0.012 lb/MMBtu Polishing Baghouse	0.60	18,879,064	171,627,855
0.010 lb/MMBtu ESP Replacement	0.58	26,380,791	202,929,162
0.006 lb/MMBtu Baghouse Conversion	0.56	18,994,460	126,629,733

TABLE BASELINE
SUMMARY OF BART EXEMPTION MODELING RESULTS - BASELINE - PROGRESS ENERGY CRYSTAL RIVER POWER PLANT
NEW IMPROVE ALGORITHM

Class I Area	Distance (km) of Source to Nearest Class I Area Boundary	Number of Days and Receptors with 8th Highest Impact >0.5 dv									22nd Highest Impact (dv) Over 3-Yr Period
		2001			2002			2003			
		No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	
Saint Marks NWA	174	0	NA	0.07	0	NA	0.07	0	NA	0.09	0.08
Chassahowitzka NWA	21	3	NA	0.55	6	NA	0.63	7	NA	0.71	0.68
Wolf Island NWA	293	0	NA	0.02	0	NA	0.02	0	NA	0.02	0.02
Okefenokee NWA	178	0	NA	0.05	0	NA	0.05	0	NA	0.04	0.05

Table 5-2 Revised- Crystal River Units 1 and 2 - PM/PM10 BACT-Level Controlled Emissions

Unit 1 Permit Limitations:	Sootblowing Mode:	0.3 lb/Mbtu
	Non-Sootblowing:	0.1 lb/Mbtu
	Heat Input:	3750 MMBtu/hr
Unit 2 Permit Limitations:	Sootblowing Mode:	0.3 lb/Mbtu
	Non-Sootblowing:	0.1 lb/Mbtu
	Heat Input:	4795 MMBtu/hr

	Sootblowing (lb/Mbtu)	Heat Input (MMBtu/hr)	Non-Sootblowing (lb/Mbtu)	Heat Input (MMBtu/hr)	Actual PM Emissions (lb/hr)
Unit 1 Control Technology	0.052	3630	0.037	3621	140.82
Unit 2 Control Technology	0.021	4384	0.027	4390	115.22

Baseline Highest Actual Emissions

SAM Emissions Calculation Spreadsheet

	"Current Coal" CR 1	"Current Coal" CR 2
H2SO4		
Coal Heating Value	12,370 BTU/lb	12,370 BTU/lb
Heat Input	3,750 mmBTU/hr	4,795 mmBTU/hr
Tons Coal Combusted	151.6 t/h	193.8 t/h
Coal Sulfur	1.03 %	1.03 %
Boiler - %S in coal to H2SO4	0.8 %	0.8 %
SO2 to SO3 conversion in SCR (.25%/layer)	0 %	0 %
H2SO4 Control efficiency	0 %	0 %
H2SO4 removal in airheater	51 %	51 %
H2SO4 removal in precipitator	51 %	51 %
H2SO4 removal in FGD	0 %	0 %
Conversion - 98 lbs H2SO4 / 80 lbs SO3	1.225	1.225
Conversion - 80 lbs SO3 / 64 lbs SO2	1.25	1.25
Conversion - 80 lbs SO3 / 32 lbs S	2.5	2.5
Conversion - 2 lbs SO2 / 1 lbs S	2	2
Conversion - 64 lbs SO2 / 80 lbs SO3	0.8	0.8
Sulfur in the coal		
Sulfur that will form SO3	25 lb/hr	32 lb/hr
Sulfur that will form SO2	3,097 lb/hr	3,961 lb/hr
At Boiler Exit		
SO3	62 lb/hr	80 lb/hr
SO2	6,195 lb/hr	7,921 lb/hr
At SCR Exit		
SO3 - generated in SCR	0 lb/hr	0 lb/hr
SO3 - generated from combustion	62 lb/hr	80 lb/hr
SO3 - total	62 lb/hr	80 lb/hr
SO2	6,195 lb/hr	7,921 lb/hr
H2SO4 (assumes all SO3 > H2SO4)	77 lb/hr	98 lb/hr
At H2SO4 Control Exit (assumes control after SCR)		
H2SO4 (assumes all SO3 > H2SO4)	77 lb/hr	98 lb/hr
At Airheater Exit		
H2SO4 (assumes all SO3 > H2SO4)	37 lb/hr	48 lb/hr
At Precipitator Exit		
H2SO4 (assumes all SO3 > H2SO4)	18.4 lb/hr	23.5 lb/hr
At FGD Exit (Stack)		
H2SO4 (assumes all SO3 > H2SO4)	18.4 lb/hr	23.5 lb/hr
Emissions Rate	0.00490 lb/mmBtu	0.00490 lb/mmBtu

TABLE 5-3 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 1

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H_2SO_4)	Organic
PM Filterable [b]	Unit 1	lb/hr	140.8	78.23	60.27	2.32	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	23.00	NA	NA	NA	18.40	4.60
		%	100%	NA	NA	NA	80%	20%
Total PM_{10} (filterable+condensable)	Unit 1	lb/hr	163.8	78.23	60.27	2.32	18.40	4.60
		%	100%	47.8%	36.8%	1.4%	11.2%	2.8%
Total PM_{10} (filterable+Organic Condensable PM)	Unit 1	lb/hr	145.4	78.23	60.27	2.32	0.0	4.60
Modeled PM Speciation % (SO_4 modeled separately)		%	100%	53.8%	41.4%	1.6%	0.0%	3.2%

PM Particle Size Distribution for CALPUFF Assessment

Species	AP-42 (Table 1.3-4) Particle Size (microns)	Cumulative (%)	Cumulative Normalized PM10 (%)	Individual Categories Filterable (%)	Individual Categories Organic Condensable	Filterable	Organic Condensable	Total
Name								
Total PM_{10}						140.8	4.6	145.4
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	46.9	2.3	49.2
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.3	2.3
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	18.7	0.0	18.7
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	75.2	0.0	75.2
Totals				100.0%	100.0%	140.8	4.6	145.4

Total Modeled PM_{10} 145.4

[a] Heat input rate for unit and fuel heat content   3,750 MMBtu/hr   3,750 Unit 1
     1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon
PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)   lb/1000 gal
emission factor (Table 1.1-5, AP-42)   PM2.5   0.24 lb/ton   Ratio =   0.44 PM2.5/PM10
    PM10   0.54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
    0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil = PM2.5 - PM elemental carbon   0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse = PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)   Inorganic   0.80 of Total
    Organic   0.20 of Total

TABLE 5-4 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 2

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H_2SO_4)	Organic
PM Filterable [b]	Unit 1	lb/hr	115.2	64.01	49.31	1.89	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	29.38	NA	NA	NA	23.50	5.88
		%	100%	NA	NA	NA	80%	20%
Total PM$_{10}$ (filterable+condensable)	Unit 1	lb/hr	144.6	64.01	49.31	1.89	23.50	5.88
		%	100%	44.3%	34.1%	1.3%	16.3%	4.1%
Total PM$_{10}$ (filterable+Organic Condensable PM) Modeled PM Speciation % (SO$_4$ modeled separately)	Unit 1	lb/hr	121.1	64.01	49.31	1.89	0.0	5.88
		%	100%	52.9%	40.7%	1.6%	0.0%	4.9%

PM Particle Size Distribution for CALPUFF Assessment

Species	AP-42 (Table 1.3-4) Particle Size (microns)	Cumulative (%)	Cumulative Normalized PM10 (%)	Individual Categories Filterable (%)	Individual Categories Organic Condensable	Emission Rate (lb/hr) Filterable	Emission Rate (lb/hr) Organic Condensable	Total
Total PM$_{10}$						115.2	5.9	121.1
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	38.3	2.9	41.3
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.9	2.9
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	15.3	0.0	15.3
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	61.5	0.0	61.5
Totals				100.0%	100.0%	115.2	5.9	121.1
						Total Modeled PM$_{10}$		121.1

[a] Heat input rate for unit and fuel heat content

	4,795 MMBtu/hr	4,795 Unit 1
	1.03 sulfur content (%)	

[b] PM fine consists of PM soil and PM elemental carbon
PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)
emission factor (Table 1.1-5, AP-42)

	lb/1000 gal			
PM2.5	0.24 lb/ton		Ratio =	0.44 PM2.5/PM10
PM10	0.54 lb/ton			

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil= PM2.5 - PM elemental carbon   0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)

	Inorganic	0.80 of Total
	Organic	0.20 of Total

OPTION 1

ESP Upgrades – 0.015 lb/MMBtu

TABLE OPTION 1 (0.015PM)
SUMMARY OF BART EXEMPTION MODELING RESULTS - BASELINE W/PM 0.015 LB/MMBTU - PROGRESS ENERGY CRYSTAL RIVER POWER PLANT
NEW IMPROVE ALGORITHM

Class I Area	Distance (km) of Source to Nearest Class I Area Boundary	Number of Days and Receptors with 8th Highest Impact >0.5 dv									22nd Highest Impact (dv) Over 3-Yr Period
		2001			2002			2003			
		No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	
Chassahowitzka NWA	21	1	NA	0.47	6	NA	0.54	5	NA	0.61	0.59

Table 5-2 Revised - Crystal River Units 1 and 2 - PM/PM10 BACT-Level Controlled Emissions

Unit 1 Permit Limitations:	Sootblowing Mode:	0.3 lb/Mbtu
	Non-Sootblowing:	0.1 lb/Mbtu
	Heat Input:	3750 MMBtu/hr
Unit 2 Permit Limitations:	Sootblowing Mode:	0.3 lb/Mbtu
	Non-Sootblowing:	0.1 lb/Mbtu
	Heat Input:	4795 MMBtu/hr

	Sootblowing (lb/Mbtu)	Heat Input (MMBtu/hr)	Non-Sootblowing (lb/Mbtu)	Heat Input (MMBtu/hr)	Actual PM Emissions (lb/hr)
Unit 1 Control Technology	0.015	3750	0.015	3750	56.25
Unit 2 Control Technology	0.015	4795	0.015	4795	71.93

Control Level of 0.015 MMBtu/hr.

TABLE 5-3 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 1

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H_2SO_4)	Organic
PM Filterable [b]	Unit 1	lb/hr	56.3	31.25	24.08	0.93	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	23.00	NA	NA	NA	18.40	4.60
		%	100%	NA	NA	NA	80%	20%
Total PM_{10} (filterable+condensable)	Unit 1	lb/hr	79.3	31.25	24.08	0.93	18.40	4.60
		%	100%	39.4%	30.4%	1.2%	23.2%	5.8%
Total PM_{10} (filterable+Organic Condensable PM)	Unit 1	lb/hr	60.9	31.25	24.08	0.93	0.0	4.60
Modeled PM Speciation % (SO_4 modeled separately)		%	100%	51.4%	39.6%	1.5%	0.0%	7.6%

PM Particle Size Distribution for CALPUFF Assessment

Species Name	Size Distribution by Category (%)					Emission Rate (lb/hr)		
	AP-42 (Table 1.3-4)		Cumulative Normalized PM10 (%)	Individual Categories		Filterable	Organic Condensable	Total
	Particle Size (microns)	Cumulative (%)		Filterable (%)	Organic Condensable			
Total PM_{10}						56.3	4.6	60.9
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	18.7	2.3	21.0
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.3	2.3
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	7.5	0.0	7.5
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	30.0	0.0	30.0
Totals				100.0%	100.0%	56.3	4.6	60.9

Total Modeled PM_{10} | 60.9

[a] Heat input rate for unit and fuel heat content   3,750 MMBtu/hr   3,750 Unit 1
       1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon
   PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)   lb/1000 gal
   emission factor (Table 1.1-5, AP-42)   PM2.5   0.24 lb/ton   Ratio =   0.44 PM2.5/PM10
                        PM10   0.54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
      0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil= PM2.5 - PM elemental carbon   0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)   Inorganic   0.80 of Total
                               Organic   0.20 of Total

TABLE 5-4 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 2

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H₂SO₄)	Organic
PM Filterable [b]	Unit 1	lb/hr	71.9	39.96	30.79	1.18	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	29 38	NA	NA	NA	23.50	5.88
		%	100%	NA	NA	NA	80%	20%
Total PM₁₀ (filterable+condensable)	Unit 1	lb/hr	101.3	39.96	30.79	1.18	23.50	5.88
		%	100%	39.4%	30 4%	1 2%	23.2%	5.8%
Total PM₁₀ (filterable+Organic Condensable PM) Modeled PM Speciation % (SO₄ modeled separately)	Unit 1	lb/hr	77.8	39.96	30.79	1.18	0.0	5.88
		%	100%	51.4%	39.6%	1.5%	0 0%	7.6%

PM Particle Size Distribution for CALPUFF Assessment

Species Name	AP-42 (Table 1 3-4) Particle Size (microns)	Cumulative (%)	Cumulative Normalized PM10 (%)	Individual Categories Filterable (%)	Organic Condensable	Filterable	Organic Condensable	Total
		Size Distribution by Category (%)				Emission Rate (lb/hr)		
Total PM₁₀						71.9	5.9	77.8
PM0063	0 63	18 5%	33.3%	33 3%	50 0%	23.9	2.9	26.9
PM0100	1	0 0%	0 0%	0.0%	50 0%	0.0	2.9	2.9
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0 0	0.0
PM0250	2.5	25 9%	46 6%	13 3%	0	9 6	0 0	9 6
PM0600	6	0 0%	0 0%	0 0%	0	0.0	0 0	0 0
PM1000	10	55.6%	100.0%	53 4%	0	38.4	0.0	38 4
Totals				100 0%	100 0%	71.9	5.9	77 8

Total Modeled PM₁₀ 77.8

[a] Heat input rate for unit and fuel heat content   4,795 MMBtu/hr   4,795 Unit 1

          1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon   lb/1000 gal

PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)   PM2.5   0.24 lb/ton   Ratio =   0.44 PM2.5/PM10

emission factor (Table 1 1-5, AP-42)   PM10   0 54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT

        0 037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10

PM soil= PM2.5 - PM elemental carbon   0.43 PM soil/PM10

PM2.5   0 44 PM2 5/PM10

PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)   Inorganic   0.80 of Total

                  Organic   0 20 of Total

OPTION 2

Polishing Baghouse – 0.012 lb/MMBtu

TABLE OPTION 2 (0.012PM)
SUMMARY OF BART EXEMPTION MODELING RESULTS - BASELINE W/PM 0.012 LB/MMBTU - PROGRESS ENERGY CRYSTAL RIVER POWER PLANT
NEW IMPROVE ALGORITHM

Class I Area	Distance (km) of Source to Nearest Class I Area Boundary	Number of Days and Receptors with 8th Highest Impact >0.5 dv									22nd Highest Impact (dv) Over 3-Yr Period
		2001			2002			2003			
		No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	
Chassahowitzka NWA	21	7	NA	0.45	8	NA	0.53	10	NA	0.60	0.57

Table 5-2 Revised- Crystal River Units 1 and 2 - PM/PM10 BACT-Level Controlled Emissions

Unit 1 Permit Limitations:	Sootblowing Mode:	0.3 lb/Mbtu
	Non-Sootblowing:	0.1 lb/Mbtu
	Heat Input:	3750 MMBtu/hr
Unit 2 Permit Limitations:	Sootblowing Mode:	0.3 lb/Mbtu
	Non-Sootblowing:	0.1 lb/Mbtu
	Heat Input:	4795 MMBtu/hr

	Sootblowing (lb/Mbtu)	Heat Input (MMBtu/hr)	Non-Sootblowing (lb/Mbtu)	Heat Input (MMBtu/hr)	Actual PM Emissions (lb/hr)
Unit 1 Control Technology	0.012	3750	0.012	3750	45.00
Unit 2 Control Technology	0.012	4795	0.012	4795	57.54

Control Level of 0.012 MMBtu/hr.

Golder Associates

TABLE 5-3 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 1

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H_2SO_4)	Organic
PM Filterable [b]	Unit 1	lb/hr	45.0	25.00	19.26	0.74	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	23.00	NA	NA	NA	18.40	4.60
		%	100%	NA	NA	NA	80%	20%
Total PM_{10} (filterable+condensable)	Unit 1	lb/hr	68.0	25.00	19.26	0.74	18.40	4.60
		%	100%	36.8%	28.3%	1.1%	27.1%	6.8%
Total PM_{10} (filterable+Organic Condensable PM) Modeled PM Speciation % (SO_4 modeled separately)	Unit 1	lb/hr	49.6	25.00	19.26	0.74	0.0	4.60
		%	100%	50.4%	38.8%	1.5%	0.0%	9.3%

PM Particle Size Distribution for CALPUFF Assessment

Species	Size Distribution by Category (%)					Emission Rate (lb/hr)		
	AP-42 (Table 1.3-4)		Cumulative	Individual Categories				
Name	Particle Size (microns)	Cumulative (%)	Normalized PM10 (%)	Filterable (%)	Organic Condensable	Filterable	Organic Condensable	Total
Total PM_{10}						45.0	4.6	49.6
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	15.0	2.3	17.3
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.3	2.3
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	6.0	0.0	6.0
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	24.0	0.0	24.0
Totals				100.0%	100.0%	45.0	4.6	49.6

Total Modeled PM_{10} 49.6

[a] Heat input rate for unit and fuel heat content 3,750 MMBtu/hr 3,750 Unit 1
1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon
PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)
emission factor (Table 1.1-5, AP-42)

lb/1000 gal
PM2.5 0.24 lb/ton   Ratio =   0.44 PM2.5/PM10
PM10   0.54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil= PM2.5 - PM elemental carbon 0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)   Inorganic   0.80 of Total
                                          Organic   0.20 of Total

TABLE 5-4 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 2

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H_2SO_4)	Organic
PM Filterable [b]	Unit 1	lb/hr	57.5	31.97	24.63	0.95	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	29.38	NA	NA	NA	23.50	5.88
		%	100%	NA	NA	NA	80%	20%
Total PM_{10} (filterable+condensable)	Unit 1	lb/hr	86.9	31.97	24.63	0.95	23.50	5.88
		%	100%	36.8%	28.3%	1.1%	27.0%	6.8%
Total PM_{10} (filterable+Organic Condensable PM) Modeled PM Speciation % (SO_4 modeled separately)	Unit 1	lb/hr	63.4	31.97	24.63	0.95	0.0	5.88
		%	100%	50.4%	38.8%	1.5%	0.0%	9.3%

PM Particle Size Distribution for CALPUFF Assessment

Species Name	AP-42 (Table 1.3-4) Particle Size (microns)	Cumulative (%)	Cumulative Normalized PM10 (%)	Filterable (%)	Organic Condensable	Filterable	Organic Condensable	Total
Total PM_{10}						57.5	5.9	63.4
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	19.1	2.9	22.1
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.9	2.9
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	7.7	0.0	7.7
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	30.7	0.0	30.7
Totals				100.0%	100.0%	57.5	5.9	63.4

Total Modeled PM_{10} 63.4

[a] Heat input rate for unit and fuel heat content   4,795 MMBtu/hr   4,795 Unit 1
1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon   lb/1000 gal
PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)   PM2.5   0.24 lb/ton   Ratio =   0.44 PM2.5/PM10
emission factor (Table 1.1-5, AP-42)   PM10   0.54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil= PM2.5 - PM elemental carbon   0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)   Inorganic   0.80 of Total
Organic   0.20 of Total

OPTION 3

ESP Replacement – 0.010 lb/MMBtu

TABLE OPTION 3 (0.010PM)
SUMMARY OF BART EXEMPTION MODELING RESULTS - W/PM 0.010 LB/MMBTU - PROGRESS ENERGY CRYSTAL RIVER POWER PLANT
NEW IMPROVE ALGORITHM

Class I Area	Distance (km) of Source to Nearest Class I Area Boundary	Number of Days and Receptors with 8th Highest Impact >0.5 dv									22nd Highest Impact (dv) Over 3-Yr Period
		2001			2002			2003			
		No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	
Chassahowitzka NWA	21	11	NA	0.44	15	NA	0.51	13	NA	0.58	0.56

TABLE 5-3 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 1

PM Category	Emission Unit[a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H_2SO_4)	Organic
PM Filterable[b]	Unit 1	lb/hr	37.5	20.83	16.05	0.62	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable[c]	Unit 1	lb/hr	23.00	NA	NA	NA	18.40	4.60
		%	100%	NA	NA	NA	80%	20%
Total PM_{10} (filterable+condensable)	Unit 1	lb/hr	60.5	20.83	16.05	0.62	18.40	4.60
		%	100%	34.4%	26.5%	1.0%	30.4%	7.6%
Total PM_{10} (filterable+Organic Condensable PM)	Unit 1	lb/hr	42.1	20.83	16.05	0.62	0.0	4.60
Modeled PM Speciation % (SO_4 modeled separately)		%	100%	49.5%	38.1%	1.5%	0.0%	10.9%

PM Particle Size Distribution for CALPUFF Assessment

Species		Size Distribution by Category (%)				Emission Rate (lb/hr)		
	AP-42 (Table 1.3-4)		Cumulative	Individual Categories				
Name	Particle Size (microns)	Cumulative (%)	Normalized PM10 (%)	Filterable (%)	Organic Condensable	Filterable	Organic Condensable	Total
Total PM_{10}						37.5	4.6	42.1
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	12.5	2.3	14.8
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.3	2.3
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	5.0	0.0	5.0
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	20.0	0.0	20.0
Totals				100.0%	100.0%	37.5	4.6	42.1

Total Modeled PM_{10} | 42.1

[a] Heat input rate for unit and fuel heat content
3,750 MMBtu/hr   3,750 Unit 1
1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon
PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)
emission factor (Table 1.1-5, AP-42)

lb/1000 gal
PM2.5   0.24 lb/ton   Ratio =   0.44 PM2.5/PM10
PM10   0.54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil= PM2.5 - PM elemental carbon   0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)
Inorganic   0.80 of Total
Organic   0.20 of Total

TABLE 5-4 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 2

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H₂SO₄)	Organic
PM Filterable [b]	Unit 1	lb/hr	48.0	26.64	20.52	0.79	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	29.38	NA	NA	NA	23.50	5.88
		%	100%	NA	NA	NA	80%	20%
Total PM₁₀ (filterable+condensable)	Unit 1	lb/hr	77.3	26.64	20.52	0.79	23.50	5.88
		%	100%	34.5%	26.5%	1.0%	30.4%	7.6%
Total PM₁₀ (filterable+Organic Condensable PM) Modeled PM Speciation % (SO₄ modeled separately)	Unit 1	lb/hr	53.8	26.64	20.52	0.79	0.0	5.88
		%	100%	49.5%	38.1%	1.5%	0.0%	10.9%

PM Particle Size Distribution for CALPUFF Assessment

Species Name	AP-42 (Table 1.3-4) Particle Size (microns)	Cumulative (%)	Cumulative Normalized PM10 (%)	Individual Categories Filterable (%)	Individual Categories Organic Condensable	Filterable	Organic Condensable	Total
Total PM₁₀						48.0	5.9	53.8
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	16.0	2.9	18.9
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.9	2.9
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	6.4	0.0	6.4
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	25.6	0.0	25.6
Totals				100.0%	100.0%	48.0	5.9	53.8

Total Modeled PM₁₀ | 53.8

[a] Heat input rate for unit and fuel heat content   4,795 MMBtu/hr   4,795 Unit 1
1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon
PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)   lb/1000 gal
emission factor (Table 1.1-5, AP-42)   PM2.5   0.24 lb/ton   Ratio =   0.44 PM2.5/PM10
PM10   0.54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil= PM2.5 - PM elemental carbon   0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)   Inorganic   0.80 of Total
Organic   0.20 of Total

OPTION 4

Baghouse Conversion – 0.006 lb/MMBtu

Table 5-2 Revised - Crystal River Units 1 and 2 - PM/PM10 BACT-Level Controlled Emissions

Unit 1 Permit Limitations:	Sootblowing Mode:	0.3 lb/Mbtu
	Non-Sootblowing:	0.1 lb/Mbtu
	Heat Input:	3750 MMBtu/hr
Unit 2 Permit Limitations:	Sootblowing Mode:	0.3 lb/Mbtu
	Non-Sootblowing:	0.1 lb/Mbtu
	Heat Input:	4795 MMBtu/hr

	Sootblowing (lb/Mbtu)	Heat Input (MMBtu/hr)	Non-Sootblowing (lb/Mbtu)	Heat Input (MMBtu/hr)	Actual PM Emissions (lb/hr)
Unit 1					
Control Technology	0.006	3750	0.006	3750	24.00
Unit 2					
Control Technology	0.006	4795	0.006	4795	30.69

Control Level of 0.006 MMBtu/hr.

Golder Associates

TABLE 5-3 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 1

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H_2SO_4)	Organic
PM Filterable [b]	Unit 1	lb/hr	24.0	13.33	10.27	0.39	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	23.00	NA	NA	NA	18.40	4.60
		%	100%	NA	NA	NA	80%	20%
Total PM_{10} (filterable+condensable)	Unit 1	lb/hr	47.0	13.33	10.27	0.39	18.40	4.60
		%	100%	28.4%	21.9%	0.8%	39.1%	9.8%
Total PM_{10} (filterable+Organic Condensable PM)	Unit 1	lb/hr	28.6	13.33	10.27	0.39	0.0	4.60
Modeled PM Speciation % (SO_4 modeled separately)		%	100%	46.6%	35.9%	1.4%	0.0%	16.1%

PM Particle Size Distribution for CALPUFF Assessment

Species Name	Size Distribution by Category (%)					Emission Rate (lb/hr)		
	AP-42 (Table 1.3-4) Particle Size (microns)	Cumulative (%)	Cumulative Normalized PM10 (%)	Individual Categories Filterable (%)	Individual Categories Organic Condensable	Filterable	Organic Condensable	Total
Total PM_{10}						24.0	4.6	28.6
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	8.0	2.3	10.3
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.3	2.3
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	3.2	0.0	3.2
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	12.8	0.0	12.8
Totals				100.0%	100.0%	24.0	4.6	28.6

Total Modeled PM_{10} 28.6

[a] Heat input rate for unit and fuel heat content   3,750 MMBtu/hr   3,750 Unit 1
                                              1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon
PM fine based on ratio of PM2.5 (fine) to PM10 (filterable)   lb/1000 gal
emission factor (Table 1.1-5, AP-42)   PM2.5   0.24 lb/ton   Ratio =   0.44 PM2.5/PM10
                                           PM10   0.54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
                                     0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil= PM2.5 - PM elemental carbon   0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42)   Inorganic   0.80 of Total
                                      Organic   0.20 of Total

TABLE 5-4 Revised
PM SPECIATION SUMMARY - CRYSTAL RIVER Unit 2

PM Category	Emission Unit [a]	Units	Total	Coarse PM	Soil (Fine PM)	Elemental Carbon (EC)	Inorganic (as H_2SO_4)	Organic
PM Filterable [b]	Unit 1	lb/hr	30.7	17.05	13.14	0.50	NA	NA
		%	100%	56%	43%	1.6%	NA	NA
PM Condensable [c]	Unit 1	lb/hr	29.38	NA	NA	NA	23.50	5.88
		%	100%	NA	NA	NA	80%	20%
Total PM_{10} (filterable+condensable)	Unit 1	lb/hr	60.1	17.05	13.14	0.50	23.50	5.88
		%	100%	28.4%	21.9%	0.8%	39.1%	9.8%
Total PM_{10} (filterable+Organic Condensable PM)	Unit 1	lb/hr	36.6	17.05	13.14	0.50	0.0	5.88
Modeled PM Speciation % (SO_4 modeled separately)		%	100%	46.6%	35.9%	1.4%	0.0%	16.1%

PM Particle Size Distribution for CALPUFF Assessment

Species		Size Distribution by Category (%)				Emission Rate (lb/hr)		
	AP-42 (Table 1.3-4)		Cumulative	Individual Categories				
Name	Particle Size (microns)	Cumulative (%)	Normalized PM10 (%)	Filterable (%)	Organic Condensable	Filterable	Organic Condensable	Total
Total PM_{10}						30.7	5.9	36.6
PM0063	0.63	18.5%	33.3%	33.3%	50.0%	10.2	2.9	13.1
PM0100	1	0.0%	0.0%	0.0%	50.0%	0.0	2.9	2.9
PM0125	1.25	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM0250	2.5	25.9%	46.6%	13.3%	0	4.1	0.0	4.1
PM0600	6	0.0%	0.0%	0.0%	0	0.0	0.0	0.0
PM1000	10	55.6%	100.0%	53.4%	0	16.4	0.0	16.4
Totals				100.0%	100.0%	30.7	5.9	36.6

Total Modeled PM_{10} 36.6

[a] Heat input rate for unit and fuel heat content   4,795 MMBtu/hr   4,795 Unit 1
  1.03 sulfur content (%)

[b] PM fine consists of PM soil and PM elemental carbon **lb/1000 gal**
 PM fine based on ratio of PM2.5 (fine) to PM10 (filterable) PM2.5 0.24 lb/ton Ratio = 0.44 PM2.5/PM10
 emission factor (Table 1.1-5, AP-42) PM10 0.54 lb/ton

PM elemental carbon based on EPA's "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", Table 5, January 2002 DRAFT
  0.037 of PM2.5

PM elemental carbon   0.016 PM elemental carbon/PM10
PM soil= PM2.5 - PM elemental carbon   0.43 PM soil/PM10
PM2.5   0.44 PM2.5/PM10
PM coarse= PM10 - PM2.5

[c] Condensable PM (Table 1.1-5, AP-42) Inorganic 0.80 of Total
  Organic 0.20 of Total