Power Plant Rehabilitation and/or Expansion Study

City of Columbia Water and Light Department
Columbia, Missouri

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Stanley Consultants INC.

A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

Executive Summary

Overview

This study identifies means of overhauling and upgrading existing units as well as the addition of new base load electrical generating capacity at the City of Columbia Power Plant. It also evaluates environmental issues and addressing the use of opportunity fuels. The outcome of this evaluation provides input into the larger evaluation of satisfying the City of Columbia's power supply needs into the future.

Working with the City of Columbia Department of Water and Light the feasibility of three alternatives have been determined and cost estimates are included for each.

Description of Alternates Evaluated

Alternative No. 1: New 108.5 MWe (net) Circulating Fluidized Bed Boiler, CFB

This option provides a new 108.5 MWe power plant on the City of Columbia power plant site north of the existing power house. The new CFB boiler and steam turbine generator with associated systems will be located west of the extended railroad tracks.

Natural gas-fired Boiler No. 8 and auxiliaries will remain in a stand-by mode of operation. To ensure that this equipment is in reliable condition, a life extension program will be implemented. Combustion turbine No. 6 also remains in service.

Alternative No. 2:

Phase 1: New 70 MWe (net) CFB Boiler; Phase 2: CFB Boiler Repowering Steam Turbine Generators

Phase 1, a new 70 MWe CFB power plant is built on the far north end of the plant similar to the 108.5 MWe plant described in Alternate No. 1, but reduced in capacity. This allows Units 6 and 7 to remain in service during this phase. This plant would be followed with a new CFB boiler plant in the second phase which would repower existing Steam Turbine Generators No. 5, 7, and 8 (73.5 MWe).

Alternative No. 3: Phase 1: New 70 MWe (net) CFB Boiler

Phase 2: Refurbish Boilers No. 6, 7, and 8 and Steam Turbine Generators

The first phase includes adding a new 70 MWe CFB boiler and steam turbine generator similar to the first phase of Alternate No. 2. The one difference with Alternative No. 2, phase 1, is the coal handling systems. The CFB boiler can combust a wide variety of fuels, which can be lower in cost, as compared to the stoker fired boilers which require a more select grade of coal. Therefore, the existing coal handling system will be retained to serve the stoker fired boilers.

The second phase includes upgrading and extending the useful life of the existing stoker fired Boilers No. 6 and 7, and natural gas-fired Boiler No. 8 with all of their auxiliary systems. This includes a life extension study to better quantify the scope and cost of the upgrades.

The existing and alternative plant parameters for the steam generators and electric generators are presented in Tables 1 and 2.

Net plant heat rates for the existing units were provided by the City of Columbia. New unit performance was calculated using Stanley Consultant's modeling program, Thermo-Flo, SteamPro, supplemented with information provided by the major equipment vendors for these applications. The net plant heat rate for the units after repowering and life extension work is completed were estimated based on expected improvements in efficiency of the new and restored equipment and potential auxiliary power changes.

Operating and maintenance costs for large CFB coal fired plants vary depending on operating practices, labor rates and the cost of consumables. However, the fixed and variable operating costs for CFB plants with spray dry absorbers to control SO_2 can be lower than pulverized coal plants with flue gas desulfurization depending on fuel(s) burned and emission limits. O&M costs for the alternatives evaluated are presented.

Table 1 Steam Generating Units – Existing and Proposed Alternatives

Existing Facility			Alternative No. 1		Alternative No. 2				Alternative No. 3			
					Phase 1 New CFB		Phase 2 Repowering		Phase 1 New CFB		Phase 2 Restored Units	
Boiler No.	Steam, lb/hr[(1)]	Fuel	lb/hr	psi/°F	lb/hr	psi/° F	lb/hr	psi/°F	lb/hr	psi/°F	lb/hr	psi/°F
-	-	-	New CFB 750,000	1,800/ 1,000	New CFB 580,000	1,800/ 1,000	New CFB 730,000	1,000/ 900	New CFB 580,000	1,800/ 1,000	New CFB 580,000	1,800/ 1,000
No. 8	340,000	NG	340,000	900/ 900	340,000	900/ 900	Retired		340,000	900/ 900	340,000	900/ 900
No. 7	240,000	Coal	Retired		240,000	900/ 900	Retired		240,000	900/ 900	240,000	900/ 900
No. 6	160,000	Coal	Retired		160,000	900/ 900	Retired		160,000	900/ 900	160,000	900/ 900

(1) Nameplate boiler ratings.

35 mW
22 mw
16.5 mw

Table 2 Electrical Generating Capability – Existing and Proposed Alternatives

Existing Electrical Generators			Alternative No. 1		Alternative No. 2				Alternative No. 3			
					Phase 1		Phase 2		Phase 1		Phase 2	
Generator	MW	Btu/kwh	MW	Btu/kwh	MW	Btu/kwh	MW	Btu/kwh	MW	Btu/kwh	MW	Btu/kwh
New ST/G	-	-	108.5	9,646	70	10,293	70	10,293	70	10,293	70	10,293
No. 8	35	13,900	35	13,900	35	13,900	35	13,900	35	13,900	35	13,900
No. 7	22	15,500	RETIRED		22	15,500	22	15,400 (1)	22	15,500	22	15,500 (2)
No. 6 GT	12.5	17,800	12.5	17,800	12.5	17,800	12.5	17,800	12.5	17,800	12.5	17,800
No. 5	16.5	15,900	RETIRED		16.5	15,900	16.5	15,800 (1)	16.5	15,900	16.5	15,900 (2)
Installed Capacity, MW	86		156		156		156		156		156	
Blended Heat Rate, Btu/kwh		15,260		11,254		13,031		13,006		13,031		13,031

(1) Alternative No. 2, Phase 2 includes repowering existing steam turbine-generators No. 5, 7 and 8 with a 900 psi CFB (73.5 MWe (net)).
(2) Alternative No. 3, Phase 2 includes extending the life of Boilers No. 6, 7, and 8 and Steam Turbine Generators No. 5, 7, and 8.

Emissions Overview

The emission rates of the proposed boilers will be significantly better than the emission rates of the existing boilers. This improvement is reflective of the installation of best available control technology and the efficiency gains from the proposed boilers. Table 3 shows a comparison of actual emission rates from the existing coal fired boilers to the projected emission ratess of the proposed boilers.

Table 3 Comparison of Existing and New Coal Boiler Emissions Rates

Pollutant	Boiler 6	Boiler 7	100 MW[c] (net) 1800 psi (Alt. No. 1)	70 MW (net) 1800 psi (Alt. No. 2 or 3 Phase 1)	70 MW (net) 900 psi Alt. No. 2 Phase 2	Estimated Reduction per MWhr
SO_2, lb/MWhr	21.96 [a]	20.22 [a]	0.39	0.41	0.50	98%
NO_X, lb/MWhr	8.16 [a]	7.95 [a]	0.98	1.02	1.25	85%
PM_{10}, lb/MWhr	0.57 [b]	0.56 [b]	0.15	0.15	0.19	70%
CO, lb/MWhr	3.52 [a]	2.24 [a]	1.48	1.54	1.87	45%
VOC, lb/MWhr	0.05 [a]	0.05 [a]	0.05	0.05	0.05	No Change
HCl, lb/MWhr	2.54 [b]	2.48 [b]	0.05	0.05	0.06	98%
Hg, lb/MWhr	$102 \cdot 10^{-6}$ [b]	$99 \cdot 10^{-6}$ [b]	$21 \cdot 10^{-6}$	$21 \cdot 10^{-6}$	$21 \cdot 10^{-6}$	80%

Source: [a] 2003 MDNR Emission Inventory Questionnaire
[b] November, 2004 Stack Test
[c] Calculations were made on the basis of a nominal 100 MW net plant output.

While the new coal boilers would be constructed to state-of-the-art emission control technology, continued operation of Boilers 6 and 7 will require addressing new environmental regulations through either emission control upgrades or switching to cleaner burning fuel. Some new regulations considered include the Clean Air Interstate Rule (CAIR), the Clean Air Mercury Rule (CAMR), and the Boiler MACT. Applicability to these rules will depend on whether Boilers 6 and 7 are defined as Electric Generating Units (EGUs), which necessitate a review of historic plant configurations not addressed in this study. CAIR and CAMR are "cap and trade" programs for EGUs whereby emission allocations for NO_x, SO_2, and Hg will be provided by the EPA and Missouri DNR. Since these allocations are based on the performance of current technology, Boilers 6 and 7 will be required to either install emission controls or purchase allowance from other facilities that have excess allowances. The Boiler MACT regulates emissions for Hazardous Air Pollutants from Non-EGUs. To comply with the Boiler MACT, the facility may either switch to a reduced chlorine content coal supply or provide lime injection in the flue gas ahead of the baghouse. The additional dust loading on the baghouse would have to be evaluated along with modifications to attain the orginal design outputs from Units 6 and 7. The output of Units 6 and 7 is currently limited by the combined booster fan.

Alternative Fuels

The CFB boiler has the flexibility of being able to burn a wider variety of fuels than a pulverized coal boiler including biomass and waste fuels. A goal of combusting one percent of the heat input required by the boiler from an alternative fuel can be met by combusting tire derived fuel (TDF) or a biomass fuel. They were evaluated as potential supplemental fuels. The cost of processing TDF to prepare it for combustion varies from $1.65-2.50/MMBtu.

Cost Estimate Summary

Table 4 Alternative Cost Summary

	Alternative No. 1	Alternative No. 2	Alternative No. 3	Plum Point P.P.
Phase 1 Description:	108.5 MWe (net) CFB	70 MWe (net) CFB	70 MWe (net) CFB	
Capital Cost	$219,700,000	$177,600,000	$176,100,000	
Renovation	$3,200,000	$900,000	$900,000	
Total Phase 1 Cost	$222,900,000	$178,500,000	$177,000,000	
$/kw	$2,025	$2,537	$2,516	$1,947
Phase 2 Description:		Repowering CFB (73.5 MWe net)	Refurbish Units 6,7,8	
New CFB Plant		$114,500,000	$0	
Upgrade Cost		$25,500,000	$94,400,000	
Total Phase 2		$140,000,000	$94,400,000	
$/kw		$1,905	$1,283	
Alternative Total	**$222,900,000**	**$318,500,000**	**$271,400,000**	

Estimates for Alternatives No. 2 and 3 have been broken into two phases. The new power generating work has also been separated from renovation activities. Estimates are given in current dollars.

Budget quotations were received from manufacturers for the major equipment items. Engineering (5%), administration (2%) and contingency (10%) have been included for the new power plant components. For the renovation and life extension activities engineering has been included at 8% due to the added challenges of retrofit activities.

Owner's costs such as interest during construction, start-up fuel and water, operator training, spare parts, financing, legal, permitting, performance testing, and insurance have not been included.

The conceptual costs for the repowering portion of Alternative No. 2, phase 2 and the life extension refurbishment work in Alternative No. 3, phase 2 were based on a percentage of the replacement cost of a similar new unit. Stanley Consultants recommends that detailed life extension programs be undertaken if either Alternative No 2 or 3 are pursued. This would consist of a detailed investigation and testing program to prioritize the repair and replacement of equipment.

Summary of Conclusions

- Each of the three alternatives evaluated provides a reliable source of baseload capacity while utilizing a relatively low cost fuel.
- Each alternative evaluated is feasible and will result in providing about 156 MW of electrical generating capacity from the Columbia Power Plant.
- Alternate No. 1 has the lowest installed cost at $2,025/kW.
- Alternate No. 1 has the lowest heat rate, which is the lowest operating cost per kWhr.
- Alternate No. 1 has lower emission rates than either the new alternatives or the existing boilers.
- Alternate No. 2 contains a greater degree of risk than Alternate No. 1 due to utilizing the existing steam turbine generators, feedwater, circulating water and condensate system components in the repowering phase of work. Alternate No. 3 has an even greater level of risk because of extending the life of the existing boilers and associated equipment and systems. Units 6, 7 and 8 have been in service since 1957, 1965 and 1970 respectively.
- Continuing to operate Boilers No. 6 and 7 will require changes in coal fuel selection or upgrades to satisfy Boiler MACT requirements by September 13, 2007. Extending the operating life of the existing boilers will also be affected by CAIR requiring either purchasing NO_x allowances or further flue gas clean up.

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APPENDICES

Section 1

Introduction

General

The City of Columbia Department of Water and Light is faced with determining the solution for providing a long-term reliable, economically sound source of electrical power for its customers. Among the considerations is to increase the power generating capability at the Columbia Power Plant utilizing coal as the primary fuel. Alternative fuels are considered on a supplemental basis within this evaluation.

The three alternatives considered represent strategies for achieving a greater component of self-generated power. Each alternative provides a total generating capability of 156 MW from the Columbia Power Plant. Circulating Fluidized Bed Boilers, CFBs, were used for each of the new steam generators due to their ability to combust a wider range of fuels as compared to pulverized coal boilers. Table 1-1 summarizes each alternative.

Table 1-1 Alternative Onsite Generating Summary

Boiler	Steam Turbine Generator	Alternate No. 1 108.5 MWe CFB		Alternate No. 2 70 MWe CFB plus Repowered Units		Alternate No. 3 70 MWe CFB plus Restored Units	
		MW	Fuel	MW	Fuel	MW	Fuel
New Unit		108.5	Coal	70	Coal	70	Coal
No. 8	No. 8	35	Gas	35(1)	Coal	35(2)	Gas
No. 7	No. 7		Retired	22(1)	Coal	22(2)	Coal
No. 6	No. 5		Retired	16.5(1)	Coal	16.5(2)	Coal
Combustion Turbine		12.5	Gas	12.5	Gas CT	12.5	Gas CT
Total MW		**156**		**156**		**156**	

Notes:

(1) Existing Steam Turbine Generators No. 5, 7, and 8 are repowered with a new (73.5 MWe) CFB boiler.

(2) Boilers No. 6, 7, and 8 are refurbished to extend their useful lives.

(3) New electric generators are shown as net power output.

This report presents feasible approaches for each of the alternatives addressed. The existing site will accommodate each scheme. Coal handling and storage, ash handling and disposal, construction logistics, air, water, and noise emissions have been considered in conceptually defining each alternative.

The coal handling and storage systems have been upgraded for these alternatives. The two rail spurs have been extended to the north end of the site. Coal will be stored for the new CFB boilers in an enclosed building to reduce fugitive emissions. This will also allow coal pile runoff to be controlled more easily. A rail car thawing shed has been included to allow coal to be received all year.

Ash will be handled dry. It will be transported pneumatically to an ash silo from which it will be trucked to an appropriate land fill. The existing ash pond will be filled to provide space for the expansion.

The method utilized in executing this evaluation was presented as part of Stanley Consultant's initial presentation to the City of Columbia. It consisted of gathering an understanding of the current operation, and the City's objectives, as well as initiating a "concept meeting" to focus on the alternatives to be evaluated. A scope and costs for those alternatives were developed and this report was prepared to deliver the results.

Section 2

Evaluated Alternatives

Development of Alternatives

The City of Columbia Water and Light Department issued a request for proposals document on August 2, 2004, seeking an engineering firm to prepare a technical study to evaluate upgrading the existing units at the site or identify means of adding to the plant base electrical generating capacity. Stanley Consultants' proposal and subsequent technical presentation identified a method of defining reliable, economic alternatives for satisfying that objective.

The Concept Team

The Concept Team was a vital link in focusing on the alternatives to be further developed and estimated during the study. Key client personnel along with Stanley Consultants' project team members began by reviewing the needs and expectations of each of the potential project stakeholders. The City of Columbia Department of Water and Light explained their operating philosophy. Significant features of anticipated plant options were presented along with site and environmental constraints.

Potential upgrade and new generation schemes for the site were offered. The ability of these schemes to satisfy project objectives were evaluated resulting in the following three alternatives for detailed consideration. The Concept Team meeting agenda and meeting notes are included in the Appendix.

Alternative No. 1 – New 108.5 MWe (Net) Circulating Fluidized Bed Boiler, CFB

This option includes providing a new, virtually independent, 108.5 MWe power plant on the City of Columbia power plant site north of the existing power house. The new CFB boiler and associated systems will be located west of the extended railroad tracks.

To make room for the plant the existing ash storage pond, two water reservoirs and oil tanks will be removed. Two parallel sets of rail tracks will be extended to the north limit of the site. A new enclosed coal storage building with car thawing shed, bottom dump hopper, and stack-out and reclaim systems will be located in the northeast corner of the property. Alternate fuel storage and handling systems will be provided.

The boiler will generate approximately 750,000 lb/hr of 1,800 psig steam at 1,000°F and 675,000 lb/hr of 500 psig reheat steam at 1,000°F. The new single reheat, steam turbine generator will produce a 108,500 kW (net) of electric power. Power will be generated at 13.8 kV with a step-up to 69 kV for connection to the existing system.

A baghouse dust collector will ensure that emissions do not exceed the particulate limit of 0.015 lb/MMBtu of heat input to the boiler. Additional environmental considerations are described in Section 3.

Highlights of this new power plant include:

- Circulating fluidized bed boiler.
- Steam turbine generator.
- Condenser.
- Feedwater system.
- Cooling tower.
- Circulating water system.
- Coal handling system.
- Enclosed coal storage building to control fugitive dust.
- Ash handling with silo and truck loading.
- Baghouse.
- Emission controls.
- Continuous emission monitoring system.
- Makeup water treatment.
- Fire protection/detection system.
- Building HVAC, plumbing.
- Instrument and plant air systems.
- Piping.
- Electrical equipment.
- Control systems.
- Soil analysis.
- Site work and access roads.

- Pond stabilization, fill, and disposal .
- Engineering, construction management, commissioning, and start-up services.

In addition to providing the new power plant facilities described above the following activities are included associated with renovating the existing facility:

- Natural Gas-Fired Boiler No. 8 and auxiliaries will remain in a stand-by mode of operation. To ensure that this equipment is in reliable condition, a life extension program will be implemented. Refer to this discussion in Section 3.
- Provide a detailed inspection of Steam Turbine Generator No. 8 with an appropriate overhaul.
- Makeup water system with a storage tower integrated to meet City requirements.
- Renovate the existing locker rooms, maintenance shops and storage areas.
- The existing building and equipment, which are not reused, will be abandoned in place.

Alternative No. 2 – Phase 1: New 70 MWe (Net) CFB Boiler

Phase 2: CFB Boiler Repowering Existing Steam Turbine Generators

This alternative could be implemented in two phases. First, a new 70 MWe CFB power plant is built on the far north end of the plant similar to the 108.5 MWe plant described in Alternate No. 1, but reduced in capacity. This would allow Units 6 and 7 to remain in service during this phase. This plant would be followed with a new CFB boiler plant in the second phase which would repower existing Steam Turbine Generators No. 5, 7, and 8 (73.5 MWe). These two phases and the interaction with the existing plant are described as follows.

Phase 1: New 70 MWe (Net) CFB Boiler

The installation of a 70 MWe CFB power plant is very similar to the 108.5 MWe plant described above except for the following differences:

- The 70 MWe CFB 1,800 psia/1,000°F is a non-reheat cycle. For further evaluation refer to, Steam Cycle Selection, Section 3.
- Estimates are based on locating the first plant the furthest west on the site to accommodate the construction of the second boiler plant.
- The coal and ash handling systems will be designed to accommodate the addition of the second CFB boiler to repower the existing steam turbine generators.

The renovation items mentioned with Alternative No. 1 apply to this case also.

Phase 2: CFB Boiler Repowering Existing Steam Turbine Generators

This case makes use of the existing steam turbine generators which have been inspected and overhauled in early 2005. Main steam piping will be routed from the new CFB boiler tie-in on a new pipe rack to the existing steam header serving these turbines. Condensate will be returned on the same pipe rack to the new boiler house.

The following systems and equipment will remain in operation supporting this alternative:

- Steam Turbine Generators No. 5, 7, and 8.
- Condensers and condensate systems.
- Cooling towers and circulating water systems.
- Feedwater heaters.

The following new equipment and systems will be included with the repowered CFB boiler plant:

- Circulating fluidized bed boiler and auxiliaries.
- Boiler feed pumps.
- Fans.
- Coal handling system interface with phase 1.
- Expansion of the coal storage building.
- Ash handling system coordinated with phase 1.
- Baghouse.
- Ductwork, breeching, and stack.
- Emission controls.
- Continuous emission monitoring system.
- Fire protection/detection system.
- Building HVAC, plumbing.
- Instrument and plant air systems.
- Piping.
- Electrical equipment.
- Control systems.
- Engineering, construction management, commissioning, and start-up services.

In addition to providing the new power plant facilities described above the following activities are included associated with renovating the existing facility:

- Boilers No. 6, 7, and 8 will be abandoned in place with associated equipment.

- Provide a detailed inspection of the cooling towers, circulating water systems, condensers, feedwater heaters, piping, electrical equipment, and controls. Then implement a life extension program to keep this equipment in reliable operating condition. Refer to Section 3.
- Provide a detailed inspection of Steam Turbine Generators No. 8 and evaluate the findings from the 2005 inspections of No. 5 and 6.
- Renovate the existing locker rooms, maintenance shops and storage areas.
- The existing building and equipment that are not reused will be abandoned in place.

Alternative No. 3 – Phase 1: New 70 MWe (Net) CFB Boiler

Phase 2: Refurbish Boilers No. 6, 7, and 8 and Steam Turbine Generators

This alternative could also be implemented in two phases. The first phase includes adding a new 70 MWe CFB boiler and steam turbine generator and is similar to the first phase of Alternate No. 2. The second phase includes upgrading and extending the useful life of the existing stoker fired Boilers No. 6 and 7, and natural gas-fired Boiler No. 8 with all of their auxiliary systems.

The one difference with Alternative No. 2, phase 1, is the coal handling systems. It is likely that the ultimate coal handling system for this alternative will need to handle two different coals. This is because of the ability of the circulating fluidized bed boiler to combust a wide variety of fuels, which can be lower in cost, as compared to the stoker fired boilers which require a more select grade of coal. The existing coal handling system with hoppers, coal pile, bucket elevators and conveyors to the silos would be retained to serve the stoker fired boilers..

Phase 2: Refurbish Boilers No. 6, 7 and 8 and Steam Turbine Generators

This second phase, or life extension process, consists of the following major steps:

1. Evaluate environmental regulations that would affect the potential extended operation of the units. Limitations on plant operation or 'deal stoppers' are clarified upfront in this way. Refer to Section 4 for illumination of this topic.
2. Identify pending significant maintenance activities and known upgrade projects. If these items do not represent overwhelming economic hurdles proceed with the next step.
3. Implement a detailed life extension program consisting of thorough inspection and testing of major equipment and systems. Provide performance testing as a benchmark. Categorize the tasks into work packages with time frames for making improvements. Generate cost estimates of the work required.
4. Execute the upgrade activities as determined by the life extension plan..
5. Evaluate the expected reliability of the completed program.

6. Provide a performance test to verify that the desired results were achieved.

Environmental regulations play a significant role in the evaluation of this alternative and are discussed in Section 4. Another major factor of concern in evaluating this alternative is the means of assessing the potential reliability of the refurbished units. The reliability of a power generating plant is composed of the sum of the reliability of each of its elements. This will be one of the key factors in the ultimate selection of the alternatives presented.

The list of anticipated upgrade projects and the approach to developing the life extension program are further discussed in Section 3, Existing Plant Life Extension.

Section 3

Technical Discussion

General

The following items which have significant impact on this evaluation are discussed here:

- Steam Cycle Selection
- Circulating Fluidized Bed Boilers
- Coal Selection
- Alternate Fuels
- Existing Plant Life Extension
- Emission Control Considerations
- Electrical Systems
- Control Systems
- Site Considerations

Steam Cycle Selection

This section reviews various cycles to identify the recommended plant configuration for the City of Columbia's needs. The specific alternatives to be evaluated during this technical study were defined at the concept team meeting. The existing main steam system operates at about 900 psig, 900°F at the turbine throttle valves. The boiler selected to repower the existing Steam Turbine Generators No. 5, 6, and 8 in Alternative No. 2, Phase 2 will match these conditions.

For the other alternatives Stanley Consultants further optimized the power cycles by preparing calculations of heat rates, initial plant costs by modeling comparisons, and further distinguishing various cycle configurations. Also, CFB boiler manufacturers (Alstom Power, Foster Wheeler Energy Corporation, and Kvaerner) and steam turbine generator manufacturers (General Electric and Siemens-Westinghouse) were consulted to determine their experience with these size units and design conditions.

Circulating fluidized bed boilers, CFB, were used in each case to generate steam. This choice was based on fuel handling flexibility as compared to similar size pulverized coal boilers.

For the 108.5 MW (net) electrical output plant, steam conditions of 1,800 psia/1,000°F and 1,500 psia/1,000°F were evaluated. Both non-reheat and single reheat condensing steam turbines were compared. The 1,800 psia/1,000°F steam cycle is recommended with single reheat at 1,000°F and a condensing steam turbine. The CFB boiler manufacturers can provide the reheat design in this size range.

Siemens-Westinghouse offered a single reheat steam turbine generator with dual casings for this application. Performance for the steam turbine generators offered by Siemens-Westinghouse are included in the Appendix.

The 70 MW (net) electrical output plant was also compared using 1,800 psia/1,000°F and 1,500 psia/1,000°F steam cycles. Non-reheat and single reheat condensing steam turbines were evaluated. For this application both Siemens-Westinghouse and General Electric recommended using non-reheat design steam turbines. Siemens-Westinghouse offered a single casing and dual casing design with a crossover pipe. The single casing design capital cost is $10,300,000 (equipment only) with a heat rate of 8,112.8 Btu/kWhr as compared to the dual casing design cost of $11,000,000 (equipment only) and heat rate of 8,068.2 Btu/kWhr. If the unit operated at an average of 95% of load and a capacity factor of 80%, the fuel savings would amount to $42,000 annually. This payback of 14 years does not justify the dual casing arrangement; therefore the single casing-type turbine has been included in the cost estimate.

For the configurations evaluated, Stanley Consultants utilized ThermoFlow, Incs., SteamPro, version 14.0 cycle modeling, and estimating software. These models provided initial comparisons, which were supported with quotations provided by the major equipment vendors. The estimates included in the Appendix have been further supported with site-specific consideration.

Heat balance diagrams are included in the Appendix for each alternative.

Circulating Fluidized Bed Boilers

The CFB type boiler was selected for this application because of its fuel flexibility and inherent low emissions. This section describes CFB advantages. In the circulating fluidized bed, fuel, and limestone are fed into the lower portion of the combustion chamber into a stream of fluidizing air.

In this turbulent environment, the fuel and limestone are mixed quickly and uniformly with the bed material. The fluidizing air causes the fuel, limestone, and bed material to circulate and rise throughout the combustion chamber and enter the separator. At that point, any unburned solids, including any unburned fuel, are captured and returned to the combustion chamber.

The limestone in the fuel mixture reacts with the sulfur dioxide (SO_2) and other sulfur compounds in the fuel gas, and the resulting inert solid material ($CaSO_4$, calcium sulfate or gypsum) is removed with the ash. The high content of gypsum in the ash has numerous beneficial uses such as soil amendments, sludge stabilization, and cement additives.

The fuel is combusted at relatively low temperatures (1,550° to 1,650°F), and because secondary air is introduced into the furnace at various levels above the grid, combustion occurs evenly throughout the combustion chamber. This low-temperature, staged combustion limits the formation of oxides of nitrogen (NO_x). From the convection zone, flue gases pass through an air heater, emission controls, the particulate collection system (baghouse) and then induced draft fans carry the gases to the stack.

Fuel Flexibility

CFB boilers can be designed to burn a wide variety of solid fuel cleanly and efficiently, including all grades and types of coal, peat, wood waste, high ash waste coals, petroleum coke, sludge, oil shale, and agricultural wastes. This is a result of two key features of CFB technology, namely the relatively low combustion temperatures and the residual heat of the bed material that circulates repeatedly through the combustion chamber. Moreover, the CFB can be designed to burn multiple fuels for the same plant, without requiring any modifications when changing fuels. This not only provides many technical advantages, but can provide significant commercial advantages. Since fuel typically represents a minimum of about 40 to 50% of a plant's operating cost, substitution of less expensive low-grade fuels can have a dramatic impact on lowering the cost of electrical generation.

A wide range of fuels have been successfully burned in CFB boilers including: from very hard anthracite coals to high ash bituminous coals, including high ash (70%) coal, waste or coal tailings. CFB boilers also easily accommodate a broad range of sulfur contents, from 0.5 to 8%. Fuels with little or no ash are also easily burned, including petroleum coke, a refinery waste product with almost no ash. High volatile fuels such as high moisture peat and wood waste have been burned successfully. The CFB, with its low combustion temperature, is a good solution for coals with low ash-fusion temperatures, preventing the formation of slag. Supplementing alternative fuels with coal as the primary fuel source is discussed in the following section.

Low SO_2 Emissions

CFB boilers do not require complicated and expensive downstream flue gas desulfurization-equipment to meet environmental regulations. Typically CFB boilers can capture 90% of the SO_2 in the furnace with higher rates of capture achieved with spray dry absorption systems added when required.

Recommended control methods are discussed for each of the specific alternatives in Section 4.

High Combustion Efficiency

The continuous circulation of solids through the system keeps the fuel in an ideal combustion environment for a long period of time. The longer residence time results in very efficient fuel combustion while minimizing process changes resulting from sudden changes in fuel quality or mixes. This combination provides for optimum carbon burnout with a broad variety of fuels.

Low NO_x Emissions

Emissions of nitrous oxides (NO_x) are controlled in the CFB boiler since they operate at a lower furnace temperature which avoids the formation of thermally generated NO_x, a major source of NO_x.

Elimination of Slagging

The low combustion temperature of the CFB technology also virtually eliminates slag formation in the furnace and reduces the volatilization of alkali salts. This boiler style eliminates the high cost and maintenance expense of furnace sootblowers. Operating at such low temperatures also means that boiler corrosion and convective surface fouling is reduced.

High Turndown

CFB technology can be designed with a high turndown capability, in the range of 40% of design load to allow cycling to match the normal daily-demand curve.

High Availability

CFB boilers are designed for reliable electrical generating plant applications and proven experience in this size range. Each of the three vendors contacted during this evaluation has produced lists of operating units with contacts. Key components such as the fuel, limestone, and ash removal systems are designed with complete redundancy. CFB boilers do not require pulverizers for fuel preparation, and have simple, reliable fuel feed systems.

Operation and Maintenance

The plant operating philosophy will be incorporated into the control system design. Design of the boiler and auxiliary systems will ensure accessibility to equipment for maintenance.

Coal Selection

This section describes considerations associated with coal parameters which impact alternatives evaluated. Coal was selected as the primary fuel source for any additional power generating capability developed at the Columbia site. It is seen as having the best long range potential for providing the greatest economic advantage to the community.

The current coal is from Eastern Kentucky and has the following properties:

	As Received	Dry Basis
Higher Heating Value, HHV	13,349 Btu/lb	0%
Moisture	4.66%	6.95%
Ash Content	6.63%	38.06%
Volatile Matter	36.29%	38.06%
Sulfur	1.02%	1.07%

The City is currently in the process of seeking and evaluating bids for a new coal supply contract. Coal prices have increased and put significant pressures on operating costs for the plant. Several factors influence coal costs including the grade of coal, heating value, and transportation affects.

During the process of establishing a new coal contract, consideration should be given to satisfying Boiler MACT regulations which must be satisfied prior to September 13, 2007. Refer to Emission Control Considerations, later in Section 3.

For the purpose of this evaluation, a design basis was established using Pittsburgh No. 8, a high volatile, bituminous coal which has characteristics which fall within Columbia Water and Light's recent coal specification parameters. This coal is conservative with respect to ash, moisture and sulfur content. This provided a consistent means for obtaining equipment sizing, pricing and emission data from the major equipment vendors. The following table describes the coal and associated ash characteristics:

Table 3-1 Design Basis Coal - Pittsburgh No. 8, High Volatile A Bituminous

Coal Properties	
LHV	11,900 Btu/lb
HHV	12,450 Btu/lb
	Ultimate Analysis (weight %)
Moisture	6.00
Ash	9.94
Carbon	69.36
Hydrogen	5.18
Nitrogen	1.22
Chlorine	0.00
Sulfur	2.89
Oxygen	5.41
Total	**100.00%**

Table 3-2 Design Basis Coal - Pittsburgh No. 8, High Volatile A Bituminous (Continued)

Ash Properties	
Ash Analysis (weight %)	
SiO_2	48.10
Al_2O_3	22.30
Fe_2O_3	24.30
CaO	1.30
MgO	0.60
Na_2O	0.30
K_2O	1.50
TiO_2	0.70
P_2O_5	0.10
SO_3	0.80
Other	0.00
Total	**100.00**
Ash Characteristics	
Fouling characteristics: Low/medium	
Initial Deformation temperature: 2,015°F	
Softening temperature: 2,135°F	

This coal is relatively high in sulfur content at 2.89% by weight. By design the circulating fluidized bed boiler captures about 90% of the SO_2. As discussed in Section 4, the need for addition environmental control will be influenced by the ultimate fuel selected.

Alternative 3 includes a new 70 MWe CFB Boiler in the first phase and restoring stoker-fired Boilers No. 6 and 7 to extend their useful life in the second phase. It is likely that two different coal supplies will be chosen to provide the most economical fuel mix. Due to its flexibility CFB boiler will use a more economical grade of coal. Stoker boilers typically require more selective characteristics.

In Alternative 3, it is anticipated that the existing coal storage and coal handling system will be retained to serve the refurbished Boilers No. 6 and 7. Boiler No. 8 continues to fire natural gas in Alternative 3. Coal handling and storage is discussed in Section 3.

Alternate Fuel

The City of Columbia's request for proposals for this study identified opportunity fuels such as tire derived fuel (TDF), paper pellets, and/or petroleum coke. The city has requested that consideration be given to using opportunity fuels or renewable fuels to supplement the base coal fuel source.

The Public Works Department, Solid Waste Division, of the City of Columbia has organized an extensive recycling and waste disposal system. A meeting was held to discuss its operation and potential alternative fuels. The meeting notes are included in the Appendix. Yard waste, which includes used pallets, and tire derived fuel are potential fuels that could be combusted in the circulating fluidized bed boiler. Byproducts of large manufacturers in the area were also mentioned including Quaker Oats (rice hulls) and Oscar Meyer (sausage casings).

The CFB boiler has two attractive advantages in this application. First, it allows a wide range of fuels to be combusted. Secondly, the combustion process occurs at a relatively low temperature reducing the amount of pollutants emitted. The following describes two concepts for supplementing fuels with TDF or a biomass fuel method.

Tire Derived Fuel

Using scrap tires as fuel can provide benefits to the community. Health hazards stem from mosquitoes carrying diseases that thrive in waste tire piles. Piles of tires also cause fire hazards and take up space in landfills. It is estimated that one tire is disposed of per person each year. In the eight county Waste Management District surrounding the City of Columbia that amounts to about 340,000 tires each year.

One percent of the maximum boiler heat input can be obtained from TDF. The heating value of tires is 15,000 Btu/lb. Each tire weighs about 20 pounds. This concept for supplementing the fuel input to the boilers at the City of Columbia site consists of receiving TDF ready to use in a nominal size of 2" x 0" with the smaller particles typically larger than ¼" or larger.

For the 108.5 MW facility the maximum daily use of TDF would be 7.7 tons. This corresponds to an average of 2.5 trucks per week (22 ton load rating) at full load operation.

The scrap tires will be collected and shredded at a facility located offsite, which is owned and operated by others. The trucks will dump the TDF on a paved area with a 4' high wall on two sides. During times when the coal silos are being filled an operator using a front end loader will move the TDF over a grizzly and a reclaim hopper which feeds a twin-screw feeder. The feeder discharges the TDF, mixing it onto the coal conveyor belt, as it is conveyed to the silos.

The estimated cost of this system including design, permitting, and construction is about $700,000.

The cost of processing tires ranges from $50 to $75 per ton which corresponds to $1.67 to $2.50/MMBtu . Using $75/ton and an annual consumption of 202,400 tires corresponding to one percent of the heat input to the boiler, an average 90% load with an 80% running capacity factor, the annual cost to process the TDF is estimated to be $152,000.

Biomass Fuel Concept

Using baled tall fescue grass as a supplemental fuel is another option that Stanley Consultants has explored recently as an alternative fuel source. This biomass fuel can be burned along with coal in the circulating fluidized bed boilers considered, which included limestone in the boiler, to capture sulfur and selective non-catalytic reduction system for NO_x control.

Fescue grass would be received in average bales of 5'-0" diameter, 5'-0" long with 20 moisture, and weighing about 1,200 pounds. Equipment is readily available that handles bales up to 2,250 pounds. The average heating value of the fescue is 6,500 Btu/lb. To provide one percent of the heat input of the 108.5 MW plant, about one bale would be required per hour.

The bales can be delivered to the site on flat bed trucks with 10 to 18 bales per truck. A truck of 10 bales can be off loaded in 20 minutes using a front-end loader or similar equipment. The bales would be stored in a covered building. A truck scale would determine the actual weight of material received.

Bales would be placed on the shredder feed belt conveyor. The shredder is a low speed, twin shaft machine with eccentric toothed cutters, which reduces the material to 6" top size. The shredder discharges onto a belt that is inclined to the silo. The silo for the material would be filled one time per day. A magnetic separator and rock removal classifier are included. Twin-screw feeders meter the material to the hammer mill, which reduces it to 2" top size. The material is then vacuim conveyed to the biomass fuel-metering bin which holds a two2 hour supply. The fuel rate is regulated by the boiler control system.

Because of the need for a conveying, sizing, and storage system that parallels the coal handling system and modifications to the boiler, this concept has a higher capital cost than simply mixing the fuels on the conveyor. The estimated capital cost of this option is $3,000,000 including engineering, equipment, and installation. Operating costs would include auxiliary power for the shredder, fuel for the front end loader, labor and the grass.

Existing Plant Life Extension

This section discusses the topic of extending the life of existing power plant facilities beyond their original intent. The operating boilers at the Columbia Power House were commissioned in the following years:

Boiler	Year	Current Age
Boiler No. 6	1957	48
Boiler No. 7	1965	40
Boiler No. 8	1970	35

Because equipment was designed with significant margin in the past, units were quite often able to achieve output exceeding nameplate capacity. Similarly, the useful life of components have been extended beyond the typical design life.

The ability to extend the operating life of equipment depends on other factors including regular maintenance, good operating practices and fuel selection.

Determining the condition and potential costs of extending the life of power generating equipment requires a great deal of information to be gathered and assessed. This information is in the form of hard facts such as wall thickness of piping and also in terms of maintenance history and observations made by operating personnel. It also requires economic judgments to be made relating reliability, availability and the costs to restore systems.

The intent of this study was not to provide an exhaustive life extension analysis including destructive and nondestructive testing of system components. Rather, the basis of this evaluation was to presume, for example, that the pressure parts of the boilers which were in excess of 50 years old, in coal-fired service, would require replacement if that alternative showed merit. With these basic assumptions, the impact of satisfying emission regulations was evaluated and a screening analysis on a larger scale was performed. The environmental concerns related to a life extension program are discussed in Section 4.

The following activities are identified associated with extending the life of stoker-fired Boilers No. 6 and 7, and natural gas-fired Boiler No. 8, for an additional 20 years of operation.

- Provide a detailed life extension evaluation of each boiler, its major equipment and systems. This will include inspection, testing, detailed review of maintenance records, and interviews with operations and maintenance personnel.
- Extensive tube replacement in the furnaces and convection passes of both stoker-fired boilers is anticipated.
- Inspect the boiler steam drums, headers, downcomers, and structural integrity.
- Steam Turbine Generators No. 5 and 6 were inspected and received major overhauls during the first quarter of 2005. Steam Turbine Generator No. 8 should be thoroughly inspected and overhauled.
- Replace the economizer of Boiler No. 6. The Boiler No. 7 economizer was replaced in the fall of 2004.
- Both boiler grates have been recently rebuilt and are assumed to be in good condition, although obtaining spare parts will continue to be a challenge into the future.
- The existing common baghouse and ID booster fan serving Boilers No. 6 and 7 restricts the unit's ability to simultaneously achieve full design load. Remove this restriction by implementing the corrective action identified in the 1993 baghouse improvement study for Boilers No. 6 and 7. The recommendations included installing baffles to reduce re-entrainment of ash from the hoppers and upgrading the ID booster fan from 720 rpm to 900-rpm speed. The cost for these improvements have been escalated and included in the cost estimate for this alternative. The speed change will result in a capacity increase of 22%.
- Seek opportunities to improve plant efficiency.
- Retube the condensers.
- Inspect and repair circulating water piping.

Emission Control Considerations

The three alternatives evaluated in this study include consideration of the appropriate emission controls that will be required for each of the boilers at the facility. These emission controls are driven by the applicable environmental regulations further described in Section 4. In some cases, the regulatory requirements are "performance based" where the emission of a pollutant must meet a specified emission limit. In other cases, a facility is required to participate in a "cap and trade" program where emission allowances must be obtained to offset the emissions that are actually generated by the source.

Where performance standards apply to the source, compliance with the standard may be achieved by either reducing the amount of emissions generated or by installing control equipment to treat the emissions. The latter approach is often required where the former approach cannot sufficiently minimize or otherwise reduce the emissions. It may also be more cost effective to install control equipment (particularly on new sources) rather than purchase emission allowances as required under some of the different cap and trade program.

The regulatory applicability of each regulation and emission source is discussed in more detail in Section 4. In general terms, the following control strategies were considered in this study by regulatory program.

Boiler MACT

The Boiler MACT only applies to Boilers No. 6 and 7. This is a performance based standard where emission limits of multiple Hazardous Air Pollutants must be met. Columbia Power & Light provided stack test results for these units in order to evaluate potential control strategies for existing boilers. Based on these stack test results, only the emissions of HCl exceeded the Boiler MACT performance standards. To achieve compliance with this standard, The City of Columbia Department of Water and Light must either fire coal that has lower chlorine content than fired during the referenced stack test or install a flue gas treatment system. The stack test was about 170% of the Boiler MACT limit. Therefore a 60% reduction in the chlorine content of the coal or installation of a flue gas treatment system capable of achieving about 60% or more reduction is required by the Boiler MACT compliance date of September 13, 2007. The ability and cost to obtain a long-term supply of low-chlorine coal is the critical factor in determining whether a fuels management control strategy or a flue gas treatment strategy is the most appropriate Boiler MACT compliance strategy. A control system designed to achieve 60% reduction may be accomplished with direct lime injection into the flue gas. Such an approach would likely be more cost effective than installing a separate dry scrubbing system. Nevertheless, significant modification of the existing baghouse would be required to make this approach feasible.

New Source Review – Prevention of Significant Deterioration (NSR/PSD)

The PSD program requires that new or modified sources establish federally enforceable emission limits that are reflective of Best Available Control Technology (BACT). Therefore, the emission controls evaluated for the new identified in Alternatives 1 – 3 represent what is currently being applied in practice. For CFBs this includes the installation of Selective Non-Catalytic Reduction (SNCR) to control NO_x emission and a baghouse to control PM, PM_{10}, Pb, and other metallic Hazardous Air Pollutants. SO_2 emissions are controlled to some extent by the inherent capability of the CFB and limestone. However, recent trends indicate that additional scrubbing of the flue gas is being achieved in practice as BACT for SO_2 control. Because the CFB is a lower emitting source of SO_2 than the uncontrolled existing coal fired boilers, the possibility of avoiding PSD by "netting-out" for SO_2 is further evaluated in

Section 4. Specific emission rates and associated BACT controls are reviewed in Section 4, Table 4-2.

Cap and Trade Programs

Additional regulatory programs implement a "cap and trade" system, where existing source are allocated emission allowances based on historic operating rates. New sources or existing sources that exceed their allowance must purchase additional allowances through a market-based system. The existing Acid Rain Program currently allocates and trades SO_2 allowances. The EPA NO_x SIP call also provides a cap and trade program for NO_x emissions from utility boilers during the "ozone season," which runs from May 1 to September 30 of each year (Boone county is not currently in the Missouri NO_x SIP Call). The recently finalized Clean Air Interstate Rule (CAIR) will establish cap and trade programs for NO_x and SO_2 that will replace or otherwise incorporate the Acid Rain and NO_x SIP Call programs. The related Clean Air Mercury Rule (CAMR) will institute an emissions cap and trade for mercury (Hg). Current spot market prices for SO_2 are selling at $700 per ton and NO_x SIP Call Allowances selling for as much as $3,500 per ton. Although there is no current marker for Hg allowances, EPA has used $35,000 per pound for Hg emission allowances in the development of the Clean Air Mercury Rule. EPA has stated that Hg allowances will be based on an emission factor that is consistent with NO_x and SO_2 budgeting under CAIR. In other words, if facilities install NO_x and SO_2 controls to stay within their CAIR allowances, then the "co-benefit" will be an Hg emission rate equal to CAMR allowance. Conversely, if a facility needs to buy CAIR NO_x and SO_2 allowances, then it will likely have to purchase Hg allowances as well. So, while a regulation may not require the installation of control equipment to meet an emission standard, it may be economically beneficial to install additional controls where the associated cost is less than the prices of these emissions allowance.

Electrical Systems

This section comments on the condition of the existing electric systems from the stand point of extending their life and on interfacing with new alternatives.

Electrical Infrastructure

The electrical system was visually surveyed to determine the general condition of the electrical equipment with respect to interfacing with the new generating alternatives or extending the life of the existing units. Operating personnel were interviewed and the history of the equipment and maintenance activities was discussed.

The walk down inspection included equipment outside the main building, such as the transformer area and 69 kV equipment, also the combustion turbine and cooling towers. It also included electrical equipment in the turbine hall, boiler auxiliary equipment, coal handling, ash handling, control room, and the medium-voltage distribution switchgear for Units No. 6, 7, and 8.

If the existing units are to be restored, consideration should be given to eliminating the 2.4 kV system and the associated transformers feeding it. This should coincide with the other electrical system improvements described below and would result in establishing the 4.16 kV system as the plant distribution voltage. It would eliminate the need for reactors to limit fault current on the bus and allow for more flexible operation

The combustion turbine, Unit 6, equipment and systems appear to be in good condition. They do not affect any of the main plant system upgrades. This is also true for the cooling tower electrical equipment.

The existing condition of the main plant electrical infrastructure, such as cable tray and wiring, which has been in place since the installation of each of the corresponding units, is in fair to poor condition. This is particularly evident around Unit 6, where it is reported that brittle insulation cracks and falls off during any movement. Unit 7 infrastructure is slightly newer, however, due to the same environmental conditions existing in the building it is likely that Unit 7 is approaching the same condition. The condition of the Unit 8's electrical infrastructure is improved.

Medium- and low-voltage switchgear maintenance activities will become more difficult as replacement parts are more difficult to obtain. Its remaining useful life is becoming reduced. This condition is of a particular problem for Unit 6 and 7. Again, Unit 8 is in significantly better condition.

Overall, the condition of Unit 6 and 7's main plant electrical infrastructure and equipment is reaching the end of its useful life after more than 50 years of operation. It is becoming more difficult to ensure safe and reliable operation. Rehabilitation of Unit 6 or 7 to extend the life of the boilers should result in a complete replacement of the electrical systems corresponding to that unit. A detailed inspection of Unit 8 prior to implementing a life extension program will determine at what point electrical upgrades will be required.

Electrical Considerations

The electrical system configurations for each of the new units are similar. Only Alternative No. 2 has some changes to accommodate the new 70 MW CFB boiler plant in phase 1 with another new CFB boiler, providing steam to repower the existing steam turbine generator units with its supporting systems. Simplified Electrical One-Line Diagrams are included in the appendix and are described as follows.

<u>Alternates No. 1 and No. 3</u>:

The generator will connect to the step-up transformer (GSU) without a generator breaker. A separate reserve auxiliary transformer (RAT) will be used to back feed the generator auxiliaries from the 69 kV bus for start-up and maintenance. Synchronization will occur across the two 69 kV substation breakers requiring complex generator synchronization controls and 69 kV breaker control wiring. A generator auxiliary transformer (GAT) provides power to the plant auxiliary medium voltage system. The connection to the GAT is a tap off the generator bus. The connections between the generator terminals, low-voltage side of the

GSU, and high-voltage side of the GAT would be bus duct. Synchronization and fast transfer will take place between the medium voltage switchgear main breakers allowing for a smooth transition during start-up and shutdown, while switching from generator power to reserve auxiliary power.

The plant medium-voltage switchgear (SWGR) feeds the low-voltage switchgear (SUS) at 480V through step-down secondary unit substation dry-type transformers. The SUSs will then distribute power to the motor control centers (MCC). Placement of the SUSs and MCCs will be throughout the plant to reduce wiring and better serve the loads locally. It is anticipated that the 480V switchgear will be single ended except for the essential service bus. The essential service bus, necessary to provide a safe shutdown of the unit, will provide power to the 125V dc system as well as UPS loads and would have dual 480V feeds, with an engine generator for longer term back-up power. The engine generator would not be capable of black start.

A fenced 69 kV yard containing the GSU, GAT, RAT, 69 kV breakers, and 69 kV switches, shown on the general arrangement next to the plant wall, will provide connection to the 69 kV system. To avoid overhead electrical lines between the plant yard and the existing 69 kV, installation of the cable will be underground in a concrete-encased duct bank. A 69 kV breaker with isolating switches will connect the breaker to the transformer and riser where the cable will transition underground. Spacing between the transformer and breakers will be sufficient to allow future bus build-out and connection to a second unit.

Alternate No. 2:

The plant configuration for the new unit will be the same as that as described for Alternates No.1 and No. 2, utilizing the breaker and a half configuration and reserve auxiliary transformer arrangement, with additional modifications to the connection at the 69 kV level and additional switchgear for the repowering effort. In this arrangement the RAT will be able to service either one of the units, but not simultaneously.

An additional step down auxiliary power transformer (APT) with connection to 69 kV feeding the medium-voltage switchgear for the new boiler will be added. This will make it possible to operate the units associated with the repowering effort independently of the new unit, also making it possible to stage the construction and allow completion of the new unit before the repowering effort commences. Boiler load power in the new plant will come from the new APT, while the steam turbine generator loads will get power from separate transformers, providing power in the existing plant. Replacement of existing plant transformers, switchgear, and electrical systems will be as discussed earlier.

Systems common to both boilers such as the coal-handling, electrical bus, and balance of plant essential service loads will have a feed from both GAT and APT. This allows operation of either boiler independently in case the new unit is shutdown. The power will normally come from the unit auxiliary transformer to reduce losses. Automatic transfer to the APT source will take place upon loss of unit auxiliary power.

Power Transmission

Other than the modifications to allow interconnection of the new plant to the existing 69 kV system, analysis by the City indicates that the existing system has the capacity to transmit the additional power generated from either of the alternatives evaluated here without additional upgrades.

The 69 kV and 161 kV transmission system equipment in the switchyard west of the Power Plant are in good condition based on discussions with operators.

Control Systems

Controls Overview

A Distributed Control System (DCS) philosophy is recommended for the portions of alternatives which include new steam generating capability. The existing unit control systems are not consolidated and generally rely on single loop controllers. For the alternatives developed in this study, which upgrade significant portions of the existing units and extend the useful life, we will address our approach to a control concept.

Advantages of DCS include, but are not limited to, the following:

- Centralized remote control, monitoring, trending, status, and alarming capabilities.
- Data historian for logs, reports, and trends.
- Plant systems diagnostics.

Multiple personal computer (pc) workstations will be located in a centrally located control room within the new facility. These workstations provide the operators and engineers with a graphical display of the plant systems providing a "window" into plant operations and control. It is anticipated that a total of six workstations would be required including two workstations dedicated to turbine controls and four workstations dedicated to the Circulating Fluidized Bed (CFB) boiler and Balance of Plant (BOP) systems.

Field instrumentation and devices would be hardwired to DCS Input/Output (I/O) cabinets, consisting of redundant processors, power supplies, and I/O modules (i.e., analog, digital, and serial) that interface with various field instrumentation and devices. A redundant communications network transfers plant information and operator commands between each I/O cabinet and the pc workstations.

It is anticipated that approximately 2,100 I/O points (including 20% spare I/O points) would be required for the CFB boiler and BOP areas. Interfaces with the following key plant systems include Boiler Fuel Safety and Burner Management System (BMS), baghouse control, sootblowers, generator metering, ash handling, and turbine control.

Existing Plant DCS Interface

Remote I/O cabinets would be utilized to incorporate existing plant systems into the DCS. Field instruments and devices would be hard wired to a remote I/O cabinet, which would be located near existing equipment, to minimize field wiring. New field instruments and devices may be necessary for existing plant systems. Control system specifics for each alternative pertaining to existing plant systems are described as follows:

Alternative No. 1

It is anticipated that approximately 150 I/O points from Boiler No. 8, Steam Turbine No. 8, and the combustion turbine would be available for monitoring within the DCS. These points would include key process parameters for various plant systems such as pressures, temperatures, flow rates, levels, and equipment status.

Limited remote control capabilities have been assumed. However, the DCS could be easily expanded in the future to include increased remote control capabilities as well as adding additional I/O points.

Alternative No. 2

It is anticipated that approximately 150 I/O points from Steam Turbines No. 5, 7, and 8 would be available for monitoring within the DCS. These points would include key process parameters for various plant systems such as pressures, temperatures, flow rates, levels, and equipment status.

Limited remote control capabilities have been assumed. However, the DCS could be easily expanded in the future to include increased remote control capabilities as well as adding additional I/O points.

Alternative No. 3

It is anticipated approximately 200 I/O points from Boilers No. 6, 7, and 8; and Steam Turbines No. 5, 7, and 8 would be available for monitoring within the DCS. These points would include key process parameters for various plant systems such as pressures, temperatures, flow rates, levels, and equipment status.

Limited remote control capabilities have been assumed. However, the DCS could be easily expanded in the future to include increased remote control capabilities as well as adding additional I/O points.

Site Considerations

This section will discuss the interface of these alternatives with certain common site systems.

Ash Pond and Ash Handling

A large portion of the remaining available space on site is taken up by the existing ash pond. By disposing of ash in a dry form that space can be used for other uses. To make room for a new power generating project on site the existing boiler ash handling systems can be converted to a dry system to allow the pond to be reclaimed.

Costs have been included in the estimate to handle the fly ash from the dust collectors by pneumatically conveying it to a storage silo. The silo would be elevated to allow the ash to be fed into covered trucks which would haul it to a landfill. The silo would have an appropriately sloped cone bottom with an air atomizing stone to ensure that the material flowed out. Ash from the stoker beds will be dewatered and also removed by truck.

The estimate also includes the cost to excavate ash currently contained in the pond and haul it to a non-hazardous landfill. The area would then be backfilled with clean material.

Water System

During the Concept Team meeting, the Water Department mentioned that the two water reservoirs on site could be removed from service to provide space for plant expansion. The arrangements shown on the site plan drawings in the appendix have utilized this space for both coal handling facilities and an additional cooling tower.

It was also mentioned that the water well in the north east corner of the property was active and that a overhead water tank may serve to maintain water pressure to satisfy fire protection needs. Stanley Consultants has included the cost for a 100,000-gallon spherical storage tank to be installed 100' above grade. This cost has been included as a planning figure, with out performing a detailed review of the water supply and firewater systems.

Coal Handling and Storage

The coal handling approach for these projects was based on minimizing the disruption to traffic across Business Route 70 at the southern boundary of the site. The quantity of coal required to be stored on site to maintain a 30-day supply is shown in the following table along with the number of 12-car trains needed to satisfy full load operation for the various alternatives considered.

Table 3-3 Coal Storage Capacity and Train Delivery

	Alternate No. 1	Alternate No. 2		Alternate No. 3	
		Phase 1	Phase 2	Phase 1	Phase 2
	100 MWe CFB	70 MWe CFB	CFB to Repower ST-G No. 5, 7, and 8	70 MWe CFB	Extend the Life of Units No. 6, 7, and 8
Storage, tons	25,100	10,030	23,060	10,030	7,603
No. of 12 car coal trains per week	5.4	4.1	5.0	4.1	1.8

Note that for Alternate No. 3, two different coals are expected to be stored. One for combustion in the circulating fluidized bed boiler and the second for the renovated stoker-fired Boilers No. 6 and 7. In this case, the existing coal pile and coal handling system would be used to supply the existing boilers.

Stanley Consultants prepared a coal handling concept which includes the following primary components:

- Coal Storage Building to reduce fugitive dust and manage coal pile run off.
- Locate the coal storage building in the northeast corner of the site.
- Extend the existing rail tracks with two new spurs.
- Car bottom unloading hopper, unloading shed and dust collection.
- Car thaw shed.
- Stack-out conveyor, tripper conveyors and traveling tripper.
- Reclaim hoppers with grizzly.
- Belt feeders, reclaim conveyors, magnetic separator, belt scale, sampling system, reclaim tunnel and transfer tower.
- Dust collection, ventilation, sump pumps, fire protection, chute work, monorails, platforms, ladders, electrical, and control systems.

The balance of the scope is defined in FMC Energy Systems budget proposal which is included in the Appendix.

Noise

Consideration can be given during project design phases to minimize noise from sources found in power plants such as rotating equipment, vents, and stacks. For example, cooling tower fan rotating speed can be limited to control noise.

Cooling Towers

Drift and the plume generated by a cooling tower under certain ambient conditions can be managed by proper siting of the cooling tower and prudent design consideration. Drift eliminators minimize water carryover.

Section 4

Environmental Review

Regulatory Overview

This section provides an overview of the major environmental regulatory aspects affecting the proposed alternatives. The following long-standing and recently finalized environmental regulations have been considered:

New Source Review (NSR) - Prevention of Significant Deterioration (PSD)

A primary regulation requiring consideration for this project is NSR's PSD regulations and the associated Best Available Control Technology (BACT) analysis. Projects subject to the PSD regulations must evaluate the technical, economic, and environmental impacts to select the most effective feasible control technology. To be subject to the PSD regulations, a source must first be considered a major source and the modification must be considered a major modification. Based on plant-wide total potential emissions, the existing facility is considered a major source under PSD regulations and, therefore, any changes must only trigger the major modification thresholds for plant-wide emission increases. Under the recent NSR reform regulations, these project increases are calculated by subtracting the average historical emission from the future potential emissions based on the long-term projected utilization of the new emission sources. These thresholds vary for each criteria pollutant as shown in Table 4-1.

Table 4-1 PSD Major Modification Thresholds

Pollutant	NO_x	SO_2	PM	PM_{10}	CO	VOC	Lead
Threshold, tons/yr	40	40	25	15	100	40	0.6

For projects subject to PSD regulations, a BACT analysis must be conducted. In accordance with the PSD regulations, the BACT analysis must establish:

> "an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Clean Air Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant."

As all three proposed alternatives consider CFB technology, a review of recent past EPA BACT determinations for CFB boilers was performed, a summary of which is shown in Table 4-2.

Table 4-2 Recent PSD BACT Determinations for CFB Boilers

	Facility Name						
	JAE Northside Generating Station	Kentucky Mountain Power	E. Kentucky Power	Indeck-Elwood	NEVCO Energy	AES-PRCP	CONSENSUS
State	Florida	Kentucky	Kentucky	Illinois	Utah	Puerto Rico	
Date	7/14/1999	4/19/2000	2/14/2002	4/7/2003	9/10/2003	4/2/2002	
Capacity	297.5 MW	250 MW	270 MW	330 MW	270 MW	227MW	
Emission Rates							
NO_x, lb/MMBtu	0.09	0.07	0.10	0.10	0.10	0.10	0.10
CO lb/MMBtu	NA	0.27	0.15	0.10	0.12	0.10	0.10
PM_{10}, lb/MMBtu	0.011	0.015	0.015	0.015	0.016	0.015	0.015
VOC, lb/MMBtu	NA	0.0072	NA	0.004	0.005	NA	0.005
SO_2, lb/MMbtu	0.20	0.13	0.20	0.15	0.05	0.022	0.04 to 0.15
Emission Controls							
NO_x	SNCR	SNCR	SNCR	SNCR	SNCR	SNCR	SNCR
CO	GCP	GCP	GCP	GCP	GCP	GCP	GCP
PM_{10}	FF	FF	FF	FF	FF	FF	FF
VOC	GCP	GCP	GCP	GCP	GCP	GCP	GCP
SO_2	NA	NIDS	NIDS+SDA	NIDS	NIDS+CDS	NIDS+CDS	NIDS+SDA

Source: EPA RACT/BACT/LAER Clearinghouse (RBLC)

[Abbreviations: SNCR = Selective Non-Catalytic Reduction; GCP = Good Combustion Practices; FF = Fabric Filter; NIDS = Naturally Integrated Desulfurization System (e.g. CFB technology); SDA = Spray Dry Absorber; CDS = Circulating Dry Scrubber]

Based on the research provided, it appears that there is a general BACT consensus for NO_x, CO, PM_{10}, and VOC emission rates and associated emission controls. However, for SO_2 BACT determinations, recent activity has shown a precipitous decrease in emission rates from approximately 0.15 lb/MMBtu to 0.05 lb/MMBtu or lower. Stanley is aware of other new CFB's currently undergoing PSD review that are also likely to have SO_2 emission limits at 0.04 lb/MMBtu or less.

This sudden drop is a reflection of the change in control technology determined to be "economically feasible." Specifically, the 0.15 lb/MMBtu SO_2 emission rate is based on the naturally integrated desulfurization (NIDS) process inherent with CFB technology. Recent regulatory reviews, however, are now determining that spray dry adsorption (SDA) or similar proprietary technologies (e.g. CDS) are economically feasible secondary treatment of the CFB flue gas and this is why the 0.05 lb/MMBtu or less SO_2 emission rates are being implemented.

National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers and Process Heaters (e.g. Boiler MACT)

On September 13, 2004, EPA promulgated new rules regulating the emissions and operations of boilers and process heaters. It is formally known as the *National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers and Process Heaters,* but it is more succinctly known as the "Boiler MACT."

A facility is subject to this rule, if you own or operate an existing, new, or reconstructed industrial, commercial, or institutional boiler or process heater as defined in 40 CFR §63.7575 that is located at, or is part of, a major source of HAP. To be major source of HAPs, the facility must have the potential to emit more than 10 tons per year of any individual HAP or more than 25 tons of all combined HAPs, then the facility is defined as a major source. The Boiler MACT does not apply to boilers in the utility industry based on power output. Boilers that are greater than 25 MW are considered electric generating units (EGUs) and are not subject to the Boiler MACT. Specifically 40 CFR §63.7491(c) provides the following exemption:

> "An electric utility steam generating unit that is a fossil fuel-fired combustion unit of more than 25 megawatts that serves a generator that produces electricity for sale. A fossil fuel-fired unit that cogenerates steam and electricity, and supplies more than one-third of its potential electric output capacity, and more than 25 megawatts electrical output to any utility power distribution system for sale is considered an electric utility steam generating unit."

The use of the term MACT refers to the "maximum achievable control technology" by which the emission limits have been established for individual or groups of hazardous air pollutants (HAPs). The Boiler MACT regulates emissions of hydrochloric acid (HCl), mercury (Hg), a group of eight total selected metals (TSM), and – again as a group – organic HAPs. Surrogate emission limits have been established for the two pollutant groups; an alternative particulate matter (PM) limit has been established as surrogate for the total selected metals and a carbon monoxide (CO) limit has been established as a surrogate for organic HAPs.

However, as we will discuss later, there are numerous other requirements beyond meeting an emission limit for these HAPs. These requirements may include stack testing, continuous emissions monitoring, parametric monitoring, establishing operating plans, record keeping, and compliance reporting. Table 4-3 identifies the emission limits for new and existing boilers subject to the Boiler MACT

Table 4-3 Boiler MACT Emission Limits

	Particulate Matter (PM) (lb/MMBtu)	or	Total Selected Metals (lb/MMBtu)	Hydrogen Chloride (HCl) (lb/MMBtu)	Mercury (Hg) (lb/MMBtu)	Carbon Monoxide (CO) (ppmv)
Existing Units	0.07		0.001	0.09	0.000009	0.07
New Units	0.025		0.0003	0.02	0.000003	400

All new units (commencing construction after January 13, 2003) must be in compliance with all standards immediately. Existing units have until September 13, 2007 to comply with the Boiler MACT standard including the emission limits in Table 4-3.

Title IV Acid Rain Program

Title IV of the Clean Air Act set a goal of reducing annual SO_2 emissions under a two-phase tightening of the restrictions placed on fossil fuel-fired power plants. Phase I began in 1995 and affected mostly coal-burning electric utility plants located in 21 eastern and mid western states. Some additional units joined Phase I of the program as substitution or compensating units, bringing the total of Phase I affected units to 445.

Phase II, which began in the year 2000, tightened the annual emissions limits imposed on these large, higher emitting plants and also set restrictions on smaller, cleaner plants fired by coal, oil, and gas, encompassing over 2,000 units in all. The program affects existing utility units serving generators with an output capacity of greater than 25 megawatts and all new utility units.

As part of the Acid Rain Program, Congress established a voluntary Opt-in Program, offering a combustion source a financial incentive to voluntarily reduce its SO_2 emissions. The Opt-in Program allows sources not required to participate in the Acid Rain Program the opportunity to enter the program on a voluntary basis and receive their own acid rain allowances. By reducing emissions below its allowance allocation, an opt-in source has unused allowances, which it can sell in the SO_2 allowance market. An opt-in source can withdraw from the program provided it meets certain conditions:

1. The opt-in source must submit its annual compliance certification report by January 30 of the first calendar year in which the withdrawal is to be effective (rather than March 1).

2. The opt-in source must immediately provide additional allowances if it has excess emissions.

3. The opt-in source must surrender all allowances allocated to it for the year in which the withdrawal is to take effect and for all years thereafter.

If the opt-in source does not meet these conditions to withdraw, the opt-in source remains in the Opt-in Program and subject to all its requirements. Upon withdrawal, all allowances allocated to those sources must be relinquished.

New utility units as described in this study are not eligible for an allocation of SO_2 allowances. New utility units may only obtain allowances through the SO_2 trading program and must maintain a balance that is at least equal to the annual tonnage of SO_2 emissions from the new sources.

Clean Air Interstate Rule (CAIR)

This regulation was just published in its final form on March 10, 2005. The full scope and implication of this rule remains unclear until the State of Missouri determines how it will implement the rule, which must occur no later than 18 months from the rules published date. However, Stanley Consultants completed an initial review of this regulation to provide some understanding of how this will affect the alternatives considered in this study.

EPA determined that 28 states (including Missouri) and the District of Columbia contribute significantly to non-attainment of the national ambient air quality standards (NAAQS) for fine particles ($PM_{2.5}$) and/or 8-hour ozone in downwind states. EPA is therefore requiring these upwind states to revise their state implementation plans (SIPs) to include control measures to reduce emissions of sulfur dioxide (SO_2) and/or nitrogen oxides (NO_x).

An Electric Generating Unit regulated under CAIR is specified as:

> "a stationary, fossil-fuel-fired boiler or stationary, fossil fuel- fired combustion turbine *serving at any time, since the start-up of the unit's combustion chamber*, a generator with nameplate capacity of more than 25 MWe producing electricity for sale."

This definition is different than the proposed rule in that it will regulate an EGU source if it powered a turbine greater than 25 MW at any time in the history of the unit rather than at the time CAIR was promulgated.

Under CAIR, EPA is specifying that the emissions reductions be implemented in two phases. The first phase of NO_X reductions starts in 2009 (covering 2009-2014), with the first phase of SO_2 reductions starting in 2010 (covering 2010-2014). The second phase of reductions for both NO_s and SO_2 starts in 2015 (covering 2015 and thereafter).

Each state will be allocated from EPA a budget of SO_2 and NO_x emissions that it may apportion to emission sources in its state. While the rule mainly targets electric utility generators (EGUs), states may choose to include non-EGUs in its budgeting/allocation process as well. EPA has established state budgets based on their historic fuel usage.

The 2010 NO_x emission budgets are based on a heat input rate of 0.15 lb/MMBtu and the 2015 NO_x budget is based on 0.125 lb/MMBtu. Since NO_X is a precursor to both PM2.5 and ozone, some states, including Missouri, will have both an annual NO_x budget and a seasonal NO_x budget. The latter is similar to the current NO_x SIP Call cap-and-trade program, which will now be replaced by the CAIR program.

SO_2 budget baselines are based on historic acid rain program budgets where the 2010 SO_2 budget will be 50% of the historic acid rain baseline in 2015, the acid rain baseline will be 65% of the Acid Rain baseline (with some minor adjustments provided based on growth projections of each state). The CAIR rule actually modifies the existing Title IV acid rain program rules with the interaction of the cap and trade program so that it follows the model SO_2 cap and trade program of the CAIR rule.

While it is reasonable to determine that existing sources will receive some allocation of NO_x and SO_2 credits, it remains unclear how the state will allocate credits to new sources. Missouri must determine during the development of its SIP revision what percentage of NO_x and SO_2 credits it will hold in reserve to allocate to new sources. Any new sources not receiving the needed allocations will likely need to purchase credits on the open market.

Clean Air Mercury Rule (CAMR)

On March 15, 2005, EPA published the final Clean Air Mercury Rule. The mercury rule establishes performance standards for mercury emissions from new EGU sources as defined in 40 CFR Part 60 Subpart D and establishes a cap and trade program for all EGUs as defined in 40 CFR Part 60 Subpart HHHH. The determination of an existing utility boiler under CAMR is determined in the same manner as with CAIR. So, the determination of whether Boilers 6 and 7 historically powered a turbine greater than 25 MW also applies in determining whether the cap and trade program of CAMR applies to these units as well. The performance standards for mercury emissions will apply to only new coal-fired units built after January 30, 2004, and are based on the categories shown in Table 4-4.

Table 4-4 Hg Emission Limits for New Coal Fired EGUs

Unit (Fuel) Type	Emission Limit
Bituminous Units	21×10^{-6} lb/MWh
Subbituminous Units:	
Wet FGD	42×10^{-6} lb/MWh;
Dry FGD	78×10^{-6} lb/MWh;
Lignite Units:	145×10^{-6} lb/MWh
Coal Refuse Units:	1.4×10^{-6} lb/MWh
IGCC Units:	20×10^{-6} lb/MWh

EPA has set a national Hg cap of 38 tons for the years 2010 to 2017, for which Missouri will be budgeted 1.393 tons per year. In 2018, the cap will be reduced to 15 tons of which Missouri will be allocated 0.55 tons per years. EPA believes that the 2010 cap reflects the Hg reduction that will be achieved by the NO_x and SO_x reduction mandated by the CAIR rule. EPA refers to this as the "co-benefits level."

States may elect to participate in an EPA-managed cap-and-trade program for coal-fired utility units greater than 25 MW. To participate, a state must adopt the model cap-and-trade rules finalized in this section of today's rule with flexibility to modify sections regarding source Hg allocations. For states that elect not to participate in an EPA-managed cap-and-trade program, their respective state Hg budgets will serve as a firm cap.

Hg allowances will be allocated based upon the states chosen allocation methodology. EPA's model Hg rule has provided an example allocation, complete with regulatory text, which may be used by states or replaced by text that implements a states alternative allocation methodology. The state Hg emission budgets are a permanent cap regardless of growth in the electric sector and, therefore, states have the responsibility of incorporating new units in their Hg emission budgets.

Regulatory Considerations for Reconstruction of Existing Boilers

The existing Boilers No. 6, 7, and 8 were built between 1957 and 1970. From a regulatory basis, they often are referred to as "grandfathered units." These emission sources often do not have the same level of regulatory requirements as emission sources built more recently. Regulations such as New Source Performance Standards do not apply to these units nor have they undergone a Federal New Source Review/Prevention of Significant Deterioration (NSR-PSD) review for Best Available Control Technology (BACT).

However, in an effort to achieve the goals of the 1990 Clean Air Act Amendments, new regulations have been promulgated to include existing and new emission sources, including boilers. In some cases, such as the Boiler MACT, new units have stricter standards than existing units.

An important point to consider is how an "existing unit," may be reclassified as a "modified" or "reconstructed" unit, which is generally regulated as new units. Although the language varies slightly depending on the regulatory citation in question, the general intent of the regulation is that reconstruction or modification is any physical or operational change to an existing facility which results in a net emission increase (or emission rate increase) to the atmosphere of any pollutant to which a standard applies.

This is an important consideration in this study when evaluating whether to "upgrade" an existing unit. An existing unit would be reclassified as a new unit if the physical capacity was increased or an operational change occurs. Examples might include increasing burner size, debottlenecking the boiler by modifying other units (e.g. upgrading the steam turbine), or making an operational change such as switching to a higher polluting fuel (e.g. gas to oil to coal). Simply increasing the hours of operation of an existing unit, however, does not qualify as a modification or reconstruction.

Baseline Environmental Conditions

In assessing the applicable environmental requirements for the project, the existing environmental conditions of the facility must first be understood. Table 4-5 lists the type, size, and the construction date (or most recent modification date) of the emission sources at the facility that may be either modified or replaced in any of the alternatives presented in this study.

Table 4-5 Project Affected Emission Sources

Emission Point ID	Emission Unit ID	Emission Unit Name	Maximum Permitted Capacity		Regulatory Applicability Date	Project Affected Unit
EP01	EU0010	Boiler Unit 6	8.83	tons/hr	1957	Yes
EP02	EU0020	Boiler Unit 7	13.20	tons/hr	1965	Yes
EP03	EU0030	Boiler Unit 8	0.40	MMcf/hr	1970	Yes
EP06	EU0040	Coal Storage Pile	13.69	tons/hr	NA	Yes
EP07	EU0050	CT Unit 6	0.18	MMcf/hr	1963	No
EP08	EU0060 – EU0130	Coal Train Unloading, Conveying, and Load-out	100 to 200	ton/yr	1964 - 1984	Yes
EP09	EU0140	Ash Pile	5.00	ton/hr	NA	Yes
EP12	Insignificant	Electric Generation #2				No
EP13	Insignificant	Diesel Storage Tank #1				No
EP14	Insignificant	Diesel Storage Tank #2				No

For these emission sources, historic emission rates were evaluated to determine baseline emissions. Emissions from sources that may be replaced under any of the proposed scenarios can sometimes be subtracted from the potential emissions of the new sources. The net difference between the past actual emissions and future potential emissions may be used to determine regulatory applicability under PSD Air Quality Construction Permitting. Computations showing the past actual emissions and future potential emissions are provided in Appendix F.

Table 4-6 City of Columbia Department of Water and Light, 2003 Reported Emissions

Emission Unit Name	Throughput		NO_X	SO_2	PM_{10}	CO	VOC
Boiler Unit 6	19,241	tons	138.25	372.12	0.32	48.10	0.48
Boiler Unit 7	23,815	tons	172.66	434.85	0.39	59.54	0.60
Boiler Unit 8	2.064	MMcf	0.29	0.00	0.01	0.09	0.01
Coal Storage Pile	43,055	tons			0.23		
Coal Train Unloading, Conveying, and Load-out	40,355	tons			1.08		
Ash Pile	3,500 and 3	tons acres			1.32		

Comparison of Emission from Existing and Proposed Boilers

The emission rates of the existing boilers will be significantly improved upon because of the additional efficiency gains and control technologies from the proposed boilers. Table 4-7 shows a comparison of actual emissions from the existing coal fired boilers (Table 4-6) to the projected emissions of the proposed boilers. Emissions of PM_{10}, HCl, and Hg emissions from the existing boiler are based on the stack test performed in November, 2004, at the power plant. Emissions from the proposed boilers are based on the Best Available Control Technology emission controls (Table 4-2), the Hg New Source Performance Standards (Table 4-4) and the vendor performance data supplied for this study.

Table 4-7 Comparison of Existing and New Coal Boiler Emissions Rates

Pollutant	Boiler 6	Boiler 7	100 MW 1800 psi (Alt. No. 1)	70 MW 1800 psi (Alt. No. 2 or 3 Phase 1)	70 MW 900 psi Alt. No. 2 Phase 2	Estimated Reduction per MWhr
SO_2, lb/MWhr	21.96 [a]	20.22 [a]	0.39	0.41	0.50	98%
NO_X, lb/MWhr	8.16 [a]	7.95 [a]	0.98	1.02	1.25	85%
PM_{10}, lb/MWhr	0.57 [b]	0.56 [b]	0.15	0.15	0.19	70%
CO, lb/MWhr	3.52 [a]	2.24 [a]	1.48	1.54	1.87	45%
VOC, lb/MWhr	0.05 [a]	0.05 [a]	0.05	0.05	0.05	No Change
HCl, lb/MWhr	2.54 [b]	2.48 [b]	0.05	0.05	0.06	98%
Hg, lb/MWhr	$102 \cdot 10^{-6}$ [b]	$99 \cdot 10^{-6}$ [b]	$21 \cdot 10^{-6}$	$21 \cdot 10^{-6}$	$21 \cdot 10^{-6}$	80%

Source: [a] 2003 MDNR Emission Inventory Questionnaire
[b] November, 2004 Stack Test
[c] Calculations were made on the basis of a nominal 100 MW net plant output.

Identification of Applicable Requirements for Proposed Options

Based on the review of applicable regulatory requirements, including the recently finalized CAIR and CAMR, the following regulatory determinations can be made.

New Source Review

All three proposed alternatives will trigger PSD review for NO_X, PM/PM_{10}, CO, and SO_2 if the new units described in each alternative are permitted at 100% of their design capacities. In some cases PSD may also be triggered for emissions of VOC, but since there are no additional BACT emission controls for VOC emissions, this determination will likely not impact the final plant configuration. A PSD analysis of BACT will result in a regulatory determination that emission controls consistent with those shown in Table 4-2 will need to be installed. It should be noted that the application of the Spray Dry Absorber to control SO2 emissions would result in an overall net decrease in SO_2 emissions such that PSD would not be triggered. While this will not provide any relief for emission controls as this is the highest capital best performing SO_2 emission control strategy available, it will provide some relief for other PSD requirements such as ambient air monitoring and air dispersion modeling for PSD increment consumption.

There is one possible permitting alternative that would provide for an exemption from PSD for SO_2 emissions. An air quality permit seeking reduced operating limits may net out of PSD for SO_2 thereby eliminating the BACT requirement for a spray dry absorber. Considering only the CFB Boiler's inherent desulfurization capability, the following two alternatives may be considered.

- For Alternative No. 1, accept an operating limit of 85% utilization for the 100 MW CFB Boiler. This would result in a net emission increase that is below PSD SO_2 major modification threshold.
- For Alternative No. 2, after applying BACT for all pollutants to the 70 MW 1800 psi CFB Boiler in Phase I, the Phase II 70 MW 900 psi CFB Boiler could net out of PSD for SO_2 with a 95% utilization limit.

Boiler MACT

The City of Columbia Department of Water and Light is a major source for HAP emissions and therefore potentially subject to MACT standards for source categories. Since the Boiler MACT does not apply to Electric Generation Units (EGUs) greater than 25 MW, the 70 MW and 100 MW boilers evaluated in this study would be exempt from this rule. Boilers 6 and 7, however, are less than 25 MW and therefore are subject to this rule. While the Boiler MACT EGU exemption intends to avoid "dual" regulation of utility boilers and industrial boilers, there is some ambiguity that EPA is currently attempting to clarify for small boilers that currently (or historically), in combination can power a steam turbine greater than 25 MW. This interpretation may impact the applicability of this rule to the existing facility. Therefore, a continued effort to seek a rule applicability determination from Missouri DNR is recommended.

The City of Columbia Department of Water and Light recently conducted a stack test for some of the Boiler MACT regulated pollutants. Upon review of the stack test results, it was determined that at 0.15 lb/MMBtu, the emissions of HCl from Boilers 6 and 7 were above the compliance threshold of 0.09 lb/MMBtu shown in Table 4-3. Therefore, prior to the September 13, 2007 compliance date, The City of Columbia Department of Water and Light must take some measures to reduce the HCl emissions from the two units.

This may be achieved through modification of the existing control system or by the reduction of the chlorine content of the coal. An add-on control system, such as a dry scrubber, would likely not be necessary. Instead, basic reagent injection upstream of the baghouse would likely provide sufficient HCl reductions to comply with the Boiler MACT HCl standard.

Alternatively, the facility may elect to combust lower chlorine content coal by an amount directly proportional to the result of the stack test and the Boiler MACT HCl limit (e.g. more than 40%). The results of the previously mentioned stack test indicated that mercury emissions were below the Boiler MACT emission limit and, with baghouse control, the PM emission limits shown in Table 4-3.

Acid Rain Program

The City of Columbia Department of Water and Light currently participates in the Acid Rain Program where it is allocated 4,659 tons per year of SO_2 allowances per year for its qualifying sources. These allowances are fungible where excess allowances not retired by the facility can be traded and/or sold through the Acid Rain trading program. Under the current plant configuration, Boilers 6 & 7 power turbines that are less than 25 MW, thereby implying the plant qualifies as an "opt-in unit," rather than an originally "affected source." However, the plant has operated under a different configuration in the past where the boilers and steam turbines may have been connected to a common header. Depending on whether the header configuration drove a turbine greater than 25 MW, the existing boilers may be classified as an "affected" or an "opt-in" source.

A further evaluation, outside the scope of this study, may provide additional insight to the historical determination of the Acid Program applicability and the determination of whether Boiler 6 & 7 qualify as affected sources or opt-in sources. The result of this additional analysis may determine whether the current Boilers 6 and 7 are affected sources or opt-in sources. If determined to be affected sources, the City will be able to maintain the Acid Rain SO_2 allowances and apply them to future project SO_2 emissions.

If, however, such an evaluation determines that Boilers 6 and 7 are opt-in sources, then the Boiler 6 and 7 SO_2 allowances would be lost and not available to the new project sources. In this instance, the boilers considered in this study would not be allocated SO_2 allowances and would instead need to procure such allowances from other sources. New units are not be part of the allocation process offered to existing units and, therefore, it will be necessary to obtain acid rain allowances from other sources within the City of Columbia Department of Water and Light system or the SO_2 trading program.

Clean Air Interstate Rule

As with the discussion of the opt-in evaluation under Acid Rain, the determination of CAIR applicability similarly applies to Boilers 6 and 7 based on whether either/both boilers historically powered a turbine (through a common header) of 25 MW or greater. If the units meet the definition of an affected EGU (e.g. *have the boilers served at any time, since the start-up of the unit's combustion chamber, a generator with nameplate capacity of more than 25 MWe*), the Boilers 6 & 7 would likely be subject to CAIR.

Should Boilers No. 6 and 7 be subject to CAIR, it is anticipated that the current SO_2 allowances for the facility would be rolled over into CAIR-based allowances, but would be retired at a 2:1 rate in 2010 and at a 2.86:1 rate in 2015. Any new sources constructed at the site would likely be able to utilize the remaining balance of SO_2 credits at the facility and any remaining needed balance would have to come from either a reserve managed by the State of Missouri for new sources or purchased on an open market. Additionally, the modification of Boilers No. 6 and 7 to achieve the HCl Boiler MACT standard will have a co-benefit of SO_2 reduction at approximately the same reduction rate.

The existing boilers currently do not have NO_x control. Based on EPA CAIR background documentation, NO_x budgets have been set on a 0.15 lb/MMBtu heat input basis for 2010 and 0.125 lb/MMBtu for 2015. As currently configured, the existing boiler emission rates at 0.50 lb/MMBtu or greater and do not perform at the CAIR baseline emission rates for NO_x.. Therefore, either additional NO_x reductions or purchasing NO_x credits on the open market may be required to operate Boilers 6, 7, and/or 8 after the effective date of January 1, 2009.

Clean Air Mercury Rule (CAMR)

The new source performance emission standards established in CAMR are only applicable to newly constructed sources. Therefore the existing boilers would not be required to meet the source specific limits established by this rule. The 70 MW and 100 MW CFB boilers would likely be able to achieve the CAMR mercury emission standards because of the co-benefit associated with the SNCR and the CFB desulfurization system. Only EGU coal fired sources greater than 25 MW would be required to participate in the cap and trade program that would be implemented in 2010. With the definition of EGU under CAMR being the same as CAIR, a determination of CAMR cap and trade applicability is again based on whether the boilers served at any time, since the start-up of the unit's combustion chamber, a generator with nameplate capacity of more than 25 MWe.

The Hg cap baseline is established based on the control achieved by those units that could comply with the SO_x and NO_x budgets in CAIR. Since the new 70 MW and 100 MW units would comply with CAIR, they would likely not need addition Hg credits. It should be noted that even though Boilers No. 6 and 7 would not be subject to CAMR, they still must comply with the Boiler MACT Hg emission limit for existing sources.

Summary of Applicable Requirements

Table 4-8 shows the affected emission units considered in each alternative defined in this study and the applicable regulatory requirements reviewed.

Table 4-8 Summary of Applicable Regulatory Requirements

Unit	Emission Controls	NSR	Boiler MACT	NSPS Da	CAIR / Acid Rain	Mercury Rule
New 100 MW CFB	PM/PM_{10}: Baghouse NO_x: SNCR SO_2: CFB Integrated Desulfurization System + Spray Dry Adsorber Hg: Co-Benefit of SNCR + CFB/SDA	Yes	No	Yes	Yes	Yes
New 70 MW CFB	PM/PM_{10}: Baghouse NO_x: SNCR SO_2: CFB Integrated Desulfurization System + Spray Dry Absorber Hg: Co-Benefit of SNCR + CFB/SDA	Yes	No	Yes	Yes	Yes
Boilers 6 and 7	To comply with Boiler MACT, Boilers No. 6 and 7 must provide additional HCl control or use low chlorine coal if still in service on 9/13/2007. Upstream lime injection and upgrade baghouse, or low chlorine fuel management strategy. If CAIR/CAMR regulated, must install NO_X controls by 2009 and SO_X/Hg controls by 2010 unless emissions allowances are purchased from other sources.	No	Compliance Date of 9/13/2007	No	No, unless historically powered a 25MW turbine	No, unless historically powered a 25MW turbine
Boiler 8	NO_x controls for CAIR by 2009 or purchase NO_x allowances above 0.15 lb/MMBtu if still in service.	No	Very Limited	No	Yes	No

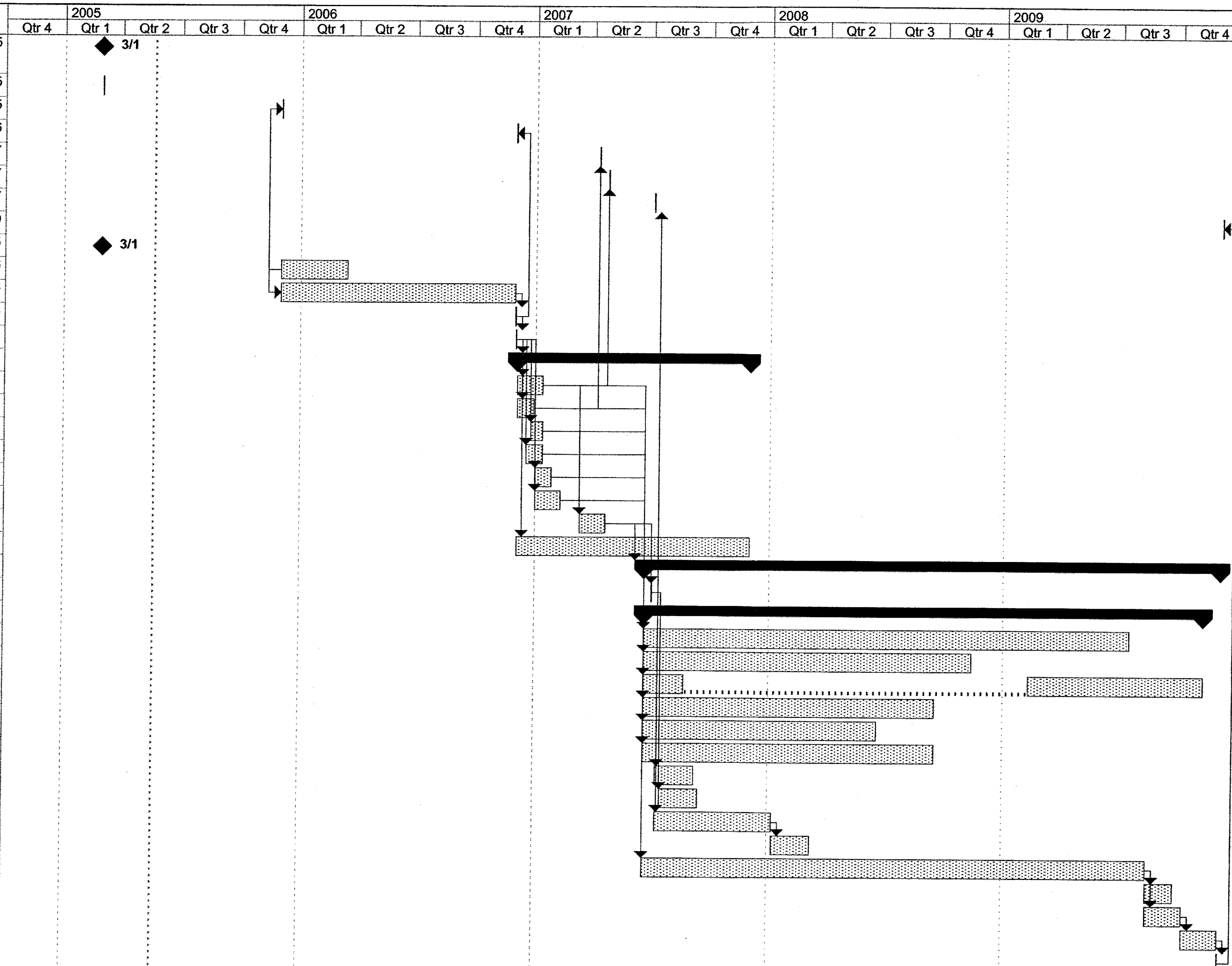
Section 5

Schedules

Schedules for each alternative are in the following section.

City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade
Stanley Cosnultants, Project No. 17788
Alternate No. 1, 100 MW CFB Power Plant

ID		Task Name	Duration	Start	Finish
1		***ALTERNATE No. 1 NEW 100 MW CFB BOILER***	0 days	Tue 3/1/05	Tue 3/1/05
2		**PROJECT MILESTONES**	1 day	Tue 3/1/05	Tue 3/1/05
3		Notice to Proceed	1 day	Thu 12/1/05	Thu 12/1/05
4		Air Permit Received	1 day	Thu 11/30/06	Thu 11/30/06
5		Award Turbine-Generator Contract	1 day	Mon 4/9/07	Mon 4/9/07
6		Award CFB Boiler Contract	1 day	Mon 4/23/07	Mon 4/23/07
7		Start Construction	1 day	Tue 7/3/07	Tue 7/3/07
8		Commercial Operation	1 day	Thu 12/3/09	Thu 12/3/09
9			0 days	Tue 3/1/05	Tue 3/1/05
10		**CONCEPTUAL ENGINEERING**	75 days	Thu 12/1/05	Wed 3/15/06
11		PERMITTING	260 days	Thu 12/1/05	Wed 11/29/06
12		Air Permit Received	1 day	Thu 11/30/06	Thu 11/30/06
13		Project Funding Approved	1 day	Fri 12/1/06	Fri 12/1/06
14		**DETAILED ENGINEERING**	**260 days**	**Mon 12/4/06**	**Fri 11/30/07**
15		CFB Boiler Specification	30 days	Mon 12/4/06	Fri 1/12/07
16		Steam Turbine-Gen Specification	20 days	Mon 12/4/06	Fri 12/29/06
17		Bag House Specification	15 days	Mon 12/25/06	Fri 1/12/07
18		Material Handling Specification	20 days	Mon 12/18/06	Fri 1/12/07
19		Electrical Equipment Specification	20 days	Mon 1/1/07	Fri 1/26/07
20		Control Systems Specification	30 days	Mon 1/1/07	Fri 2/9/07
21		Prepare Construction Contract	30 days	Mon 3/12/07	Fri 4/20/07
22		Engineering	260 days	Mon 12/4/06	Fri 11/30/07
23		**CONSTRUCTION**	**641 days**	**Thu 6/21/07**	**Thu 12/3/09**
24		Start Construction	1 day	Mon 7/2/07	Mon 7/2/07
25		**MAJOR EQUIPMENT DELIVERY**	**622 days**	**Thu 6/21/07**	**Fri 11/6/09**
26		CFB Boiler Delivery	540 days	Thu 6/21/07	Wed 7/15/09
27		Steam Turbine-Gen Delivery	365 days	Thu 6/21/07	Wed 11/12/08
28		Bag House Delivery	239 days	Thu 6/21/07	Fri 11/6/09
29		Material Handling Delivery	324 days	Thu 6/21/07	Tue 9/16/08
30		Electrical Equipment Delivery	260 days	Thu 6/21/07	Wed 6/18/08
31		Control Systems Delivery	324 days	Thu 6/21/07	Tue 9/16/08
32		Site Work	44 days	Tue 7/10/07	Fri 9/7/07
33		Modify Existing Ash Handling	44 days	Tue 7/17/07	Fri 9/14/07
34		Ash Pond	130 days	Tue 7/10/07	Mon 1/7/08
35		Foundatons	44 days	Tue 1/8/08	Fri 3/7/08
36		CFB Boiler Construction Complete	560 days	Thu 6/21/07	Wed 8/12/09
37		Training & Documentation	30 days	Thu 8/13/09	Wed 9/23/09
38		Start-up	40 days	Thu 8/13/09	Wed 10/7/09
39		Commissioning	40 days	Thu 10/8/09	Wed 12/2/09
40		Commercial Operation	1 day	Thu 12/3/09	Thu 12/3/09



Alternate No. 1
100 MW CFB Power Plant
Date: Fri 5/20/05

Task	Progress	Summary	External Tasks	Deadline
Split	Milestone	Project Summary	External Milestone	

City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade
Stanley Cosnultants, Project No. 17788
Alternate No. 2, 70 MW CFB Power Plant & Repowered ST/G No. 5,6 & 8

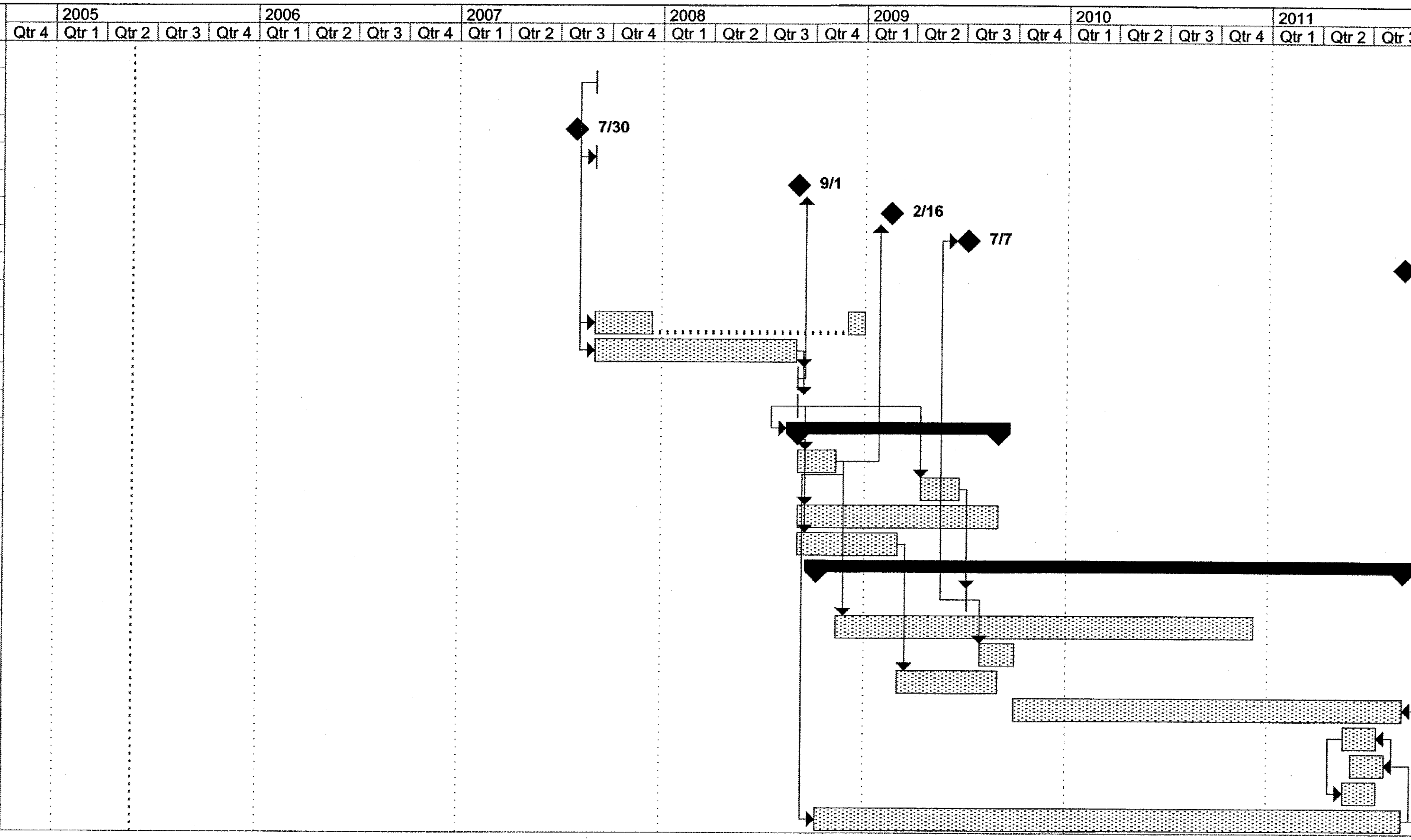
ID		Task Name	Duration	Start	Finish
1		***ALTERNATE No. 2 - PHASE 1: NEW 70 MW CFB BOILER***	0 days	Thu 12/1/05	Thu 12/1/05
2		**PROJECT MILESTONES**	0 days	Tue 3/1/05	Tue 3/1/05
3		Notice to Proceed	1 day	Thu 12/1/05	Thu 12/1/05
4		Air Permit Received	0 days	Thu 11/30/06	Thu 11/30/06
5		Award Turbine-Generator Contract	1 day	Mon 4/16/07	Mon 4/16/07
6		Award CFB Boiler Contract	1 day	Mon 4/16/07	Mon 4/16/07
7		Start Construction	1 day	Wed 8/1/07	Wed 8/1/07
8		Phase 1: Plant Operational	1 day	Tue 6/22/10	Tue 6/22/10
9					
10		**CONCEPTUAL ENGINEERING**	75 days	Thu 12/1/05	Wed 3/15/06
11		PERMITTING	260 days	Thu 12/1/05	Wed 11/29/06
12		Air Permit Received	1 day	Thu 11/30/06	Thu 11/30/06
13		Project Funding Approved	1 day	Fri 12/1/06	Fri 12/1/06
14		**DETAILED ENGINEERING**	**260 days**	**Mon 12/4/06**	**Fri 11/30/07**
15		CFB Boiler Specification	25 days	Mon 12/4/06	Fri 1/5/07
16		Steam Turbine-Gen Specification	25 days	Mon 12/4/06	Fri 1/5/07
17		Bag House Specification	20 days	Mon 12/25/06	Fri 1/19/07
18		Material Handling Specification	20 days	Mon 12/18/06	Fri 1/12/07
19		Electrical Equipment Specification	20 days	Mon 1/1/07	Fri 1/26/07
20		Control Systems Specification	25 days	Mon 1/1/07	Fri 2/2/07
21		Prepare Construction Packages	30 days	Thu 4/19/07	Wed 5/30/07
22		Engineering	260 days	Mon 12/4/06	Fri 11/30/07
23		**CONSTRUCTION**	**1066 days**	**Mon 7/30/07**	**Tue 8/30/11**
24		Contractor on Site	1 day	Wed 8/1/07	Wed 8/1/07
25		**MAJOR EQUIPMENT DELIVERY**	**540 days**	**Tue 7/31/07**	**Mon 8/24/09**
26		CFB Boiler Delivery	540 days	Tue 7/31/07	Mon 8/24/09
27		Steam Turbine-Gen Delivery	367 days	Tue 7/31/07	Wed 12/24/08
28		Bag House Delivery	195 days	Tue 7/31/07	Mon 4/28/08
29		Material Handling Delivery	324 days	Tue 7/31/07	Fri 10/24/08
30		Electrical Equipment Delivery	260 days	Tue 7/31/07	Mon 7/28/08
31		Control Systems Delivery	324 days	Tue 7/31/07	Fri 10/24/08
32		Site Work	44 days	Thu 8/9/07	Tue 10/9/07
33		Modify Existing Ash Handling	44 days	Thu 8/16/07	Tue 10/16/07
34		Ash Pond	130 days	Thu 8/9/07	Wed 2/6/08
35		Foundatons	44 days	Thu 2/7/08	Tue 4/8/08
36		CFB Boiler Construction Complete	500 days	Wed 7/23/08	Tue 6/22/10
37		Start-up - Phase I	44 days	Tue 3/9/10	Fri 5/7/10
38		Commissioning - Phase I	44 days	Tue 3/23/10	Fri 5/21/10
39		Training & Documentation - Phase I	44 days	Tue 3/9/10	Fri 5/7/10
40		Phase 1: Plant Operational	756 days	Tue 7/31/07	Tue 6/22/10
41					

Alternate No. 2
70 MW CFB Plant & Repowered ST/G
Date: Fri 5/20/05

Task		Progress		Summary		External Tasks		Deadline
Split		Milestone		Project Summary		External Milestone	

City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade
Stanley Cosnultants, Project No. 17788
Alternate No. 2, 70 MW CFB Power Plant & Repowered ST/G No. 5,6 & 8

ID	Task Name	Duration	Start	Finish
42				
43	***ALT. No. 2 - PHASE 2: REPOWER ST/G No. 5,6 & 8***	1 day	Mon 9/3/07	Mon 9/3/07
44	**PROJECT MILESTONES**	0 days	Mon 7/30/07	Mon 7/30/07
45	Notice to Proceed	1 day	Mon 9/3/07	Mon 9/3/07
46	Air Permit Received	0 days	Mon 9/1/08	Mon 9/1/08
47	Award CFB Boiler Contract	0 days	Mon 2/16/09	Mon 2/16/09
48	Start Construction	0 days	Tue 7/7/09	Tue 7/7/09
49	Phase 2: Plant Operational	0 days	Tue 8/30/11	Tue 8/30/11
50				
51	**CONCEPTUAL ENGINEERING**	98 days	Mon 9/3/07	Wed 12/31/08
52	PERMITTING	260 days	Mon 9/3/07	Fri 8/29/08
53	Air Permit Received	1 day	Mon 9/1/08	Mon 9/1/08
54	Project Funding Approved	1 day	Mon 9/1/08	Mon 9/1/08
55	**DETAILED ENGINEERING - Phase II**	**260 days**	**Tue 9/2/08**	**Mon 8/31/09**
56	CFB Plant Equipment Specifications	50 days	Tue 9/2/08	Mon 11/10/08
57	Prepare Construction Packages	50 days	Tue 4/14/09	Mon 6/22/09
58	CFB Engineering	260 days	Tue 9/2/08	Mon 8/31/09
59	Power House Upgrade Evaluation	130 days	Tue 9/2/08	Mon 3/2/09
60	**CONSTRUCTION - Phase II**	**756 days**	**Tue 10/7/08**	**Tue 8/30/11**
61	Contractor on Site - Phase II	1 day	Tue 7/7/09	Tue 7/7/09
62	CFB MAJOR EQUIPMENT DELIVERY	540 days	Tue 11/11/08	Mon 12/6/10
63	CFB Foundatons - Phase II	44 days	Fri 7/31/09	Wed 9/30/09
64	Power House Upgrade Work Complete	130 days	Tue 3/3/09	Mon 8/31/09
65	CFB Construction Complete - Phase II	500 days	Wed 9/30/09	Tue 8/30/11
66	Start-up - Phase II	44 days	Tue 5/17/11	Fri 7/15/11
67	Commissioning - Phase II	44 days	Tue 5/31/11	Fri 7/29/11
68	Training & Documentation - Phase II	44 days	Tue 5/17/11	Fri 7/15/11
69	Repowered Plant Operational - Phase II	756 days	Tue 10/7/08	Tue 8/30/11

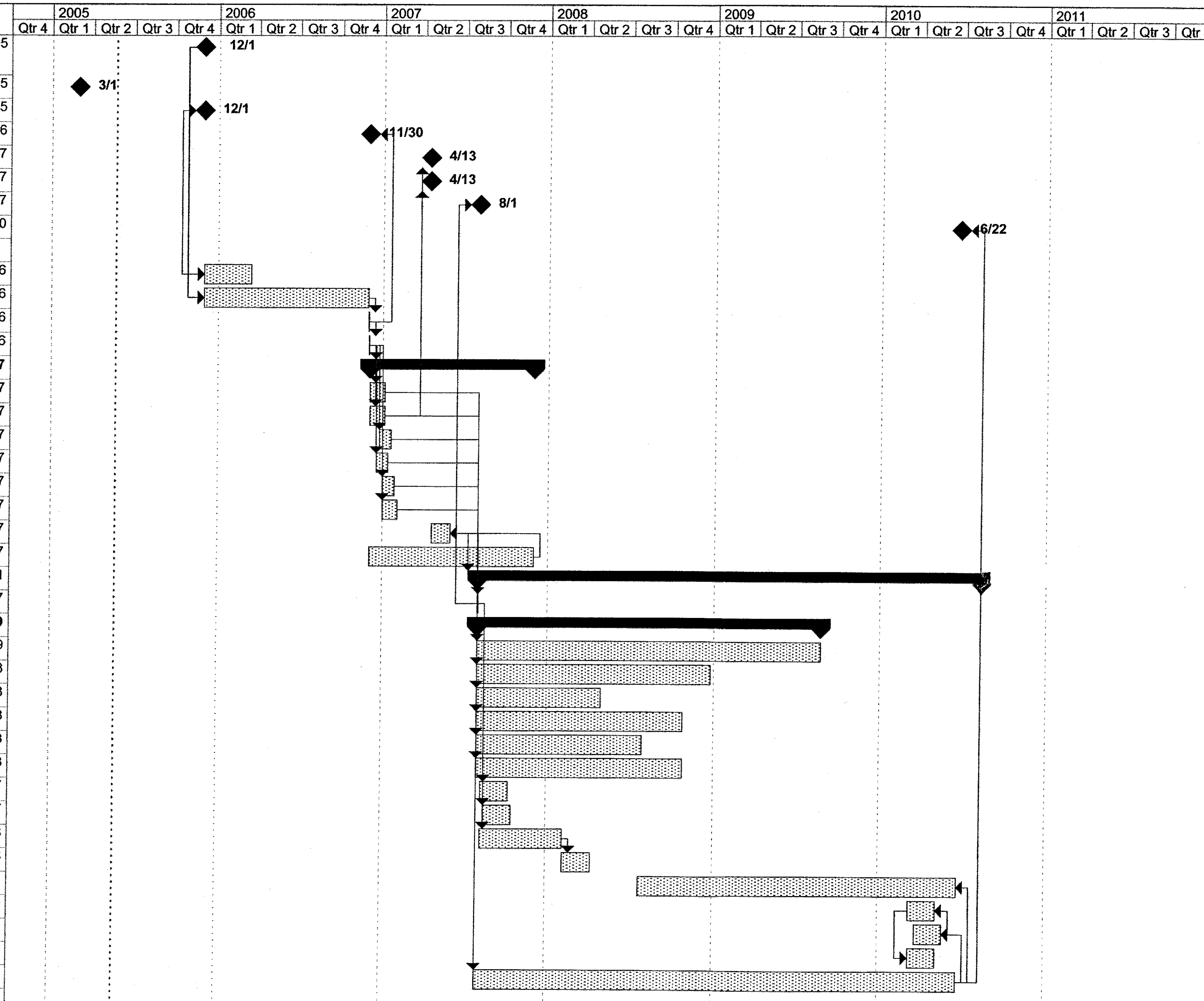


Alternate No. 2
70 MW CFB Plant & Repowered ST/G
Date: Fri 5/20/05

Task	Progress	Summary	External Tasks
Split	Milestone	Project Summary	External Milestone
Deadline			

City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade
Stanley Cosnultants, Project No. 17788
Alternate No. 2, 70 MW CFB Power Plant & Repowered ST/G No. 5,6 & 8

ID	Indicators	Task Name	Duration	Start	Finish
1		***ALTERNATE No. 3 - PHASE 1: NEW 70 MW CFB BOILER***	0 days	Thu 12/1/05	Thu 12/1/05
2		**PROJECT MILESTONES**	0 days	Tue 3/1/05	Tue 3/1/05
3		Notice to Proceed	0 days	Thu 12/1/05	Thu 12/1/05
4		Air Permit Received	0 days	Thu 11/30/06	Thu 11/30/06
5		Award Turbine-Generator Contract	0 days	Fri 4/13/07	Fri 4/13/07
6		Award CFB Boiler Contract	0 days	Fri 4/13/07	Fri 4/13/07
7		Start Construction	0 days	Wed 8/1/07	Wed 8/1/07
8		Phase 1: Plant Operational	0 days	Tue 6/22/10	Tue 6/22/10
9					
10		**CONCEPTUAL ENGINEERING**	75 days	Thu 12/1/05	Wed 3/15/06
11		PERMITTING	260 days	Thu 12/1/05	Wed 11/29/06
12		Air Permit Received	1 day	Thu 11/30/06	Thu 11/30/06
13		Project Funding Approved	1 day	Fri 12/1/06	Fri 12/1/06
14		**DETAILED ENGINEERING**	**260 days**	**Mon 12/4/06**	**Fri 11/30/07**
15		CFB Boiler Specification	25 days	Mon 12/4/06	Fri 1/5/07
16		Steam Turbine-Gen Specification	25 days	Mon 12/4/06	Fri 1/5/07
17		Bag House Specification	20 days	Mon 12/25/06	Fri 1/19/07
18		Material Handling Specification	20 days	Mon 12/18/06	Fri 1/12/07
19		Electrical Equipment Specification	20 days	Mon 1/1/07	Fri 1/26/07
20		Control Systems Specification	25 days	Mon 1/1/07	Fri 2/2/07
21		Prepare Construction Packages	30 days	Thu 4/19/07	Wed 5/30/07
22		Engineering	260 days	Mon 12/4/06	Fri 11/30/07
23		**CONSTRUCTION**	**1106 days**	**Mon 7/30/07**	**Tue 10/25/11**
24		Contractor on Site	1 day	Wed 8/1/07	Wed 8/1/07
25		**MAJOR EQUIPMENT DELIVERY**	**540 days**	**Tue 7/31/07**	**Mon 8/24/09**
26		CFB Boiler Delivery	540 days	Tue 7/31/07	Mon 8/24/09
27		Steam Turbine-Gen Delivery	367 days	Tue 7/31/07	Wed 12/24/08
28		Bag House Delivery	195 days	Tue 7/31/07	Mon 4/28/08
29		Material Handling Delivery	324 days	Tue 7/31/07	Fri 10/24/08
30		Electrical Equipment Delivery	260 days	Tue 7/31/07	Mon 7/28/08
31		Control Systems Delivery	324 days	Tue 7/31/07	Fri 10/24/08
32		Site Work	44 days	Thu 8/9/07	Tue 10/9/07
33		Modify Existing Ash Handling	44 days	Thu 8/16/07	Tue 10/16/07
34		Ash Pond	130 days	Thu 8/9/07	Wed 2/6/08
35		Foundatons	44 days	Thu 2/7/08	Tue 4/8/08
36		CFB Boiler Construction Complete	500 days	Wed 7/23/08	Tue 6/22/10
37		Start-up - Phase I	44 days	Tue 3/9/10	Fri 5/7/10
38		Commissioning - Phase I	44 days	Tue 3/23/10	Fri 5/21/10
39		Training & Documentation - Phase I	44 days	Tue 3/9/10	Fri 5/7/10
40		Phase 1: Plant Operational	756 days	Tue 7/31/07	Tue 6/22/10
41					

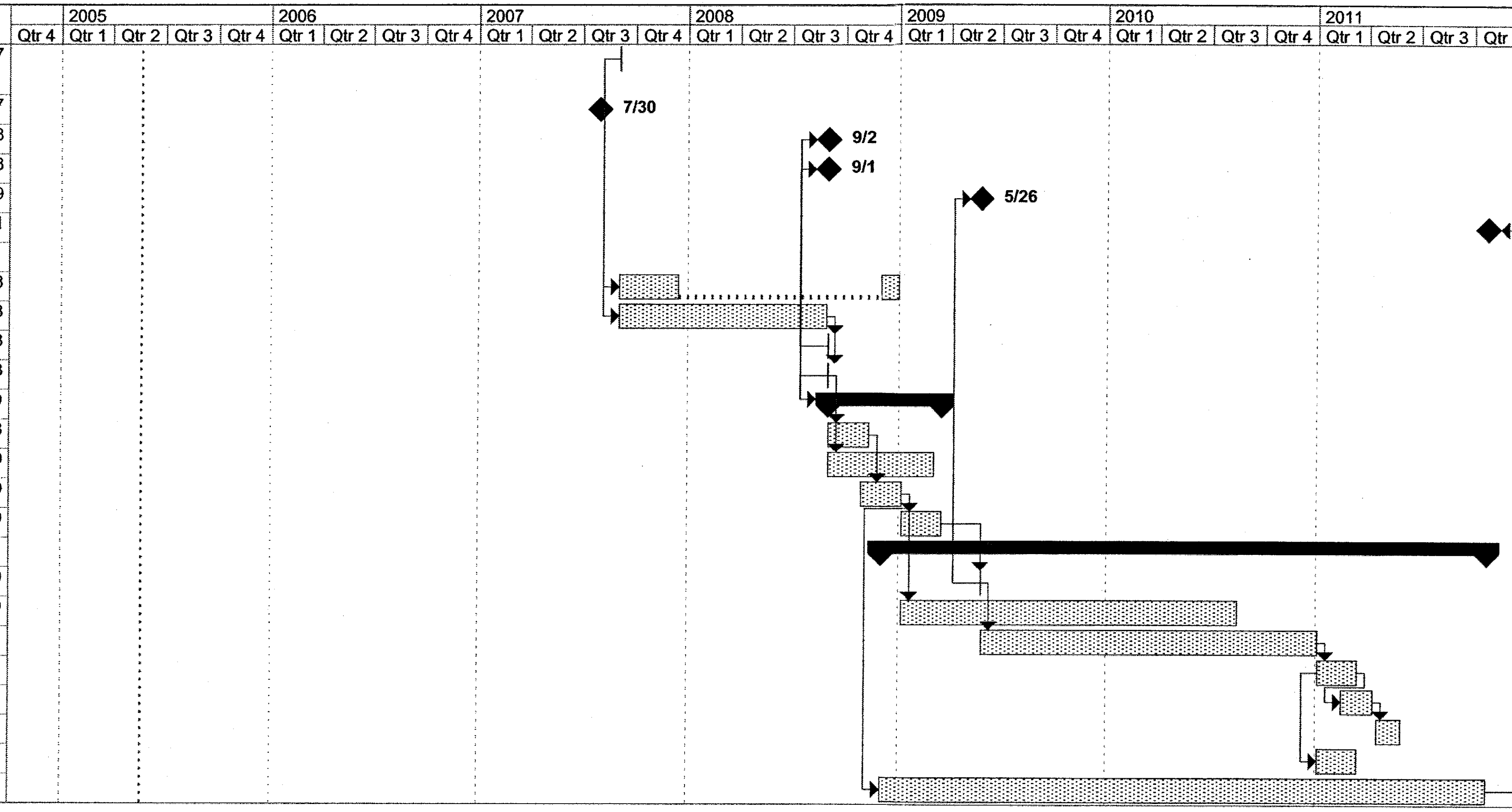


Alternate No. 2
70 MW CFB Plant & Repowered ST/G
Date: Fri 5/20/05

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade
Stanley Cosnultants, Project No. 17788
Alternate No. 2, 70 MW CFB Power Plant & Repowered ST/G No. 5,6 & 8

ID	Task Name	Duration	Start	Finish
42	***ALT. No. 3 - PHASE 2: Life Extension of Units 6, 7,***	1 day	Mon 9/3/07	Mon 9/3/07
43	**PROJECT MILESTONES**	0 days	Mon 7/30/07	Mon 7/30/07
44	Notice to Proceed	0 days	Tue 9/2/08	Tue 9/2/08
45	Air Permit Received	0 days	Mon 9/1/08	Mon 9/1/08
46	Start Construction	0 days	Tue 5/26/09	Tue 5/26/09
47	Phase 2: Plant Operational	0 days	Tue 10/25/11	Tue 10/25/11
48				
49	Life Extension Detailed Evaluation	98 days	Mon 9/3/07	Wed 12/31/08
50	PERMITTING	260 days	Mon 9/3/07	Fri 8/29/08
51	Air Permit Received	1 day	Mon 9/1/08	Mon 9/1/08
52	Project Funding Approved	1 day	Mon 9/1/08	Mon 9/1/08
53	**DETAILED ENGINEERING - Phase II**	**140 days**	**Tue 9/2/08**	**Mon 3/16/09**
54	Life Extension Evaluation & Testing	50 days	Tue 9/2/08	Mon 11/10/08
55	Engineering	130 days	Tue 9/2/08	Mon 3/2/09
56	Specifications	50 days	Tue 10/28/08	Mon 1/5/09
57	Construction Work Packages	50 days	Tue 1/6/09	Mon 3/16/09
58	**CONSTRUCTION - Phase II**	**756 days**	**Tue 12/2/08**	**Tue 10/25/11**
59	Contractor on Site - Phase II	1 day	Tue 5/26/09	Tue 5/26/09
60	Major Equipment Delivery	420 days	Tue 1/6/09	Mon 8/16/10
61	Construction Complete - Phase II	420 days	Wed 5/27/09	Tue 1/4/11
62	Start-up - Phase II	50 days	Wed 1/5/11	Tue 3/15/11
63	Commissioning - Phase II	40 days	Wed 2/16/11	Tue 4/12/11
64	Performance Tests - Units 6, 7, 8	30 days	Wed 4/20/11	Tue 5/31/11
65	Training & Documentation - Phase II	50 days	Wed 1/5/11	Tue 3/15/11
66	Units 6, 7, 8 Life Extension Complete	756 days	Tue 12/2/08	Tue 10/25/11



Alternate No. 2
70 MW CFB Plant & Repowered ST/G
Date: Fri 5/20/05

Task		Progress		Summary		External Tasks		Deadline
Split		Milestone		Project Summary		External Milestone		

Section 6

Cost Estimates

Capital Cost Estimating Approach

Stanley Consultants' capital cost estimates for the three alternatives evaluated in this analysis are shown in Appendix C and summarized in the following table.

Table 6-1 Alternative Capital Cost Summary

	Alternative No. 1	Alternative No. 2	Alternative No. 3
Phase 1 Description	108.5 MWe CFB	70 MWe CFB	70 MWe CFB
Phase 1	$219,700,000	$177,600,000	$176,100,000
Renovation	$3,200,000	$900,000	$900,000
Total Phase 1	$222,900,000	$178,500,000	$177,000,000
Phase 2 Description		Repowering CFB (73.5 MW)	Refurbish Units 6,7,8
New CFB Plant		$114,500,000	$0
Upgrade Cost		$25,500,000	$94,400,000
Total Phase 2		$140,000,000	$94,400,000
Alternative Total	**$222,900,000**	**$318,500,000**	**$271,400,000**

Estimates for Alternatives No. 2 and 3 have been broken into two phases. The new power generating activities have also been separated from renovation work items. Estimates are given in current dollars. Each estimate should be escalated to the time of contract award once a project schedule is defined.

Budget quotations from manufacturers have been utilized for the major equipment items. A line item for "undeveloped design details" has been included to capture work which is not yet defined at this conceptual point in time. Engineering (5%), administration (2%) and contingency (10%) have been included for the new power plant components. For the renovation and life extension activities engineering has been included at 8% due to the added challenges of retrofit activities.

Other than the administrative cost mentioned, other Owner's costs such as interest during construction, start-up fuel and water, performance testing, and insurance have not been included.

The conceptual costs for the repowering portion of Alternative No. 2, phase 2 and the life extension refurbishment work in Alternative No. 3, phase 2 were based on a percentage of the replacement cost of a similar new unit, except for tasks which were known to require attention at this point. Stanley Consultants recommends that detailed life extension programs be undertaken if either Alternative No 2 or 3 are pursued. This would consist of a detailed investigation and testing program to prioritize the repair and replacement of equipment. Those items which will not be fully defined until after the life extension program is initiated are addressed with an allowance.

Operating and Maintenance Costs

Operating and maintenance costs for the alternatives evaluated are provided in the following Table 6-2.

Table 6-2 Operating and Maintenance Costs

Stoker Fired Boiler Plants	
Fixed O&M ($/kW-yr)[2]	15.32
Variable O&M (mills/kWh)[2]	8.03
Circulating Fluidized Bed Boiler Plants	
Fixed O&M ($/kW-yr)[1]	$30 - 37.00
Variable O&M (mills/kWh)[1]	2 - 5.50

Operating and maintenance costs for the CFB boiler alternatives were determined based on industry data.[1] Costs will vary depending on operating practices, labor rates and the cost of consumables.

Variable and fixed O&M costs for the stoker fired boilers were escalated to 2005 dollars at 2% per year from the 1992 reported data.[2] For comparison, industry referenced O&M data for coal fired plants in 2002 showed a fixed cost of $40.92/kw-yr and variable cost of $3.08 /MWh.[3] Note that the recent costs for inspecting and overhauling turbine generators No. 5 and 7 and rebuilding the economizer are not included.

O&M costs for CFB boilers with spray absorption SO_2 control are less than pulverized coal plants with flue gas desulfurization systems (FGD) although this depends on many variables including fuel quantity, emission levels, and type of FGD equipment.

Alternate Fuels

Alternate fuels have been addressed in Section 3. The CFB boilers can combust, and the supporting systems can handle the percentage of alternate fuel compositions considered here. Approaches for preparing, handling and combusting these fuels are outlined. Because of the variety of sources available to the City, costs for these options were not included in the base estimate summaries shown in Appendix C.

Estimated costs for two alternate fuel approaches are provided here for further consideration. First, tire-derived fuel (TDF) is a viable fuel source in addition to aiding in ridding the community from disease associated with stagnant water accumulating in abandoned tires. The cost for TDF ranges from $1.67 to 2.50/MMBtu. The capital cost for the handling system is estimated to be $700,000 to provide one percent of heat input. Initial discussions indicate an abundant supply of tires available in the region.

Baled tall fescue grass is the second source of alternate fuel considered. This biomass fuel system would include receiving bales of grass, a handling system, shredding, and pneumatically conveying the material into the CFB boiler. The estimated installed cost to provide one percent of the heat input from this system is $3,000,000.

[1] Tavoulareas, E. Stratos, Energy Technologies Enterprises Corporation, Jozewicz, Wojciech, ARCADIS G&M, Multipolutant Emission Control Technology Options for Coal-fired Power Plants, EPA Contract No. 68-C-99-201. March 2005

[2] Burns & McDonnell, Integrated Resource Planning Study for Columbia Water & Light Department, No.19-285-4, December 10, 1992

[3] R.W. Beck, Wholesale Power Supply Report, January 17, 2002

Section 7

Conclusions

General

Stanley Consultants has provided the critical feasibility analysis, scope definition and costs for the alternatives requested by the City of Columbia through this evaluation. These results are presented to the City to perform additional economic evaluation and comparison with other alternatives. Conclusions drawn from this analysis are presented in this section.

- Each of the three alternatives will provide the City with the same generating capability at the Columbia Power House site. Each provides a reliable source of base load capacity, utilizing a relatively low cost fuel.

- Each of the alternatives can be effectively sited at this location and arrangements can be made in each case to maintain operation of the existing generating units during the new construction activities.

- Comparing total capital costs for the cases, Alternative 1 has the lowest total capital cost. The installed cost for the 108.5 MWe plant is $2,025 per kW. This includes all site work and demolition.

- The installed cost for the 70 MWe plant, (Phase 1, Alternative 2) is $2,537 per kW. This case also includes the same site work costs. The CFB boilers and auxiliaries make up a large portion of the project costs

- Alternative 2, Phase 2 consists of repowering Steam Turbine Generators No, 5, 7, and 8 with steam provided by a new CFB boiler. The estimate includes a cost for an inspection and testing program and an allowance for anticipated upgrades to equipment. This allowance would be further detailed after the program was initiated.

- Similarly, Alternate 3, Phase 2 includes allowances for anticipated work that would be detailed in the life extension program.

- Each of the alternatives can accommodate the air emission environmental regulations evaluated. Costs have been included accordingly for each case.

- Stoker-fired Boilers No. 6 and 7 will need to switch to a lower chlorine content coal or provide lime injection ahead of the baghouse to comply with Boiler MACT requirements for HCl prior to September 13, 2007.

- Each alternative is based on draining the existing ash pond, using dry ash handling methods for the existing boilers in the interim period and for the new boiler. The existing ash will be excavated, hauled to a non-hazardous landfill and the pond will be backfilled to utilize the space for expansion.

- The existing two oil storage tanks will be demolished.

- Costs have been included to remove the two underground water reservoirs.

- The CFB boilers can accommodate the amount of opportunity fuel blended with coal. Tire derived fuel and biomass systems are described.

- A high volatile bituminous coal was selected as a design basis for developing costs for this analysis. It is a 2.89 % sulfur coal with properties within the ranges specified by the City recently. The ultimate fuel selected will affect equipment selection and emission calculations.

- Based on discussions with the City of Columbia, the existing electrical transmission system at the site can transmit the additional power generated by each of the alternatives considered.

- An allowance has been included in the estimates to upgrade the shops, locker rooms and offices at the existing plant.

- The cost for a 100,000-gallon water tower has been included to upgrade the water system pressure.

- Complete coal handling and storage systems are included with extensions of the rail tracks. The calculated number of deliveries per week is included in Section 3. The coal storage is enclosed in a building to reduce fugitive dust and allow runoff to be managed. A coal car-thawing shed is also included.

Respectfully submitted,

Stanley Consultants, Inc.

Prepared by ______________________________
Gary A. Wilkinson, P.E.

Reviewed by ______________________________
Marc A. Elliott, P.E.

Approved by ______________________________
P. Russell Price, P.E.

STATE OF MISSOURI
MARC A. ELLIOTT
NUMBER
E-21385
REGISTERED PROFESSIONAL ENGINEER
5/20/05

Appendix A

Aerial Site Plan / Arrangement Drawings

Boone County Parcel Information Viewer

Zoom to Location... | Zoom to Map Sheet....

Search by Parcel ID Number:

17-109-00-01-097.00 01

Submit Search

Back

Tom Schauwecker
Boone County
Assessor
(573) 886-4270

Owner	**CITY OF COLUMBIA**
Address	
City, State Zip	**COLUMBIA, MO 65201**
School	**COLUMBIA (C1)**
Legal Description	**E C MORE SD LOTS 47 29 30 31 & PT 28 & HALL, GUITAR + MURRAY SD LOTS 1-12**
Parcel	**17-109-00-01-097.00 01**

Owner information current as of: 1/14/2005 9:18:59 AM CST

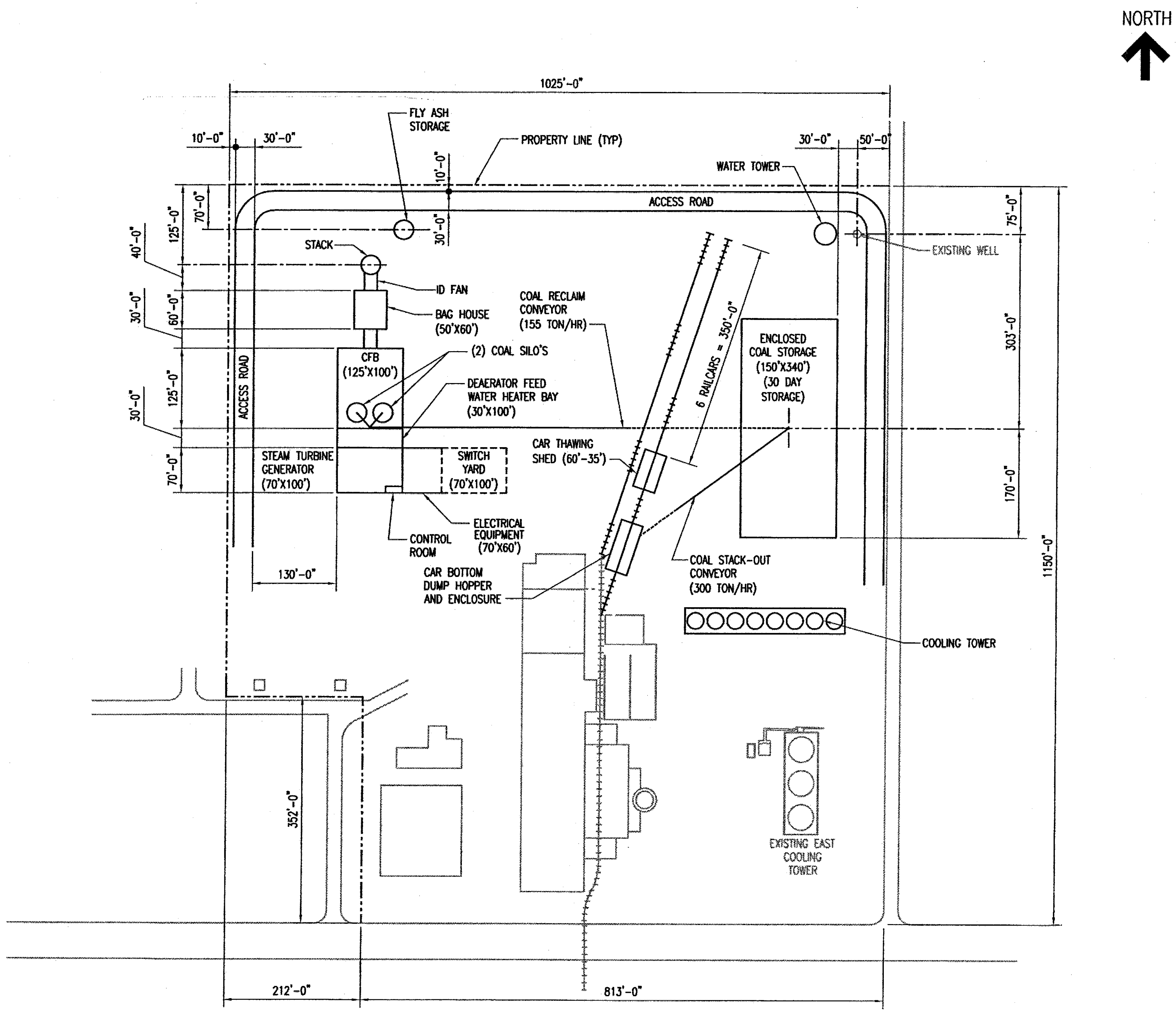
Click here for full real estate summary

Zoom Level (City) (County)

Photo ON

Active Tool: Zoom In

Stanley Consultants



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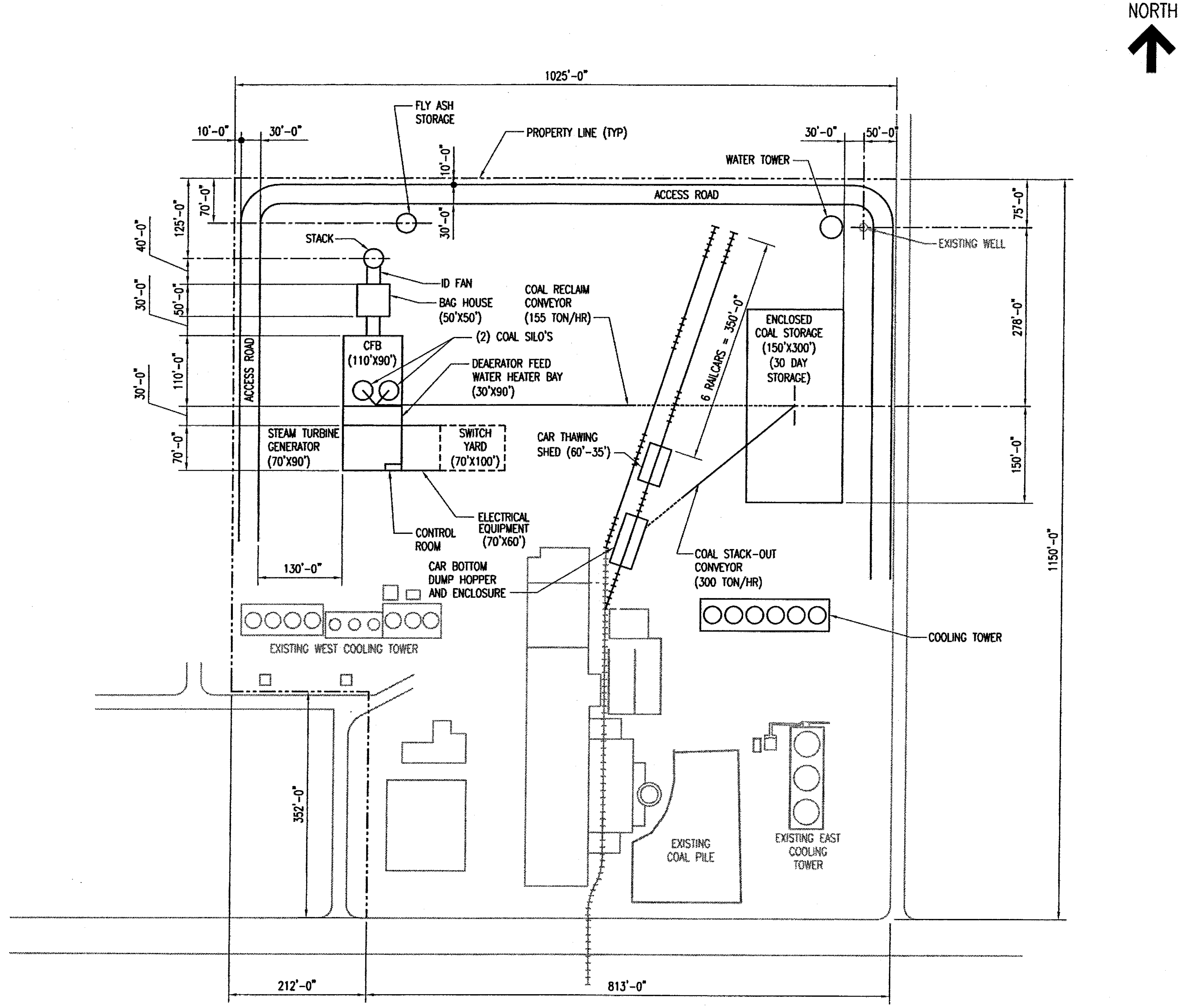
CITY OF COLUMBIA
DEPARTMENT OF WATER AND LIGHT
POWER PLANT REHABILITATION AND UPGRADE
STANLEY PROJECT NO. 17788
ALTERNATE NO. 1 – SITE PLAN
100MWe CFB BOILER (1800 PSI)
RESTORE GAS BOILER NO. 8; ST/G NO. 8
RETIRE BOILERS NO. 6, 7; ST/G NO. 5, 6
SCALE: 1' = 200'

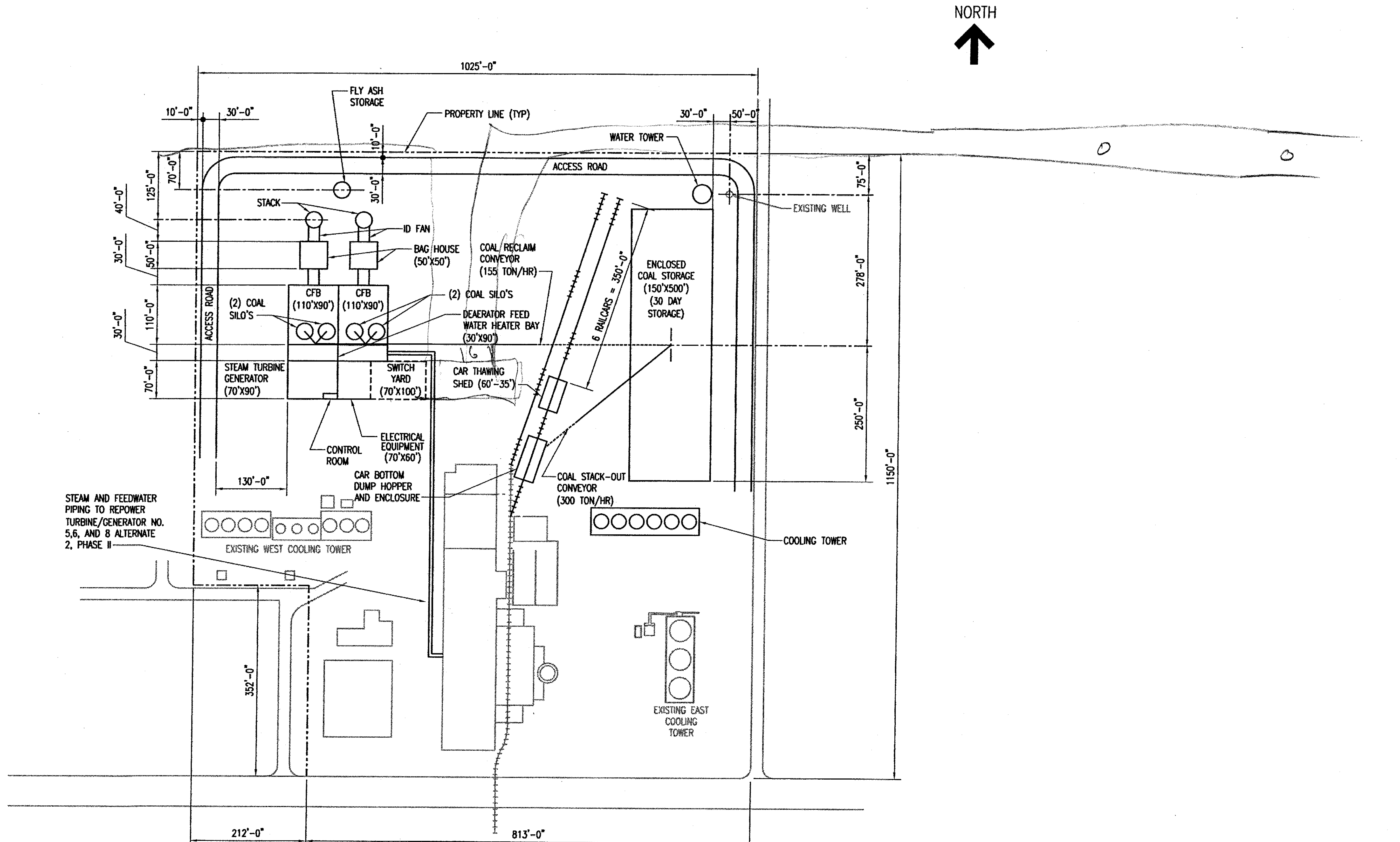
Stanley Consultants



CITY OF COLUMBIA
DEPARTMENT OF WATER AND LIGHT
POWER PLANT REHABILITATION AND UPGRADE
STANLEY PROJECT NO. 17788
ALTERNATE NO. 2 – PHASE I – SITE PLAN
70MWe CFB BOILER (1800 PSI)
SCALE: 1' = 200'

$$$$$$$$$FILENAME$$$$$$$$$$
CADD B2-R3

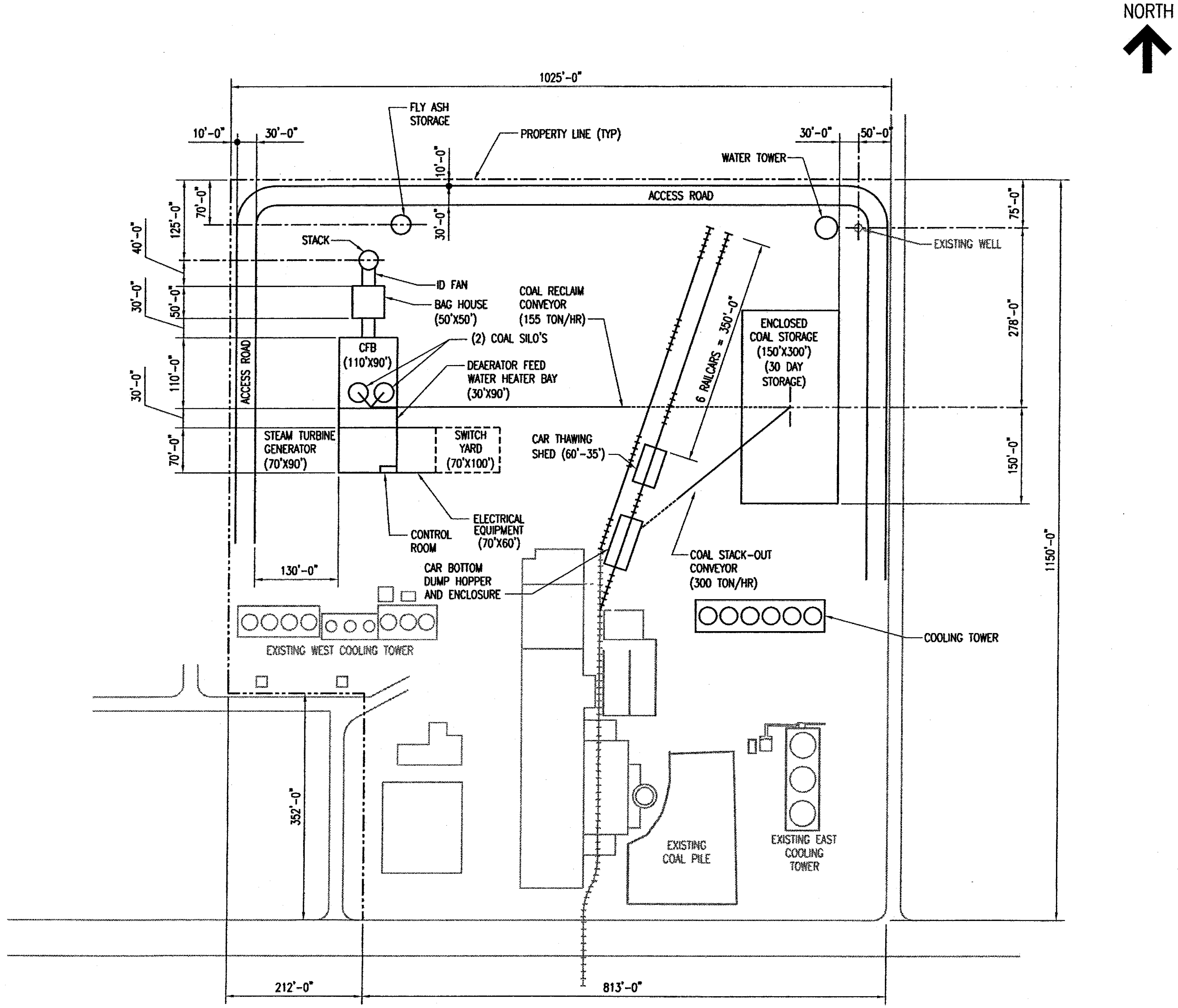
Stanley Consultants



CITY OF COLUMBIA
DEPARTMENT OF WATER AND LIGHT
POWER PLANT REHABILITATION AND UPGRADE
STANLEY PROJECT NO. 17788
ALTERNATE NO. 2 – PHASE II – SITE PLAN
70MWe CFB BOILER (1800 PSI) (PHASE I)
70MWe CFB BOILER (900 PSI) AND
REPOWER ST/G NO. 5, 6 AND 8
RETIRE BOILERS NO. 6, 7 AND 8
SCALE: 1' = 200'

$$$$$$$$$FILENAME$$$$$$$$$$$$$
CADD B2-R3

Stanley Consultants



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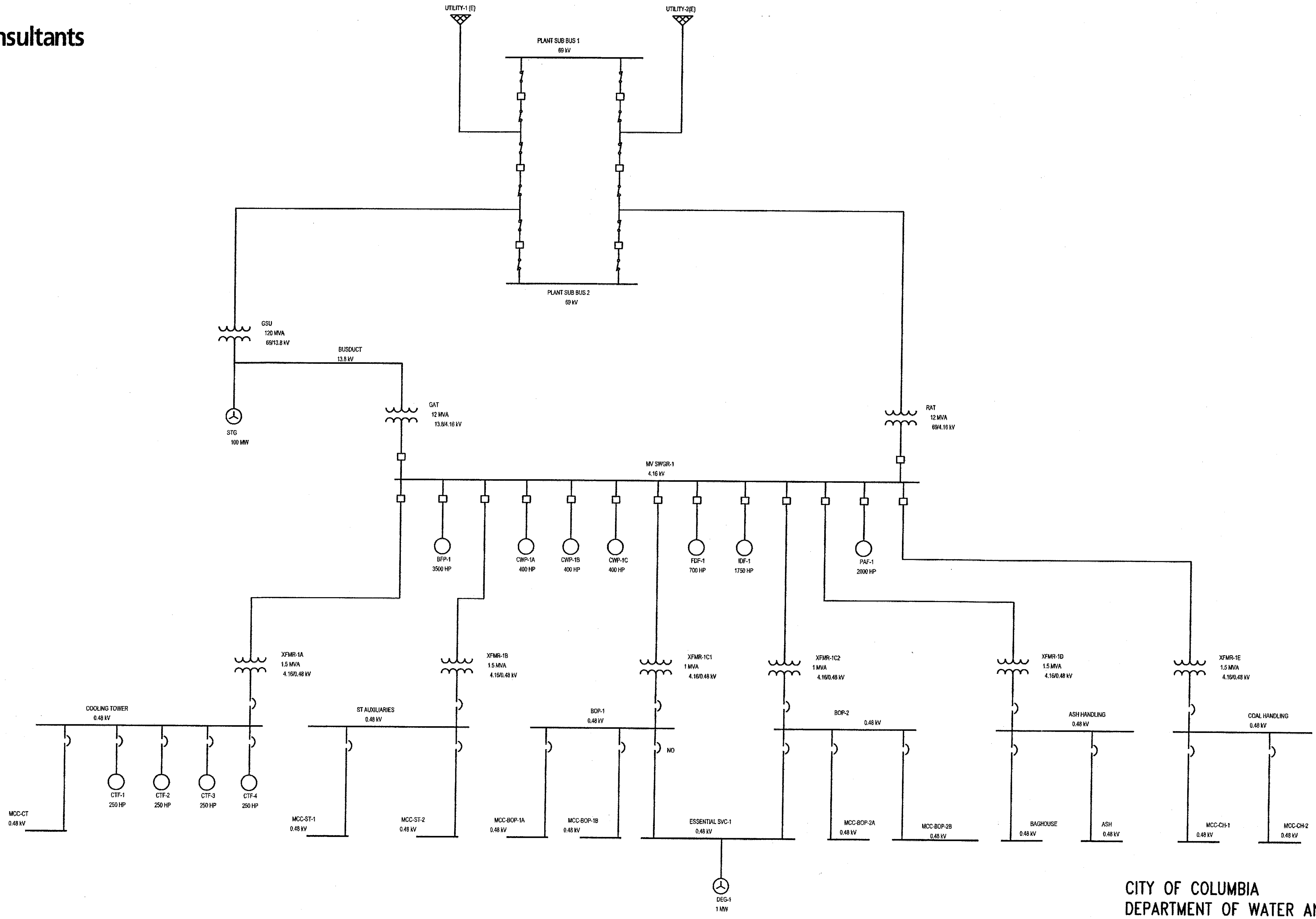
CADD B2-R3 © STANLEY CONSULTANTS

CITY OF COLUMBIA
DEPARTMENT OF WATER AND LIGHT
POWER PLANT REHABILITATION AND UPGRADE
STANLEY PROJECT NO. 17788
ALTERNATE NO. 3 - SITE PLAN
70MWe CFB BOILER (1800 PSI) AND
RESTORED UNITS 5,6, AND 8
SCALE: 1' = 200'

Appendix B

Electrical One-Line Diagrams

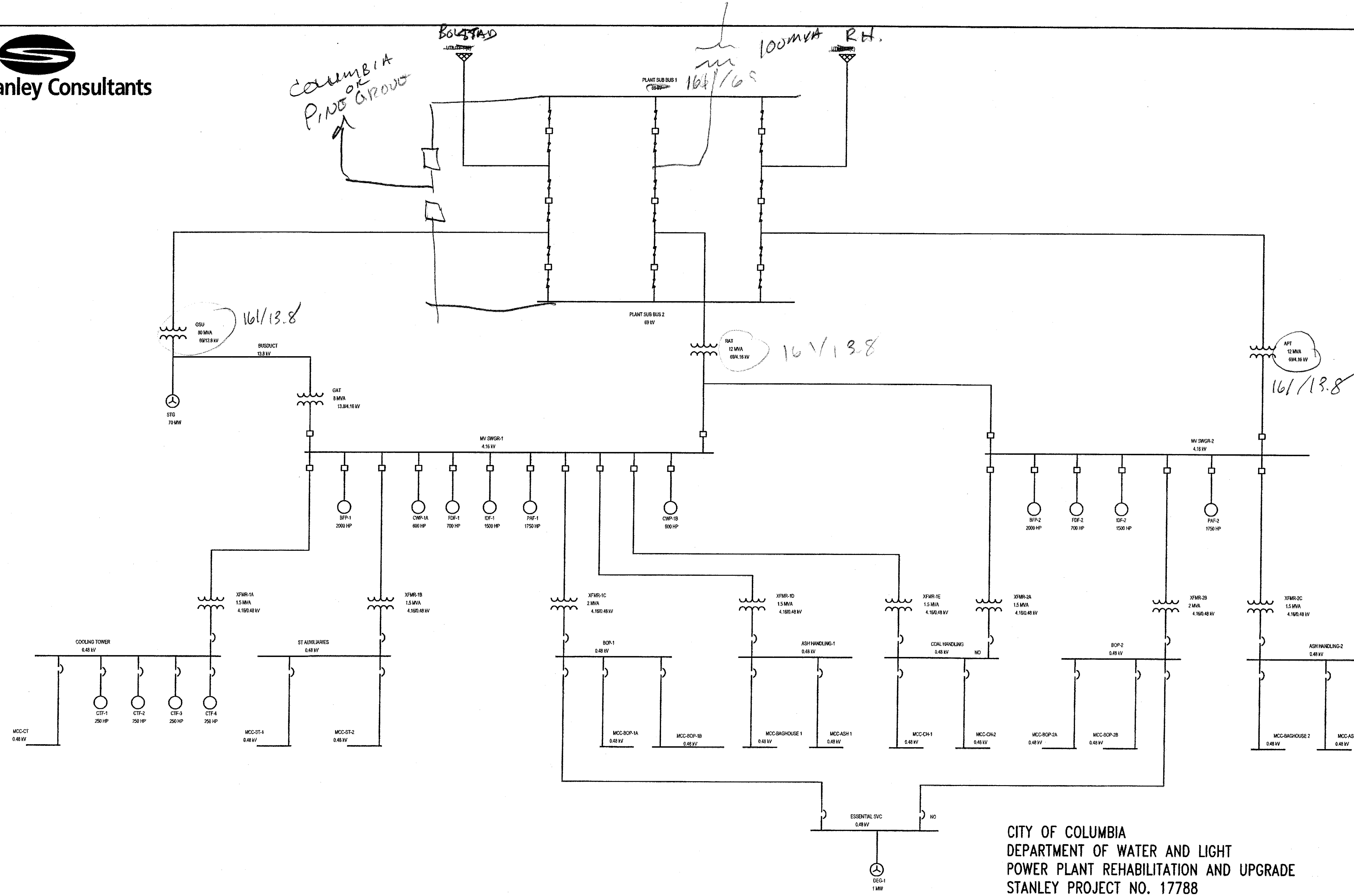
Stanley Consultants



CITY OF COLUMBIA
DEPARTMENT OF WATER AND LIGHT
POWER PLANT REHABILITATION AND UPGRADE
STANLEY PROJECT NO. 17788
ALTERNATE NO. 1 – ONE-LINE DIAGRAM
100MWe CFB BOILER
SCALE: NONE

$$$$$$$$$FILENAME$$$$$$$$$$
CADD B2-R3

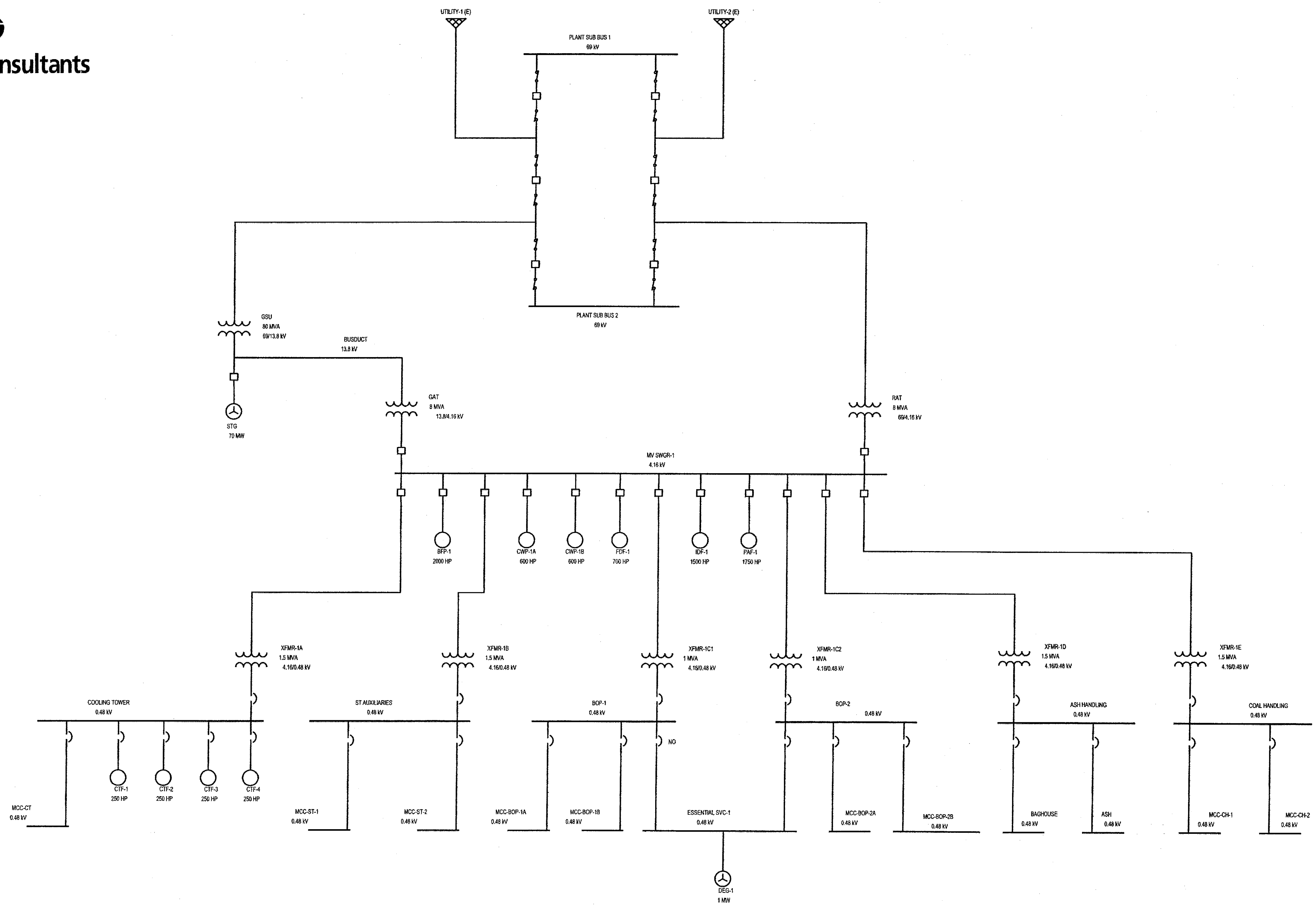
Stanley Consultants



CITY OF COLUMBIA
DEPARTMENT OF WATER AND LIGHT
POWER PLANT REHABILITATION AND UPGRADE
STANLEY PROJECT NO. 17788
ALTERNATE NO. 2 – ONE-LINE DIAGRAM
PHASE I: 70MWe CFB BOILER
PHASE II: CFB BOILER TO REPOWER ST/G NO. 5, 6 AND
SCALE: NONE

$$$$$$$$FILENAME$$$$$$$$$$$
CADD B2-R3

Stanley Consultants



CITY OF COLUMBIA
DEPARTMENT OF WATER AND LIGHT
POWER PLANT REHABILITATION AND UPGRADE
STANLEY PROJECT NO. 17788
ALTERNATE NO. 3 – ONE-LINE DIAGRAM
PHASE I: 70MWe CFB BOILER
SCALE: NONE

Appendix C

Cost Esimates

17788
City Of Columbia, Missouri
Power Plant Rehabilitation and/or Upgrade

Alternative 1: 100 Mwe, New CFB Boiler and Steam Turbine/Generator

ITEM		ESTIMATED COST
Sitework (Including Demolition)	$	6,616,260
Bridge Crane	$	341,315
CFB Boiler (Baghouse, SNCR, SDA)	$	63,012,000
Turbine Generator	$	17,748,380
Feedwater Heaters	$	630,120
Deaerator	$	136,526
Condenser	$	672,128
Circulating Water Pumps	$	346,566
Condensate Pumps	$	136,526
Boiler Feed Pumps	$	866,415
Alloy Piping	$	1,050,200
Coal Handling	$	11,268,646
Limestone Handling Yard	$	3,150,600
Ash Handling	$	5,986,140
Chimney	$	2,520,480
Cooling Tower	$	1,470,280
Building Work, Substructure & Piling	$	29,615,640
Miscellaneous Equipment	$	4,137,788
Mechanical Work	$	14,702,800
Electrical Work (Incl Transformers & Switchgear)	$	13,722,400
Distributed Controls System	$	2,100,400
Instrumentation & Installation	$	1,050,200
Painting	$	1,260,240
SUBTOTAL	*$*	*182,542,050*
Undeveloped Design Details	*$*	*5,251,000*
SUBTOTAL	$	187,793,050
Engineering Administration & Contingency (17%)	$	31,924,819
TOTAL	$	219,717,869
Probable Cost 100 MW CFB Use	**$**	**219,700,000**
Renovation Work Items		
Inspect And Test Boiler No. 8 (Natural Gas) and Major Supporting Equipment	$	500,000
Inspect Steam Turbine-Generator No.8	$	350,000
Convert Ash Handling To Dry System	$	400,000
Known Items Needed To Extend Unit 8 Life:		
Circulating Water Piping Repair	$	200,000
Condenser Retubing	$	300,000
Makeup Water Storage Tower	$	300,000
Renovation Of Existing Locker Rooms, Maintenance Shops, Storage Areas Allowance	$	250,000
SUBTOTAL	*$*	*2,300,000*
Undeveloped Design Details	$	345,000
SUBTOTAL	$	2,645,000
Engineering Administration & Contingency (20%)	$	529,000
TOTAL	$	3,174,000
Probable Cost Plant Renovation Use	**$**	**3,174,000**
TOTAL ALTERNATIVE 1	**$**	**222,874,000**

17788
City Of Columbia, Missouri
Power Plant Rehabilitation and/or Upgrade

Alternative 2: 70 MW, New CFB Boiler and Steam Turbine/Generator

Alt. 2, Phase 1: New 70 MWE CFB

ITEM	ESTIMATED COST	
Sitework (Including Demolition)	$	6,300,000
Bridge Crane	$	325,000
CFB Boiler (Baghouse, SNCR, SDA)	$	50,400,000
Turbine Generator	$	12,300,000
Feedwater Heaters	$	500,000
Deaerator	$	105,000
Condenser	$	520,000
Circulating Water Pumps	$	270,000
Condensate Pumps	$	105,000
Boiler Feed Pumps	$	670,000
Alloy Piping	$	800,000
Coal Handling	$	10,810,000
Limestone Handling Yard	$	2,400,000
Ash Handling	$	4,600,000
Chimney	$	1,900,000
Cooling Tower	$	1,130,000
Building Work, Substructure & Piling	$	22,800,000
Miscellaneous Equipment	$	3,180,000
Mechanical Work	$	11,300,000
Electrical Work	$	13,140,000
Distributed Controls System	$	1,500,000
Instrumentation & Installation	$	800,000
Painting	$	970,000
SUBTOTAL	*$*	*146,825,000*
Undeveloped Design Details	$	5,000,000
SUBTOTAL	$	151,825,000
Engineering Administration & Contingency (17%)	$	25,810,250
TOTAL	$	177,635,250
Probable Cost 70 MW CFB Use	**$**	**177,635,000**

Renovation Work Items

Renovation Of Existing Locker Rooms, Maintenance Shops, & Storage Areas Allowance	$	250,000
Convert Ash Handling To Dry System	$	400,000
SUBTOTAL	*$*	*650,000*
Undeveloped Design Details	$	97,500
SUBTOTAL	$	747,500
Engineering Administration & Contingency (20%)	$	149,500
TOTAL	$	897,000
Probable Cost Plant Renovation Use	**$**	**897,000**
TOTAL ALTERNATIVE 2, Phase 1	**$**	**178,532,000**

17788
City Of Columbia, Missouri
Power Plant Rehabilitation and/or Upgrade

Alternative 2, Phase 2: Repowering

ITEM	ESTIMATED COST
CFB Boiler (Baghouse, SNCR, SDA)	$ 51,200,000
Coal Handling	$ 350,000
Distributed Controls System	$ 1,500,000
Instrumentation & Installation	$ 800,000
Piping (Pipe, Insulation & Pipe Rack)	$ 419,000
Boiler Building, Substructure & Piling	$ 8,600,000
Boiler Feed Pumps	$ 670,000
Miscellaneous Pumps	$ 140,000
Limestone Handling	$ 1,200,000
Ash Handling	$ 2,300,000
Chimney	$ 1,900,000
Miscellaneous Equipment	$ 2,500,000
Mechanical	$ 7,000,000
Electrical	$ 6,060,000
Painting	$ 400,000
SUBTOTAL	*$ 85,039,000*
Undeveloped Design Details	$ 12,755,850
SUBTOTAL	$ 97,794,850
Engineering Administration & Contingency (17%)	$ 16,625,125
TOTAL	$ 114,419,975
Probable Cost Alt 2 Phase 2-Repowering Use	**$ 114,420,000**
Retrofit And Upgrade Activities:	
Inspect And Test Steam Turbine/Generator No. 8	$ 350,000
Inspect And Test No. 5, 7, And 8 Auxiliaries	$ 900,000
Known Items Needed To Extend Life:	
Circulating Water Piping	$ 900,000
Cooling Towers	$ 300,000
Condenser Retubing	$ 300,000
Makeup Water Storage Tank (100,000 Gal), System Upgrades	$ 400,000
FW System/Condensate System/Water Treatment	$ 500,000
Control System Upgrades	$ 1,500,000
Electrical System Upgrades	$ 6,000,000
Allowance For Unknown Equipment Up Grades	$ 7,350,000
SUBTOTAL	*$ 18,500,000*
Undeveloped Design Details	$ 2,775,000
SUBTOTAL	$ 21,275,000
Engineering Administration & Contingency (20%)	$ 4,255,000
TOTAL	$ 25,530,000
Probable Cost Retrofitting And Upgrade Total	**$ 25,530,000**
TOTAL ALTERNATIVE 2, PHASE 2 REPOWERING, RETROFIT & UPGRADE	**$ 139,950,000**

17788
City Of Columbia, Missouri
Power Plant Rehabilitation and/or Upgrade

Alternative 3: New 70 MWE CFB Boiler and Steam Turbine/Generator

Alt. 3, Phase 1: New 70 MWE CFB

ITEM		ESTIMATED COST
Sitework (Including Demolition)	$	6,300,000
Bridge Crane	$	325,000
CFB Boiler (Baghouse, SNCR, SDA)	$	50,400,000
Turbine Generator	$	12,300,000
Feedwater Heaters	$	500,000
Deaerator	$	105,000
Condenser	$	520,000
Circulating Water Pumps	$	270,000
Condensate Pumps	$	105,000
Boiler Feed Pumps	$	670,000
Miscellaneous Pumps	$	140,000
Alloy Piping	$	800,000
Coal Handling	$	10,810,000
Limestone Handling Yard	$	2,400,000
Ash Handling	$	4,600,000
Chimney	$	1,900,000
Cooling Tower	$	1,130,000
Building Work, Substructure & Piling	$	22,800,000
Miscellaneous Equipment	$	3,180,000
Mechanical Work	$	11,300,000
Electrical Work	$	11,640,000
Distributed Controls System	$	1,500,000
Instrumentation & Installation	$	800,000
Painting	$	970,000
SUBTOTAL	$	145,465,000
Undeveloped Design Details	$	5,000,000
SUBTOTAL	$	150,465,000
Engineering Administration & Contingency (17%)	$	25,579,050
TOTAL	$	176,044,050
Probable Cost 70 MW CFB Use	**$**	**176,044,000**
Renovation Work Items		
Renovation Of Existing Locker Rooms, Maintenance Shops, & Storage Areas Allowance	$	250,000
Convert Ash Handling To Dry System	$	400,000
SUBTOTAL	*$*	*650,000*
Undeveloped Design Details	$	97,500
SUBTOTAL	$	747,500
Engineering Administration & Contingency (20%)	$	149,500
TOTAL	$	897,000
Probable Cost Plant Renovation Use	**$**	**897,000**
TOTAL ALTERNATIVE 3, Phase 1	**$**	**176,941,000**

17788
City Of Columbia, Missouri
Power Plant Rehabilitation and/or Upgrade

3, Phase 2: Refurbish Existing Units

ITEM		ESTIMATED COST
Distributed Controls System	$	100,000
Instrumentation & Installation	$	400,000
Bag House Upgrade: Hopper Baffles/ID Booster Speed Increase	$	100,000
ID Booster Fan Upgrade	$	520,000
Electrical Upgrade	$	2,650,000
Life Extension Inspection		
Inspection Unit 6:		
Inspection & Testing	$	500,000
Condenser Retubing	$	400,000
Equipment Allowance	$	16,500,000
Inspection Unit 7:		
Inspection & Testing	$	500,000
Condenser Retubing	$	400,000
Equipment Allowance	$	22,500,000
Inspection Unit 8:		
Inspection & Testing	$	500,000
Condenser Retubing	$	400,000
Turbine Inspection	$	400,000
Equipment Allowance	$	21,000,000
SUBTOTAL	*$*	*66,870,000*
Undeveloped Design Details	$	10,030,500
SUBTOTAL	$	76,900,500
Engineering Administration & Contingency (20%)	$	15,380,100
TOTAL	$	92,280,600
Probable Cost Refurbish Existing Units Use	**$**	**92,281,000**
Renovation Work Items		
Renovation Of Existing Locker Rooms, Maintenance Shops, & Storage Areas	$	1,100,000
Convert Ash Handling To Dry System	$	400,000
SUBTOTAL	*$*	*1,500,000*
Undeveloped Design Details	$	225,000
SUBTOTAL	$	1,725,000
Engineering Administration & Contingency (20%)	$	345,000
TOTAL	$	2,070,000
Probable Cost Plant Renovation Use	**$**	**2,070,000**
TOTAL ALTERNATIVE 3, Phase 2	**$**	**94,351,000.00**

Appendix D

Vendor Information

Heat Balance Diagrams

Circulating Fluidized Bed Boiler

Steam Turbine Generator

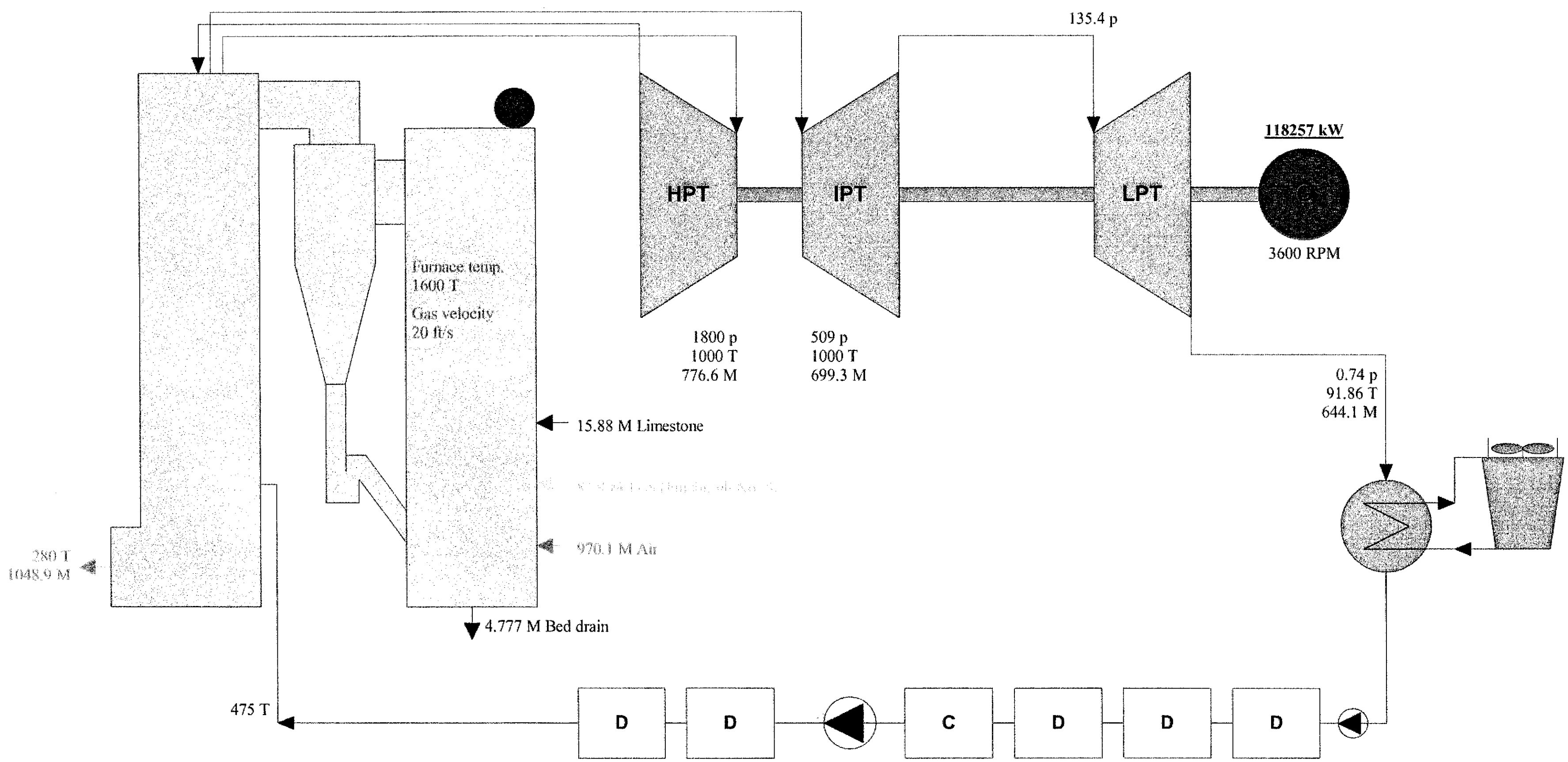
Coal Handling System

Bag House

Control System

Plant net power	108431	kW
Number of units	1	
Plant net HR (HHV)	9634	BTU/kWh
Plant net HR (LHV)	9209	BTU/kWh
Plant net eff (HHV)	35.42	%
Plant net eff (LHV)	37.05	%
Aux. & losses	9827	kW
Fuel heat input (HHV)	1044.6	mmBTU/h
Fuel heat input (LHV)	998.5	mmBTU/h

Ambient
14.22 p
59 T
60% RH



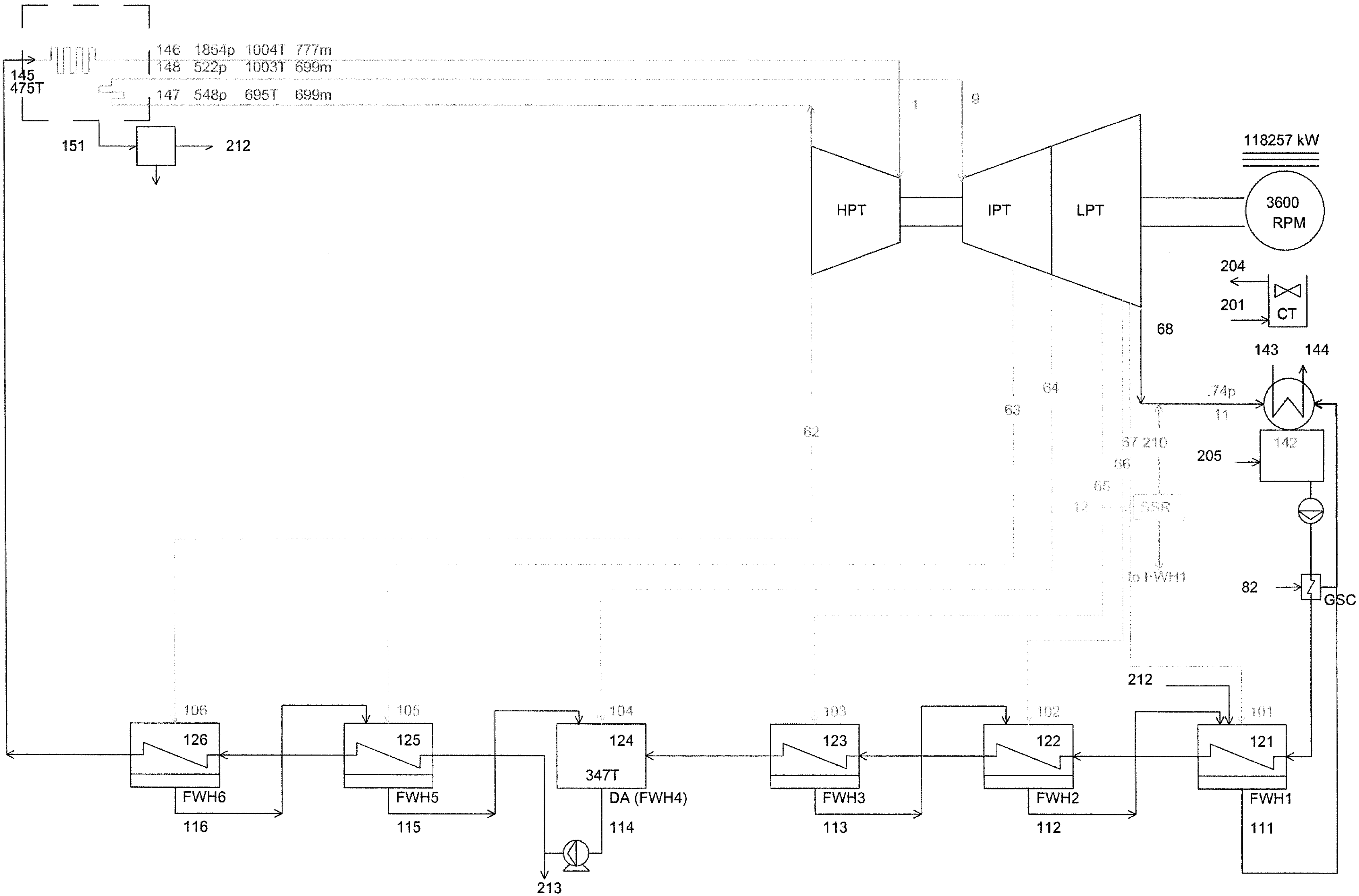
STEAM PRO 14.0 Information Services Stanley Consultants
484 05-13-2005 10:53:17 c:\Tflow14\MYFILES\1_5hgCol100MW1800RH1000.STP

p [psia] T [F] M [kpph]

BOILER EFF (HHV/LHV) 87.5% / 91.6%
NET PLANT EFF (HHV/LHV) 35.4% / 37.1%

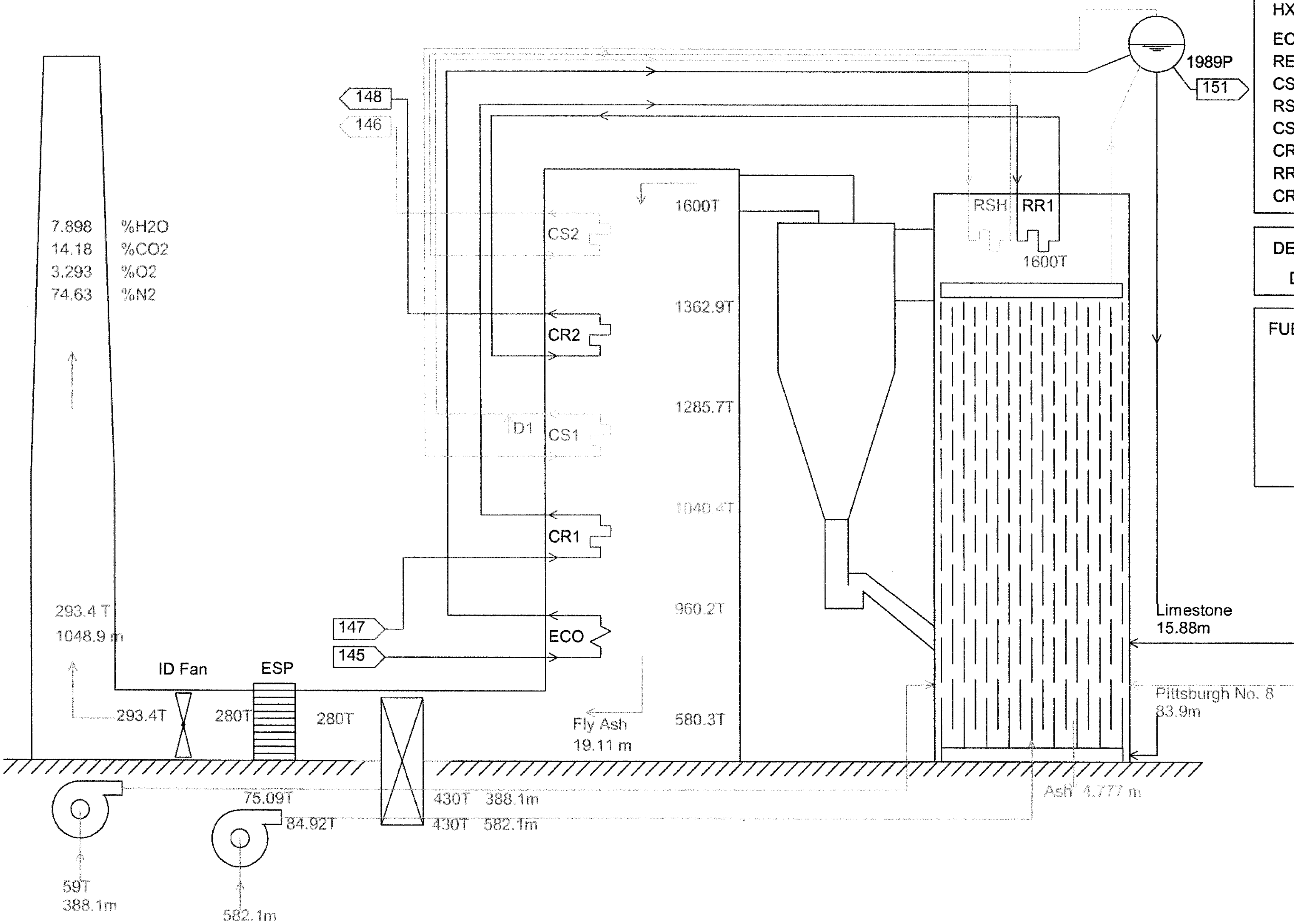
NET POWER 108431 kW
NET PLANT HR (HHV/LHV) 9634 / 9209 BTU/kWh

AUX 9827 kW
TURBINE HR 7708 BTU/kWh



Information Services STEAM PRO 14.00 484 05-13-2005 10:53:17 Steam Properties: Thermoflow-STQUIK
FILE: c:\Tflow14\MYFILES\1_5hgCol100MW1800RH1000.STP CYCLE SCHEMATIC

p	T	m	h
psia	F	kpph	BTU/lb



HX	Tin	Tout
ECO	475	590
REV	590	635
CS1	635	686.8
RSH	672.4	860.1
CS2	860.1	1004.4
CR1	695.4	754.6
RR1	754.6	940
CR2	940	1002.5

DESUP	m	h
D1	15.5	329

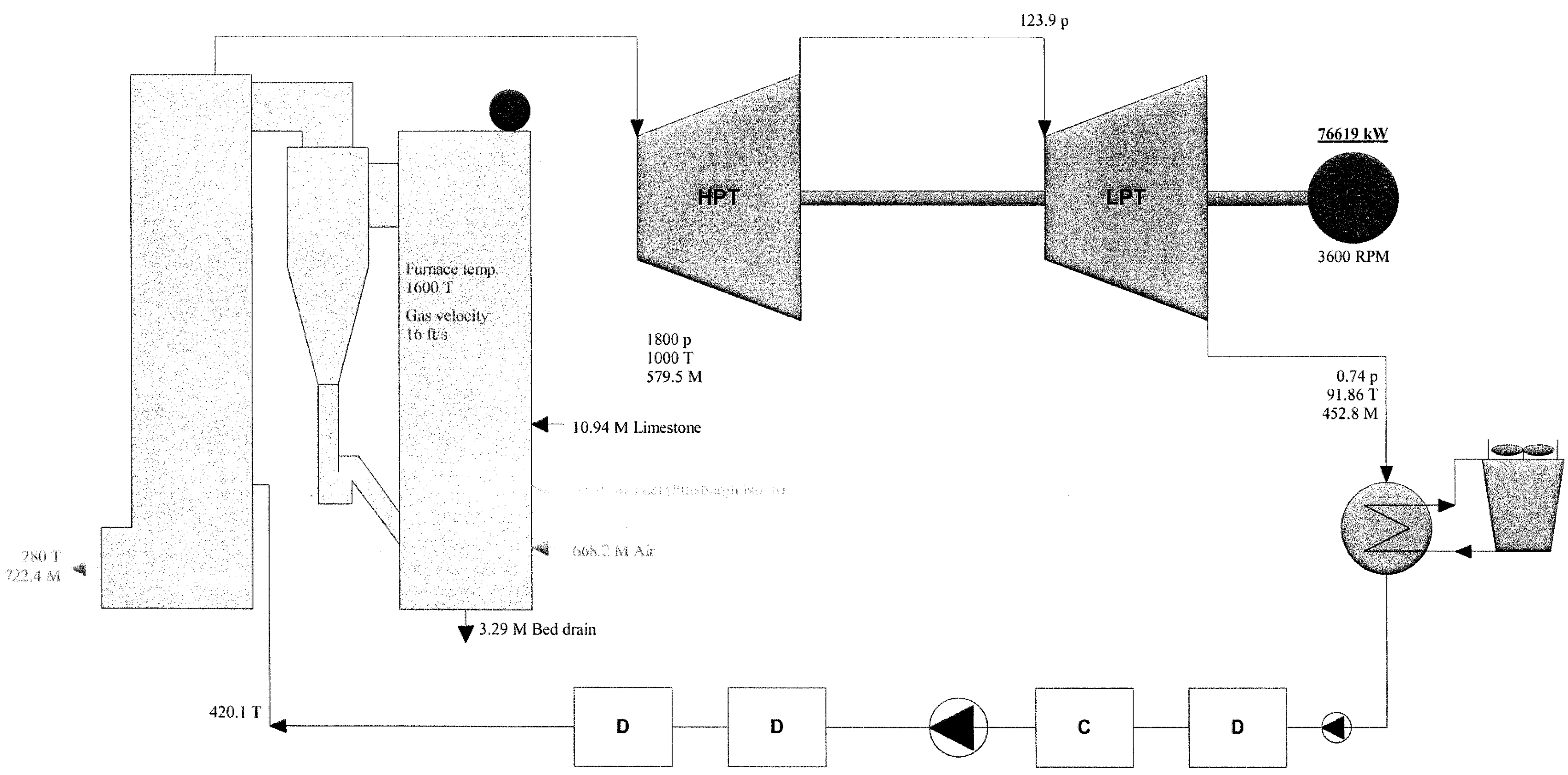
FUEL		WEIGHT%
C	%	69.4
H	%	5.9
O	%	10.74
N	%	1.22
S	%	2.89
ASH	%	9.94

Information Services STEAM PRO 14.00 484 05-13-2005 10:53:17 Steam Properties: Thermoflow-STQUIK
FILE: c:\Tflow14\MYFILES\1_5hgCol100MW1800RH1000.STP BOILER SCHEMATIC

p	T	m	BOILER EFF		BOILER FUEL INPUT (BTU/s)	
psia	F	kpph	87.5 % (HHV)	91.6 % (LHV)	290162(HHV)	277364(LHV)

Plant net power	69894	kW
Number of units	1	
Plant net HR (HHV)	10293	BTU/kWh
Plant net HR (LHV)	9839	BTU/kWh
Plant net eff (HHV)	33.15	%
Plant net eff (LHV)	34.68	%
Aux. & losses	6725	kW
Fuel heat input (HHV)	719.4	mmBTU/h
Fuel heat input (LHV)	687.7	mmBTU/h

Ambient
14.22 p
59 T
60% RH



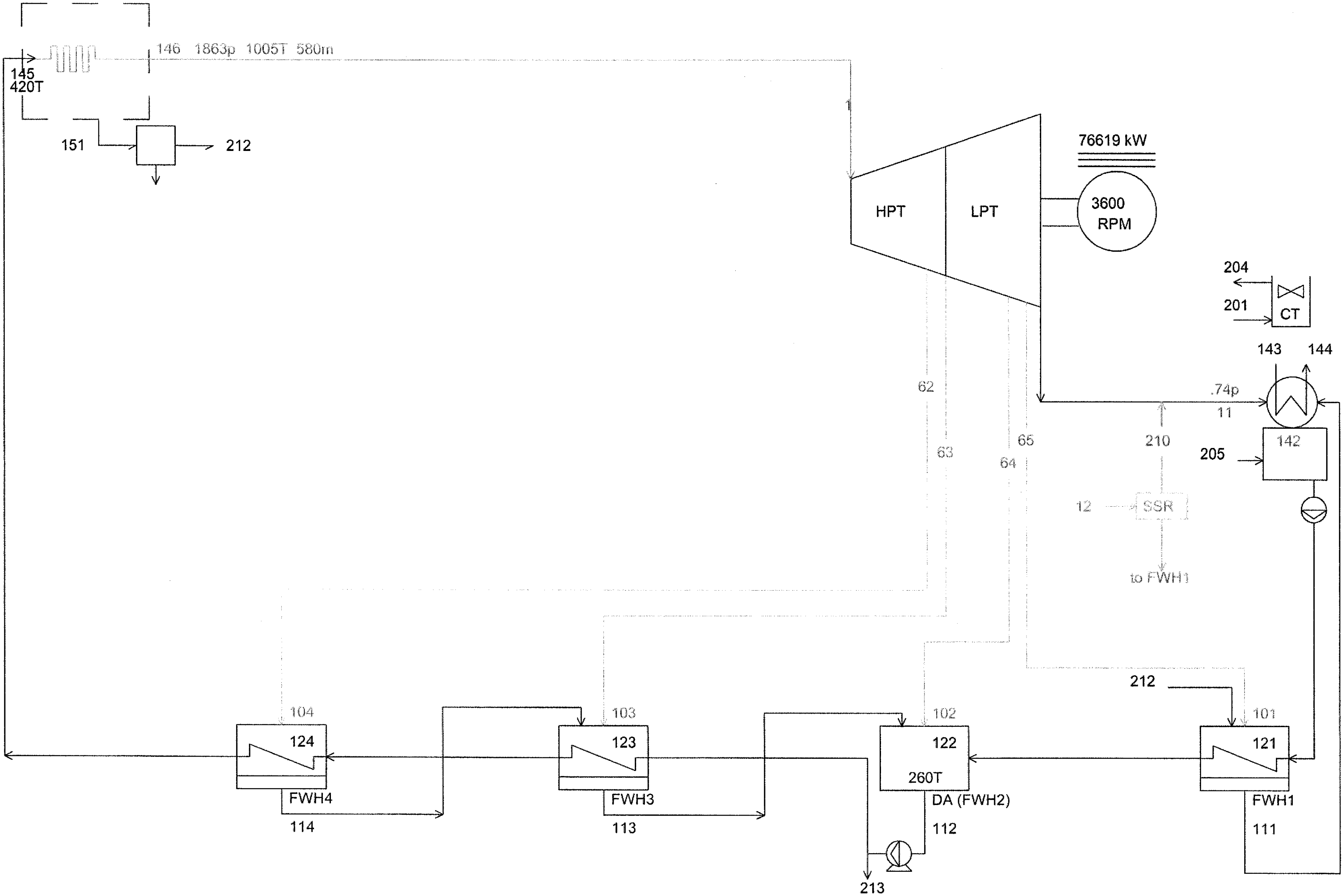
STEAM PRO 14.0 Information Services Stanley Consultants
484 01-10-2005 10:17:38 c:\Tflow14\MYFILES\1_5hgCol70MW1800.STP
City of Columbia, Power Plant Rehabilitation and/or Upgrade Study
70 MW CFB, 1500 psia, 1000 F

p [psia] T [F] M [kpph]

BOILER EFF (HHV/LHV) 87.5% / 91.6%
NET PLANT EFF (HHV/LHV) 33.2% / 34.7%

NET POWER 69894 kW
NET PLANT HR (HHV/LHV) 10293 / 9839 BTU/kWh

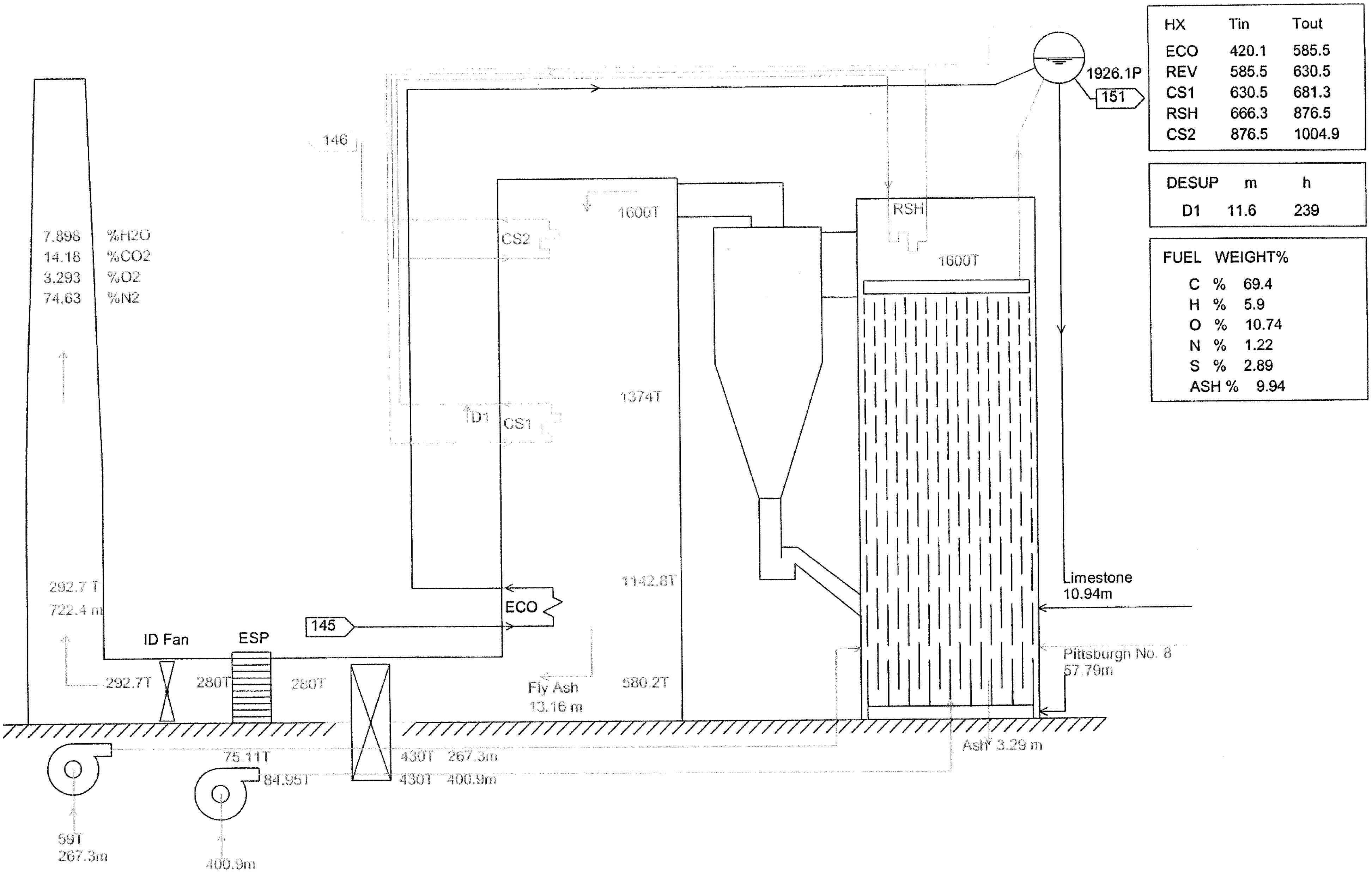
AUX 6725 kW
TURBINE HR 8205 BTU/kWh



City of Columbia, Power Plant Rehabilitation and/or Upgrade Study
70 MW CFB, 1500 psia, 1000 F

Information Services STEAM PRO 14.00 484 01-10-2005 10:17:38 Steam Properties: Thermoflow-STQUIK
FILE: c:\Tflow14\MYFILES\1_5hgCol70MW1800.STP CYCLE SCHEMATIC

p T m h
psia F kpph BTU/lb



HX	Tin	Tout
ECO	420.1	585.5
REV	585.5	630.5
CS1	630.5	681.3
RSH	666.3	876.5
CS2	876.5	1004.9

DESUP	m	h
D1	11.6	239

FUEL	WEIGHT%
C %	69.4
H %	5.9
O %	10.74
N %	1.22
S %	2.89
ASH %	9.94

City of Columbia, Power Plant Rehabilitation and/or Upgrade Study
70 MW CFB, 1500 psia, 1000 F

Information Services STEAM PRO 14.00 484 01-10-2005 10:17:38 Steam Properties: Thermoflow-STQUIK
FILE: c:\Tflow14\MYFILES\1_5hgCol70MW1800.STP BOILER SCHEMATIC

p	T	m	BOILER EFF		BOILER FUEL INPUT (BTU/s)	
psia	F	kpph	87.5 % (HHV)	91.6 % (LHV)	199841(HHV)	191027(LHV)

ALSTOM

Power Environment
Heat Recovery and Plants

To: Stanley Consultants
Attn: Gary A. Wilkinson

Copy: I. Lutes, V. Pacello, T. Hawranko

From: Edward I. Broadhurst, Jr.
Tele No: 860 285 9160
Fax: No: 860 285 2047
Mobile: 860 930 2231
Email: edward.i.broadhurst@power.alstom.com

Date: January 12, 2005

Subject: **Our Ref: 31004047**
Budget Proposal for One(1) Modular CFB Boiler

ALSTOM Power is pleased to submit this Budget Proposal 31004047 for the supply of one (1) modular Circulating Fluid Bed Boiler in response to your request for quotation dated January 4, 2005.

ALSTOM Power is a highly qualified vendor of fluidized bed boiler systems for power producers and industry. ALSTOM Power now has greater than eighty-eight (88) CFB boiler systems in operation, ranging in size from 10MWe to 320 MWe on a variety of fuels. Extensive research and development in the 1970's and 1980's as well as a solid commercial base of experience have provided a broad expertise in fluidized bed comb midwestern bituminous coal ustion and emissions controls, enabling ALSTOM Power this extensive range. A list of ALSTOM Power's Circulating Fluidized bed boilers is available on request.

Indicative Pricing:

Item Description	Price In USD
1 x 638,000 lb./hr. at 900 psig/900°F modular CFB boiler firing midwestern bituminous coal with up to five percent of either waste wood, petroleum coke or tire derived fuel, supplied and delivered to site, with the scope noted herein below.	$25,300,000
Erection and Commissioning of the Supplied equipment	$19,900,000
TOTAL (+/- 15%)	**$ 45,200,000**

Prices provided are first estimates and are for information only at this stage. As such they are not binding and are not offered for acceptance. Erection estimates are based on non-union labor and a free and clear site. Actual erection costs are dependent on site conditions, local labor rates and productivity, and experience. We will be pleased to submit a firm offer, if requested, upon receipt of a technical specification, complete scope of work to be offered and terms and conditions of contract.

Typical Delivery and Erection Schedule
A typical schedule for delivery and erection is:

Item	Weeks from Notice to Proceed
Start of the delivery of equipment to site (steelwork first)	52 weeks
Start of Erection on site	52 weeks
Completion of delivery of all components to site	70 weeks
Completion of Hydrostatic testing	86 weeks
Completion of Mechanical erection	92 weeks
Completion of Commissioning	104 weeks

ALSTOM

Power
Heat Recovery & Plant Business

Scope of Supply

	ALSTOM	By Others
Mechanical Equipment:		
Fuel Unloading and Reclaiming Systems		X
Fuel Preparation Systems		X
Fuel Storage Systems (in yard)		X
Fuel Conveying System to 8-Hour Silos		X
Fuel Feed System:		
8 Hour Silos and Silo Dust Control	X	
Silo Outlet Isolation Valves	X	
Gravimetric Feeders	X	
Pneumatic Spreaders	X	
Feed Chute Systems to Furnace including Supports	X	
Feed Chute Isolation Valves	X	
Limestone Unloading and Preparation System		X
Limestone Storage System (in yard)		X
Limestone Conveying System to Bunkers		X
Limestone Feed System:		
Silos (5 days) and Silo Dust Control	X	
Silo Outlet Isolation Valves	X	
Transport and Feed Systems	X	
Blowers with Motors	X	
Piping Systems from Blowers to Furnace including Supports	X	
Furnace Feed Pipe Isolation Valves	X	
Furnace Equipment:		
Steam Drum including Internals, Nozzles, Lugs and Hanger Rods	X	
Internal Boiler Piping including Headers, Downcomers, Feeders, Risers, and Transfer Pipes	X	
Furnace Side and End Panels	X	
Furnace Roof, Risers and Recycle Cyclones with Downcomers	X	
Furnace Inlet and Outlet Manifolds	X	
Furnace Water-Cooled Distributor Supports and Plenum	X	
Furnace Evaporators (In-bed and Freeboard)	X	
Fluidizing Air Nozzles (Air Distributors)	X	
Pressure Part Hangers and Supports (rigid and spring)	X	
Bed Material Transfer Systems:		
Storage Silos	X	
Blowers with Motors	X	
System Isolation and Control Valves	X	
Transport System Interconnecting Piping including Supports	X	
Furnace Plenum Water Cooling System:		
Water Circulation Pumps with Motors	X	
Water Return Pumps with Motors	X	
Water Storage Tanks with System Skids	X	
System Isolation and Control Valves	X	

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Power
Heat Recovery & Plant Business

	ALSTOM	By Others
System Interconnecting Piping including Supports	X	
Start-Up Burner System:		
Auxiliary Fuel-Fired In-line Duct Burner	X	
Burner Valve Trains	X	
Burner Controls and Local Panel	X	
SNCR - Aqueous Ammonia Injection System:		
Unloading and Storage Systems	X	
Metering and Feed Systems on Skids	X	
Feed System Isolation and Control Valves	X	
Feed System Interconnecting Piping including Supports	X	
Feed System Controls and Local Panels	X	
Primary Loop Metal Ducts:		
Gas Ducts: Furnace Outlets to Backpass Inlets	X	
Gas Duct Hangers and Supports (rigid and spring)	X	
Buckstay Systems:		
Furnace	X	
Backpass	X	
Pressure Parts Hangers and Supports (rigid and spring)	X	
Backpass Convective Sections:		
Connecting Tubes and Piping	X	
Tube Panels and Headers	X	
Economizer	X	
Superheater	X	
Superheater Desuperheater (Attemperator)	X	
Desuperheater Valve Station	X	
Desuperheater Piping (from Control Valve to Desuperheater)	X	
Economizer Piping to Steam Drum	X	
Steam Drum Piping to Superheater	X	
Superheater Interconnecting Piping	X	
Superheater Piping to Stop and Non-Return Valves	X	
Superheater Piping from Valves to Turbines		X
Boiler Trim:		
Vent, Drain and Isolation Valves (Double Valves)	X	
Intermittent and Continuous Blowdown Valves	X	
Steam Drum and Superheater Safety Valves	X	
Feedwater Control Valve Station	X	
Economizer Inlet Stop and Check Valves	X	
Steam Drum Pressure Gauges	X	
Steam Drum Pressure Transmitters	X	
Steam Drum Level Devices	X	
Local and Remote Level Indicators for the Steam Drums	X	
Steam Drum Level Transmitters	X	
Steam Drum Metal Thermocouples	X	
Desuperheater Block and Check Valves and Flow Measuring	X	

	ALSTOM	By Others
Device		
Temperature Elements for Steam Temperature Control	X	
Main Steam Flow Measuring Devices	X	
Main Steam Stop and Non-Return Valves	X	
Steam System Depressurization Valves	X	
Start-Up Vent Valves	X	
Safety Valve and Vent Silencers	X	
Boiler Trim Piping:		
Vent Piping to Double Valves	X	
Drain Piping to Double Valves	X	
Intermittent Blowdown Piping to Double Valves	X	
Continuous Blowdown Piping to Double Valves	X	
Piping from Boiler System Connection to Supplied Boiler Trim	X	
Piping from Supplied Boiler Trim to Operating Floor		X
Piping from Supplied Boiler Trim to Vent Silencers		X
Piping from Vent Valves to Boiler Roof Elevation		X
Soot Blowing System:		
Steam Retractable and Rotary Soot Blowers	X	
Soot Blower Motor Drives	X	
Steam Pressure Reducing Station	X	
Soot Blower Interconnecting Piping and Isolation Valves	X	
System Pipe Supports and Hangers	X	
Soot Blower Local Pushbutton Stations and Motor Starters	X	
Air Systems:		
Ductwork: Inlet Ducts to Forced Draft (FD) Fan	X	
Ductwork: Inlet Ducts and Dampers to FD Fans from Building		X
FD Fans including Inlet Silencers, Vanes and Actuators	X	
FD Fan Motor Drive	X	
FD Fan Lube Oil System (if required by ALSTOM) – Skid Mounted	X	
Ductwork: FD Fan Outlet to Air Heater Inlets	X	
Tubular Air Heater	X	
Tubular Air Heater Bypass System	X	
Ductwork: Air Heater to Furnace Walls and Plenum	X	
Ductwork: FD Fan Outlet to Service Air Users	X	
Dampers and Expansion Joints up to Furnace Inlets	X	
Hangers and Supports (rigid and spring)	X	
Gas Systems:		
Ductwork: Backpass Gas Outlet to Air Heater Inlet	X	
Ductwork: Air Heater Gas Outlet to Baghouse Inlet	X	
Backpass and Air Heater Ash Hoppers	X	
Baghouse with Ash Hoppers	X	
Ductwork: Baghouse to Induced Draft (ID) Fan Inlet	X	
ID Fan including Inlet Vanes and Actuators and Discharge Silencer	X	
ID Fan Motor Drive	X	

ALSTOM

Power
Heat Recovery & Plant Business

	ALSTOM	By Others
ID Fan Lube Oil System (if required by ALSTOM) – Skid Mounted	X	
Ductwork: ID Fan Outlet to Stack Inlet Flange	X	
Stack	X	
Dampers and Expansion Joints to ID Fan Inlet	X	
Dampers and Expansion Joints from ID Fan Outlet to Stack	X	
Hangers and Supports for Ducts to ID Fan Inlet	X	
Hangers and Supports for Ducts from ID Fan Outlet to Stack Inlet	X	
Ash Handling Systems:		
Bottom Ash:		
Furnace Bed Ash Drain Piping and Isolation Valve	X	
Water-Cooled Screw Cooler with VF Motor Drive	X	
Ash Handling/Conveying from Water-Cooled Screw Discharge		X
Ash Conveying System Controls		X
Fly Ash:		
Fly Ash Conveying Systems from All Ash Hoppers		X
Fly Ash Storage Silos		X
Fly Ash Silo Unloading/Transfer Systems		X
Fly Ash Controls		X
Fly Ash Piping Hangers and Supports		X
Steam and Water Sampling Systems		X
Main Feedwater Pumps and Drives		X
Emergency Feedwater Pumps and Drives		X
Feedwater Heaters and Treatment Systems		X
Feedwater Piping to Boiler Connections		X
Deaerator Systems		X
Blowdown Coolers		X
Blowdown Tanks		X
Flash Tanks		X
Chemical Feed / Injection / Dosing Systems		X
Fire Protection Systems		X
Boiler Island Elevators		X
Fan Maintenance Hoists		X
Underground Piping Systems		X
Underground Electrical Cable Ducts		X
Grounding Systems		X
Balance of Plant Equipment and Systems (Not Specified Above)		X
Civil:		
Site Preparation for Total Plant:		X
Demolition and Grading		X
Roads, Parking and Fencing		X
Site Drainage		X
Waste Water/Fire Pond		X
Sanitary Systems		X
Site Preparation for Laydown		X
Site Access Roads/Rail Spur Upgrades (If Required)		X

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Power
Heat Recovery & Plant Business

	ALSTOM	By Others
Architectural:		
Permits, Right-of-Ways, Permissions, etc.		X
Boiler Island Building Complete		X
Turbine Generator Building Complete		X
Office Buildings Complete		X
Plant Control Room Complete		X
Maintenance Building Complete		X
Guard House Complete		X
Pump Houses Complete		X
HVAC as Required		X

Foundations:		
Piling for Boiler Islands and Backends		X
Piling for Balance of Plant		X
Concrete Foundations, Elevated Slabs for Boiler Islands and Backends		X
Concrete Foundations and Elevated Slabs for Balance of Plant		X
Anchor Bolts for Boiler Islands		X
Anchor Bolts for Backend Foundations		X
Anchor Bolts for Balance of Plant Foundations		X

Structural:		
Boiler Island Structural Steel:		
Furnace Support Steel	X	
Backpass Support Steel	X	
Tubular Air Heater Support Steel	X	
Air Heater Bypass Support Steel	X	
Bed Material Transfer Silo Support Steel	X	
Furnace Plenum Cooling System Support Steel	X	
Furnace Bed Ash Cooler Support Steel	X	
Fuel Bunker Bay Structural Steel	X	
Limestone Bunker Bay Structural Steel	X	
Backend Structural Steel:		
Baghouse Support Steel	X	
Boiler Piping	X	
Boiler Ductwork Support Steel to ID Fan Inlet	X	
Boiler Ductwork Support Steel from ID Fan Outlet to Stack	X	
Balance of Plant Structural Steel including Boiler Building		X
Boiler and Backend Platforms, Stairways and Ladders	X	
Particle Emission Control Platforms, Stairways and Ladders		X
Balance of Plant Platforms, Stairways and Ladders		X

Piping (Additional):		
Aux. Fuel Piping to Inlet Connections of Burner Isolation Valves		X
Auxiliary Fuel Storage and Feed System		X
Instrument Air Piping		X
Cooling Water Piping		X
Plant Service Air Piping		X

ALSTOM

Power
Heat Recovery & Plant Business

	ALSTOM	By Others
Plant Service Water Piping		X
Fire Protection Water Piping		X
Feedwater Piping up to 1 meter Outside Boiler Casing		X
Low Pressure Steam and Condensate Piping		X
Balance of Plant Piping		X

Electrical:		
Motor Control Centers and Switchgears for Boiler Islands and Backends		X
Low/High Voltage Wiring, Cable Trays, Conduit, Lighting for Boiler Islands and Backends		X
Motor Control Centers and Switchgears for Balance of Plant (BOP)		X
Low/High Voltage Wiring, Cable Trays, Conduit, Lighting for BOP		X
Substations As Required		X

Instrumentation and Control Systems:		
Burner Management (FBSS) System – Logic	X	
Burner Management (FBSS) System – Hardware		X
Field Instrumentation (for Supplied Scope) (Includes Primary Elements, Thermocouples, RTDs, Pressure Switches and Flow Elements)	X	
Field Instrumentation (Thermocouple Transmitters, if required)		X
Field Instrumentation Connecting Tubing/Piping		X
Desuperheater Control Valves and Thermocouples	X	
Feedwater Controls		X
Control Valves (For Supplied Scope)	X	
Distributed Control System and Related Software		X
Conceptual SAMA's (Boiler Process Control)	X	
SAMA for Implementation Controls to DCS		X
Furnace Oxygen Analyzer		X
Stack Emissions Monitors and System		X

Refractory:		
Internal Refractory Lining Material (For Supplied Scope)	X	
Onsite Refractory Representative for Installation and Dryout	X	
Internal Refractory Lining Installation and Dryout	X	
Refractory Dryout Fuel		X
Indoor Heated Refractory Storage Building		X

External Insulation and Lagging:		
External Insulation and Lagging for Heat Conservation	X	
External Insulation and Lagging for Personnel Protection	X	
External Insulation and Lagging for Boiler Island Building		X
External Insulation and Lagging for Balance of Plant		X
External Insulation and Lagging Installation		X
External Insulation and Lagging Installation for Balance of Plant		X

ALSTOM

Power
Heat Recovery & Plant Business

	ALSTOM	By Others
Painting:		
Shop Prime Paint Coating - Supplied Scope	X	
Shop Prime Paint Coating - Balance of Plant		X
Field Finish Paint Coating for Boiler Island, Including Touch Up	X	
Field Finish Paint Coating for Balance of Plant		X
Field Touch-up Paint – Supplied Scope	X	
Field Touch-up Paint – Balance of Plant		X

Representation:		
Construction Representation:		
Construction Representative (option on per diem rates)		
Start-Up Representation:		
- Start-Up Representative (90 days included – more on per diem)	X	
- Sub-Supplier Start-up Representatives	X	
- Housing Facilities	X	
- Transportation (To and From Home Base)	X	
- Transportation (To and From Job Site)	X	
- Office Space, Equipment, Furniture, Telephone, Fax		X
- Living Expenses	X	

Miscellaneous:		
Operator and Maintenance Training Program – Supplied Scope	X	
Operator and Maintenance Training Program – BOP		X
Plant Operators		X
Office or Trailer for Site Personnel		X
Washroom / Toilets		X
Camp Housing		X
Site Transportation	X	
Liaison Meetings, Travel and Living Expenses	X	
Instruction Manuals – 10 Copies (Supplied Scope)	X	
Instruction Manuals - (Balance of Plant)		X
Start-Up Spare Parts (Supplied Scope)	X	
Start-Up Spare Parts (Balance of Plant)		X
Plant Operating Spare Parts		X
Performance Testing / System Demonstrations Including Test Personnel, Equipment and Materials		X
Performance Testing, Advisory Personnel Only	X	
Fuel, Water and Power for Commissioning and Erection		X
Boiler Chemical Cleaning Including Chemicals		X
Chemical Waste Disposal		X
Offsite Waste Disposal		X
First Fill of Lubricants		X
Compressed Air System		X
Boiler Island Erection		X
Backend Erection		X
Balance of Plant Erection		X

	ALSTOM	By Others
Transportation for Supplied Scope Only:		
FOB Port of Entry	X	
FOB Job Site	X	
Protection of Equipment During Storage (as required)	X	
Unloading to Storage / Laydown Areas		X
Permits and Licenses for Construction and Plant Operation		X
Taxes as applicable:	X	
Import Duties	X	
Sales Taxes		X
Boiler Testing Program		X
Boiler Hydro Testing including all Temporary Equipment and Piping		X
Insurance:		
Project Insurance Program		X
Workers Compensation for ALSTOM Power Employees	X	
Employees Liability for ALSTOM Power Employees	X	
Comprehensive General for ALSTOM Power Employees	X	
Liability for ALSTOM Power Employees	X	
Builders Risk Insurance (For Plant)		X
Steam Blow of Lines, Including Temporary Piping and Materials		X
Plant Operation Including Boilers and Backends During Commissioning and Start-Up		X

Terminal Points

Fuel, Limestone and Additive Connections

- Inlet Flange Connections of the Fuel Silos
- Inlet Auxiliary Fuel Isolation Valves on the Start-Up Burner
- Inlet Flange Connections of the Limestone Bunker
- Inlet Connections of the SNCR - Aqueous Ammonia Unloading System

Steam Connections

- Superheater Outlet of the Main Steam Stop Valve
- Outlet of Vent Silencers
- Outlet of Vent Valves
- Outlet of Drum and Superheater Safety Valves
- Outlet of Steam Sampling Valves

Water Connections

- Economizer Inlet of the Feedwater Check Valve
- Inlet and Outlet Connections of all Furnished Equipment Requiring Water Cooling
- Inlet of Superheater Desuperheater Spray Water Check Valve
- Outlet of Drain Valves
- Outlet of Continuous Blowdown Valve
- Outlet of Water Sampling Valves
- Outlet of Intermittent Blowdown Valves

Air and Flue Gas Connections

- Forced Draft Fan Inlet Screens
- Flue Gas at Stack outlet

Ash Connections

- Outlet of the Bed Ash Screw Cooler
- Outlets of the Economizer, Air Heater, and Baghouse Ash Hoppers

Facility Air Connections

- Impulse, Signal, Control and Air Supply Connections on all Control Equipment supplied by ALSTOM Power, such as Actuating Devices, Transmitters, Panel Stations, Control Cabinets, etc.

- Service Air Connections at the Various Elevations of all ALSTOM Power Furnished Equipment Requiring Service Air

Miscellaneous Terminal Points

- Inlet to Chemical Feed Valves

- Inlet to Inert Gas Purge Valves

- Pressure Gauge Connections as required

- Thermowell Connections as required

- Draft Connections as required

- Air Flow Measurement as required

- Blanked Tests Connections as required

Electrical

- Electrical Terminals on all Motors, Igniters, Burners, Valves, Switches and Lights

- Soot Blower Electrical Connections at the Terminals of the Individual Blowers and the Soot Blower Control Devices

- Electrical Terminals on all Control Equipment such as Actuating Devices, Transmitters, Panel Stations, Control Cabinets, etc.

- Thermocouple Wires at the Junction Boxes (supplied by others) at Various Elevations

We trust this provides the information you need at this time on this project. Thank you for considering ALSTOM's products and services. If you have any questions please contact the undersigned.

Yours Sincerely,

Edward I. Broadhurst, Jr.
Director Sales
Heat Recovery & Plants

1800 psi CFB DATA

STANDARD CFB SCOPE VERIFICATION LIST (DIVISION OF WORK)		
NR = NOT REQUIRED Option: Included in erection option	**SUPPLIED BY ALSTOM**	**SUPPLIED BY OTHERS**
MECHANICAL EQUIPMENT		
FUEL SYSTEMS		
COAL FEEDING SYSTEM:		
Fuel Unloading System		X
Fuel Reclaiming System		X
Fuel Preparation System		X
Fuel Crushers		X
Fuel Storage System		X
Silo Dust Control		X
Silo	X	
Coal Bin Isolation Valves	X	
Gravimetric Feeders	X	
Isolation Valves	X	
Piping To Furnace Including Supports	X	
LIMESTONE FEEDING SYSTEM:		
Limestone Unloading System		X
Limestone Crusher System		X
Limestone Storage System		X
Silo Dust Control		X
Silo	X	
Limestone Bin Isolation Valves	X	
Rotary Feeders	X	
Blowers	X	
Piping To Injection Points Including Supports	X	
SAND FEEDING SYSTEM (IF FIRING PET COKE) or required	NR	
Sand Unloading and Storage System		
Silo Dust Control		
Silo		
Isolation Valve		
Blower		
Piping to Injection Points Including Supports		

STANDARD CFB SCOPE VERIFICATION LIST (DIVISION OF WORK)		
NR = NOT REQUIRED Option: Included in erection option	SUPPLIED BY ALSTOM	SUPPLIED BY OTHERS
FURNACE LOOP EQUIPMENT:		
Drum Including Complete Accessories	X	
Downcomer System	X	
Connecting Tubes/Piping	X	
Furnace Tube Panels/ Headers	X	
IPLS Superheater Pendants/Headers/Piping	X	
Furnace Grate And Plenum Including Nozzles	X	
Plenum Ash Drain Valves	X	
Start-Up Burner System	X	
Recycle Cyclone System	X	
Metal Refractory Expansion Joints	X	
Seal Pot System – Complete	X	
Buckstay System – Complete	X	
BACKPASS EQUIPMENT:		
Connecting Tubes/Piping	X	
Backpass Tube Panels/Headers	X	
Backpass Heat Absorbing Surface:		
- Economizer	X	
- Reheater / Fluidized Bed Heat Exchanger	X	
- Superheater	X	
Superheater / Desuperheater (S)	X	
Desuperheater Valve Stations	X	
Desuperheater Piping	X	
Economizer Piping To Drum	X	
Superheater / Interconnecting Piping	X	
Feedwater Stop And Check Valves	X	
Safety Valves With Vent Piping And Silencers	X	
Electromatic Relief Valve (not required by code)	NR	
Silencer	X	
Boiler Trim Valves, Double Valves	X	
Drum Level Gauge And Indicators	X	
SOOTBLOWING SYSTEM:		
Retracts/Rotaries As Required	X	
Integral Control Panel (S)	X	
Valves	X	
Piping	X	

STANDARD CFB SCOPE VERIFICATION LIST (DIVISION OF WORK)		
NR = NOT REQUIRED **Option: Included in erection option**	**SUPPLIED BY ALSTOM**	**SUPPLIED BY OTHERS**
AIR SYSTEM:		
Primary Air Fan With Drive	X	
Secondary Air Fan With Drive	X	
Inlet Silencers For Fans And Blowers	X	
Fluidizing Air Blower With Drive	X	
Airheater	X	
Air Ducts	X	
- Hangers And Supports	X	
- Expansion Joints	X	
Steam Coil Air Preheaters, If Required	X	
Dampers With Operators	X	
FLUE GAS SYSTEM:		
Baghouse	X	
- Inlet And Outlet Plenums	X	
- Controls	X	
- Supports	X	
Induced Draft Fan With Drive	X	
Gas Ducts:	X	
Air Heater To Baghouse	X	
Baghouse Outlet to ID Fan	X	
ID Fan to Stack	X	
Dampers with Operators as required	X	
NOx REDUCTION SYSTEM (SNCR)	X	
SO2 REMOVAL (FDA or STEAM REACTIVATION)	X	
ASH HANDLING SYSTEM:		
Ash Drain Valves	X	
Ash Drain Piping	X	
Ash Screw Coolers or HBAC	X	
Bottom Ash System:		
- Conveyors From All Collecting Points		X
- Bottom Ash Storage Silo		X
- Controls		X
- Hangers And Supports		X
- Insulation And Lagging		X

STANDARD CFB SCOPE VERIFICATION LIST (DIVISION OF WORK)		
NR = NOT REQUIRED Option: Included in erection option	**SUPPLIED BY ALSTOM**	**SUPPLIED BY OTHERS**
Fly Ash System:		
- Piping From All Collecting Points		X
- Fly Ash Storage Silo		X
- Controls		X
- Hangers And Supports		X
- Insulation And Lagging		X
CIVIL		
Site Preparation For Total Plant:		X
Demolition And Grading		X
Roads, Parking And Fencing		X
Site Drainage		X
Waste Water		X
Ponds		X
Sanitary Systems		X
Preparation For Laydown Areas		X
Site Access Roads		X
Rail Spurs And/Or Upgrades		X
FOUNDATIONS		
Pilings For Boiler Island		X
Pilings For Balance Of Plant		X
Concrete Foundations And Elevated Slabs		X
Anchor Bolts For Boiler Island And Balance Of Plant		X
Underground Piping System		X
Underground Electrical Cable Ducts		X
Complete Grounding System		X
ARCHITECTURAL		
Permits		X
Boiler Island Building – Complete		X
Turbine Island Building – Complete		X
Office Building – Complete		X
Plant Control Room- Complete		X
Maintenance Building – Complete		X
Guard House – Complete		X
Pump House – Complete		X
HVAC As Required		X

STANDARD CFB SCOPE VERIFICATION LIST (DIVISION OF WORK)		
NR = NOT REQUIRED Option: Included in erection option	**SUPPLIED BY ALSTOM**	**SUPPLIED BY OTHERS**
STRUCTURAL		
Steam Generator Structural Steel	X	
Steam Generator Platforms System	X	
Steam Generator Internal Grid Steel	X	
Balance Of Plant Structural Steel		X
Boiler Island Elevator		X
Boiler Building Siding / Roofing / Doors / Windows/		X
PIPING AND DUCTING		
Start-up Fuel Piping To Boiler Column		X
Start-up Fuel Storage Tanks And Associated PV&F/Pumps		X
Instrument Air Piping To and from user		X
High Pressure Steam Piping		X
Cooling Water System Pipe To and from user		X
Plant Service Water System Pipe To and from user		X
Feedwater Piping To Feedwater Check Valve Inlet		X
Balance Of Plant Piping		X
ELECTRICAL		
Motor Control Centers		X
Switchgear As Required		X
High And Low Voltage Wiring		X
Cable Trays		X
Conduit Lighting For Boiler Island		X
Conduit Lighting For Balance Of Plant		X
Substations As Required		X
INSTRUMENTATION AND CONTROL SYSTEMS		
Burner Management System	X	
CFB Steam Generator Field Inst.	X	
Desuperheater Control Valves And Thermocouples	X	
Distributive Control System (DCS)		X
Conceptual SAMA's (Boiler Process Control)	X	
SAMA For Implementation Controls to DCS		X

STANDARD CFB SCOPE VERIFICATION LIST (DIVISION OF WORK)		
NR = NOT REQUIRED Option: Included in erection option	SUPPLIED BY ALSTOM	SUPPLIED BY OTHERS
REFRACTORIES		
Refractory Material For CFB Steam Generator	X	
Installation Of Refractory Material For CFB Steam Generator	X	
Refractory Curing Including Dry Out Fuel	X	
INSULATION AND LAGGING		
Insulation And Lagging For Heat Conservation Of AP Equipment	X	
PAINTING		
Shop Prime Painting For AP Supplied Equipment	X	
Shop Prime Painting For Balance Of Plant Equipment		X
Finish Painting For Boiler Island, Including Touch-Up		X
Finish Painting For Balance Of Plant Equipment		X
TURBINE		
Turbine, Generator, Condenser, Oil Lube System, And Control Sage Guard System, BOP For Turbine Generator		X
MISCELLANEOUS EQUIPMENT / SERVICES		
Spare Parts (Start-Up)	X	
Steam Sampling System		X
Main Feed Pumps And Drives		X
Emergency Feed Pumps And Drives		X
Feedwater Heaters & Treatment System		X
Deaerator System		X
Blowdown And Flash System	X	
Chemical Feed System / Injection / Dosing		X
Stack		X
Fire Protection Piping, Hose Stations & Racks		X
First Fill Of Lubricants	X	
Compressed Air System		X
Services Of Erection And Startup Personnel For Consultation	X	
Training Of Operating & Maintenance – Field	X	
Erection Of AP equipment		X
Erection Of Balance Of Plant Equipment		X

STANDARD CFB SCOPE VERIFICATION LIST (DIVISION OF WORK)		
NR = NOT REQUIRED Option: Included in erection option	**SUPPLIED BY ALSTOM**	**SUPPLIED BY OTHERS**
Freight – To Site	X	
Receiving, Unloading At Dock And Inland Transportation	X	
Protection Of Equipment During Storage		X
Boiler Hydrostatic Testing, Incl. All Temperature. Equip. & Piping		X
Boil Out And Acid Clean Including Chemicals		X
Disposing Of Chemical Wastes		X
Steam Blow Of Lines, Including Temporary Piping & Materials		X
Performance Tests, Advisory Personnel Only	X	
Performance Tests, Incl. Test Personnel, Equip., & Materials		X
Fuel, Water, And Power For Commissioning & Erection		X
Plant Operators		X
Office Or Trailer For AP Site Personnel	X	
Washrooms / Toilets		X
Camp Housing		X
Site Transportation		X
Instruction Manuals – AP Equipment	X	
TAX AND DUTY's		
Taxes	Excluded	
Import Duties for AP Equipment	X	
INSURANCE		
Workers Comp. For AP Employees	X	
Employees Liability For AP Employees	X	
Auto For AAP Employees	X	
Comprehensive General For AP Employees	X	
Liability For AP Employees	X	
Builders All Risk		X

City of Columbia - 100 MW Unit
Numbers are per Unit.

Alstom Power

Performance Summary

Fuel		Design
Steam Flow	lb/hr	747,800
Superheat Temperature (at boiler outlet)	°F	1,000
Superheat Pressure (at boiler outlet)	psig	1,785
Feedwater Temperature	°F	493
Reheater Flow	lb/hr	673,000
Reheater Inlet Pressure	psig	541
Reheater Inlet Temperature	°F	657
Reheater Outlet Pressure	psig	509
Reheater Outlet Temperature	°F	1,000
Gas Temp Leaving Air Heater (uncorr)	°F	276
Ambient Temperature	°F	70
Gas Flow Rate Leaving Unit	lb/hr	963,000
Air Flow Rate Entering Unit	lb/hr	892,450
Excess Air	%	20
Boiler Efficiency (HHV)	%	89.45
Fuel Feed Rate	lb/hr	79,000
Limestone Feed Rate (1)	lb/hr	11,950
Ash Flow Rate	lb/hr	20,350
SO2 Removal with FDA	%	98.0

Fuel Analysis (as received)		
Carbon	wt %	69.36
Hydrogen	wt %	5.18
Oxygen	wt %	5.41
Nitrogen	wt %	1.22
Sulfur	wt %	2.89
Ash	wt %	9.94
Moisture	wt %	6.00
HHV (Btu/lb)		12,450

Sorbent Analysis		
CaCO3	wt %	96.20
H2O	wt %	1.00
Inerts	wt %	2.20
MgCO3	wt %	0.60

Notes
(1) Limestone flow based on highly reactive limestone.
Required limestone size:
- 99% less than 1200 um
- d50 between 300 um - 450 um
- No more than 2% less than 40 um

(2) Required fuel size:
- 99.9% less than 3/8"
- d50 between 650 um - 1200 um
- No more than 5% less than 40 um

ALSTOM POWER

City of Columbia - 70 MW Unit
Numbers are per Unit.

Performance Summary

Fuel		Design
Steam Flow	lb/hr	526,100
Superheat Temperature (at boiler outlet)	°F	1,000
Superheat Pressure (at boiler outlet)	psig	1,785
Feedwater Temperature	°F	493
Reheater Flow	lb/hr	480,200
Reheater Inlet Pressure	psig	541
Reheater Inlet Temperature	°F	657
Reheater Outlet Pressure	psig	509
Reheater Outlet Temperature	°F	1,000
Gas Temp Leaving Air Heater (uncorr)	°F	282
Ambient Temperature	°F	70
Gas Flow Rate Leaving Unit	lb/hr	680,200
Air Flow Rate Entering Unit	lb/hr	630,400
Excess Air	%	20
Boiler Efficiency (HHV)	%	89.28
Fuel Feed Rate	lb/hr	55,800
Limestone Feed Rate (1)	lb/hr	8,400
Ash Flow Rate	lb/hr	14,400
SO2 Removal with FDA	%	98.0

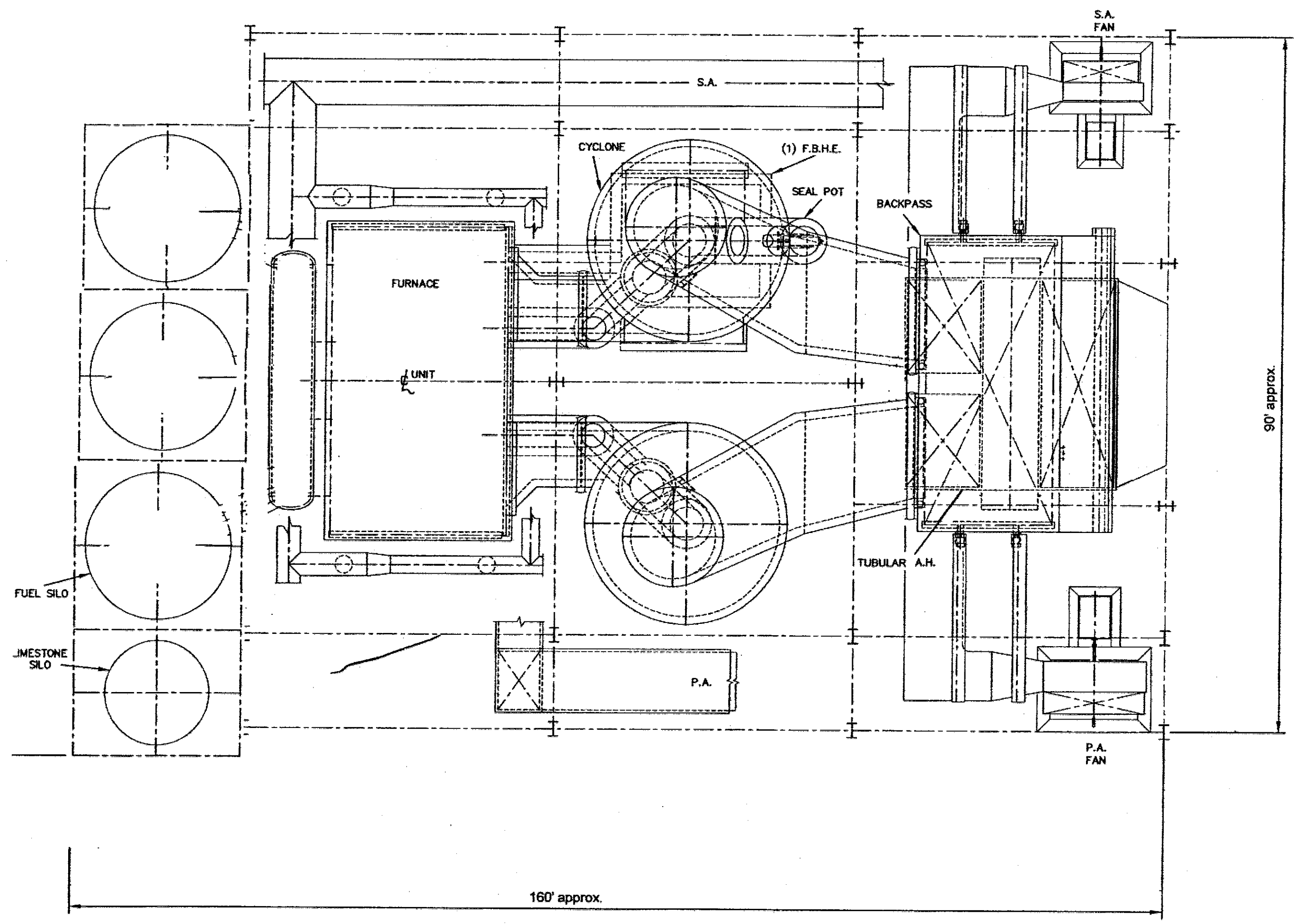
Fuel Analysis (as received)		
Carbon	wt %	69.36
Hydrogen	wt %	5.18
Oxygen	wt %	5.41
Nitrogen	wt %	1.22
Sulfur	wt %	2.89
Ash	wt %	9.94
Moisture	wt %	6.00
HHV (Btu/lb)		12,450

Sorbent Analysis		
CaCO3	wt %	96.20
H2O	wt %	1.00
Inerts	wt %	2.20
MgCO3	wt %	0.60

Notes
(1) Limestone flow based on highly reactive limestone.
Required limestone size:
- 99% less than 1200 um
- d50 between 300 um - 450 um
- No more than 2% less than 40 um

(2) Required fuel size:
- 99.9% less than 3/8"
- d50 between 650 um - 1200 um
- No more than 5% less than 40 um

REVISION



PLAN VIEW

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PLAN ARRANGEMENT OF STEAM GENERATOR	
TYPICAL 100 MW	
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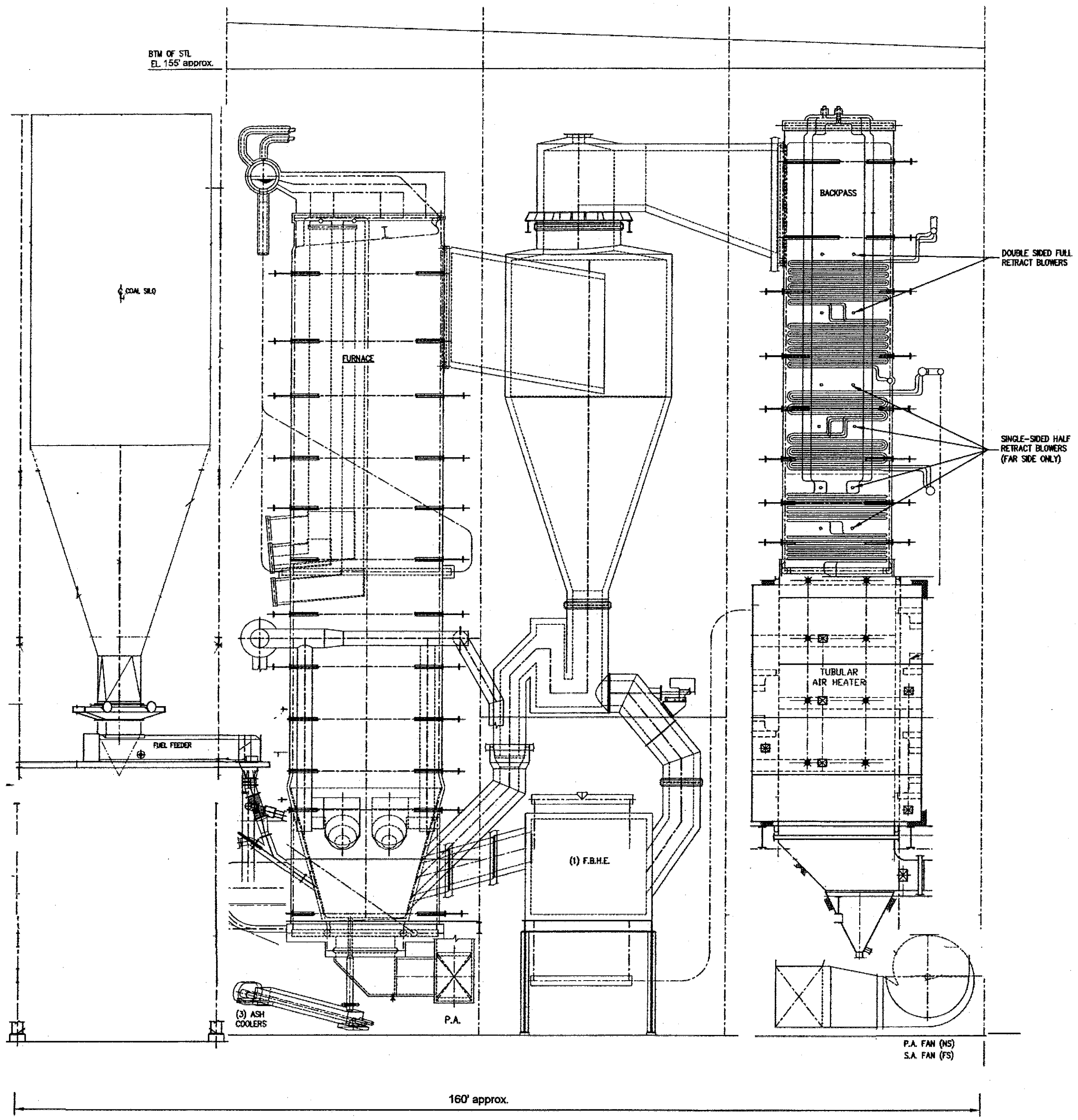

SIDE ELEVATION

SIDE ARRANGEMENT OF STEAM GENERATOR

TYPICAL 100 MW

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January 3, 2005

Mr. Caesar Hussain
Foster Wheeler
1401 Branding Lane, Suite 315
Downers Grove, Illinois 60515

Subject: City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade

Dear Caesar:

Stanley Consultants are performing a study for the City of Columbia, Missouri which includes evaluating alternatives for upgrading their power generating capability. We are seeking budget pricing and supporting information for three Circulating Fluidized Bed Boiler arrangements. The boiler sizes are as follows:

<u>Option 1: 100 MW Net Electrical Output</u>
CFB Boiler producing 747,800 lb/hr at 1,800 psia/1000 F main steam, with single reheat at 673,000 lb/hr, 509 psia/1000 F.

<u>Option 2: 70 MW Net Electrical Output</u>
CFB Boiler producing 526,100 lb/hr at 1,800 psia/1000 F main steam, with single reheat at 480,200 lb/hr, 509 psia/1000 F.

<u>Option 3: Repower Existing Steam Turbines</u>
CFB Boiler producing 638,000 lb/hr at 900 psia/900 F main steam with no reheat.

Each CFB Boiler will burn a midwestern bituminous coal as its primary fuel with the capability of burning up to five percent of either waste wood, petroleum coke or tire derived fuel. For performance purposes refer to the attached type A bituminous coal.

Specifically, the following information is required:

- Budget price for each CFB option with auxiliaries.
- A detailed list of the scope of supply (preferably including from silo inlet through the stack).
- Performance including boiler efficiency, auxiliary loads, energy and mass balance.
- General arrangement drawings.
- Estimated delivery time.

As we discussed, to support our efforts your response is required by Wednesday, January 19, 2005. Please do not hesitate to call me at (563) 264-6463 if you have any questions. Your cooperation is greatly appreciated.

Sincerely,

Gary A. Wilkinson, P.E.
Project Manager
Stanley Consultants, Inc.

Attachment: Coal Analysis
cc. Project Team

FOSTER WHEELER

FOSTER WHEELER NORTH AMERICA CORP.
Perryville Corporate Park
Clinton, NJ USA 08809-4000

Stanley Consultants

BUDGETARY PROPOSAL

For

City of Columbia, MO
CFB Project

FWPGI Proposal No. B05-002
Date: Jan. 18, 2005

SECTION 1.0

INTRODUCTION OF FOSTER WHEELER CFB TECHNOLOGY

Foster Wheeler CFB Design

The Foster Wheeler North America Corp. (FWNA) CFB combustion system operates on the circulating fluidized bed concept. Fuel and limestone are fed into the lower portion of the combustion chamber into a stream of fluidizing air. In this turbulent environment, the fuel and limestone are mixed quickly and uniformly with the bed material. The fluidizing air causes the fuel, limestone and bed material to circulate and rise throughout the combustion chamber and enter the hot cyclone separator. At that point, any unburned solids, including any unburned fuel, are captured and returned to the combustion chamber through a non-mechanical loopseal.

The limestone in the fuel mixture reacts with the sulfur dioxide and other sulfur compounds (SO_2) in the fuel gas, and the resulting inert solid material ($CaSO_4$, calcium sulfate or gypsum) is removed with the ash. The high content of gypsum in the ash has numerous beneficial uses such as soil amendments, sludge stabilization, and cement additives.

The fuel is burned at relatively low temperatures (1550-1650°F or 850-900°C), and because secondary air is introduced into the furnace at various levels above the grid, combustion occurs evenly throughout the combustion chamber. This low-temperature, staged combustion limits the formation of oxides of nitrogen (NO_x). From the convection zone, flue gases pass through a particulate collection system and then induced draft fans carry the gases to the stack.

Foster Wheeler Experience

There are more than 225 Foster Wheeler CFB units in operation or under construction worldwide with over 500 unit years of operating experience. Foster Wheeler has considerable experience with CFB boilers in paper mill applications; 45 projects and 49 boilers worldwide. Foster Wheeler also has considerable experience in firing petroleum coke in CFB boilers; 11 projects and 15 boilers designed for 100% coke firing and 10 additional projects with 15 boilers co-firing coke with other fuels. Note also that Foster Wheeler has provided two CFB boilers to the Georgia-Pacific Rincon facility, which have been in successful operation for many years. Foster Wheeler clearly offers the most comprehensive experience with CFB technology in the world today.

This extensive operating history is of value to the customer because it provides a solid operating data base on a wide variety of fuels and steam flow conditions. Foster Wheeler boilers are located in several paper mills where extensive fuel and component research and development has been carried out enabling full scale commercial testing to occur. This makes Foster Wheeler unique among boiler suppliers - focusing our designs on user sensitivity. As a result of this experience, many improvements have been made to our CFB boilers to enhance reliability and to lower maintenance costs. Our boilers have consistently demonstrated availabilities in excess of 95%, even in the most demanding operating situations such as pulp and paper mills, chemical plants, etc. All Foster Wheeler units have delivered at least 100% of the rated steam conditions while meeting the strictest emission limits. The Quality Management System for Foster Wheeler Power Group, Inc. is based on the recommendations of International Standard ISO 9001.

Environmental Awards

Foster Wheeler is proud of our ability to provide boiler equipment that consistently meets strict environmental requirements. All of our CFB units in operation have met their guaranteed emissions requirements, with several of these meeting some of the most stringent requirements in the United States. As a result, our boilers have received numerous environmental and energy conservation awards from the U.S. Department of Energy and from Power and Power Engineering Magazines, including the following:

1991	Power Plant Award for Mt. Carmel Cogeneration Facility in Mt. Carmel, PA.
1992	DOE Energy Innovation Award for the ACE Cogeneration Facility at Trona, CA.
1992	Power Plant Award for the Cambria Cogeneration Facility in Edensburg, PA.
1993	Power Plant Award for the Nelson Industrial Steam Co. (NISCO) Facility in Lake Charles, LA.
1994	Power Plant Award for the Point Aconi Plant in Nova Scotia, Canada
1995	Power Plant Award for the Cedar Bay Generating Station in Jacksonville, FL.
1996	Power Plant Award for the Colver Power Project in Colver, PA.
1997	Power Plant Award for the Robbins Resource Recovery Facility in Robbins, IL.
1998	Power Plant Award for the Sonoco Products Facility in Hartsville, SC.
1999	Power Plant Award for the Turow Rehabilitation Project in Bogatynia, Poland.
2002	Power Plant Award for the JEA Northside Repowering Project in Jacksonville, FL.
2003	Top Plant Award for the Southern Illinois Power Cooperative Repowering Project in Marion, Il.

SECTION 2.0

DESCRIPTION OF FOSTER WHEELER CFB TECHNOLOGY ADVANTAGES

Foster Wheeler's CFB boiler system has been well demonstrated through over 500 unit-years of operating experience from over one-hundred commercially operating units. Additional units are currently under construction. Moreover, Foster Wheeler has extensive field service capabilities to erect, commission and support our customers during the warranty period, as well as providing aftermarket services for outage work and spare parts supply.

Fuel Flexibility

Foster Wheeler CFBs can burn virtually any solid fuel cleanly and efficiently, including all grades and types of coal, peat, wood waste, high-ash waste coals, petroleum coke, sludge, oil shale, and agricultural wastes. This is a result of two key features of CFB technology, namely the relatively low combustion temperatures and the residual heat of the bed material that circulates repeatedly through the combustion chamber. Moreover, the Foster Wheeler CFB can be designed to burn multiple fuels for the same plant, without requiring any modifications when changing fuels. This not only provides many technical advantages, but also provides significant commercial advantages. Since fuel typically represents a minimum of about 40-50% of a plant's operating cost, substitution of less expensive low-grade fuels can have a dramatic impact on lowering the cost of electrical generation.

The range of fuels being successfully burned in Foster Wheeler CFBs is broad: from very hard anthracite coals to high ash bituminous coals, including very high ash (70%) coal waste or coal tailings from coal washeries. Foster Wheeler CFBs also easily accommodate a broad range of sulfur contents, from 0.5 - 8%. Fuels with little or no ash are also easily burned, including petroleum coke, a refinery waste product with almost no ash at all. High volatile fuels such as high moisture peat and wood waste have been burned successfully. The CFB, with its low combustion temperature, is an especially good solution for coals with low ash-fusion temperatures, preventing the formation of slag.

Low SO_2 Emissions

Foster Wheeler CFBs do not require complicated and expensive downstream flue gas desulfurization-equipment to meet environmental regulations. Foster Wheeler has a majority of CFB installations operating at over 90% SO_2 capture, with many operating above 95% SO_2 capture. To achieve SO_2 capture, limestone is injected into the furnace and reacts with the sulfur dioxide and other sulfur compounds in the flue gas to form an inert dry solid, calcium sulfate ($CaSO_4$), or more commonly called gypsum. This dry solid is a reusable by-product such as an additive for the cement industry, soil amendment for acidic soils, sewage sludge neutralizer and stabilizer.

High Combustion Efficiency

The continuous circulation of solids through the Foster Wheeler system keeps the fuel in an ideal combustion environment for a long period of time. The longer residence time results in very efficient fuel combustion, while minimizing process changes resulting from sudden changes in fuel quality or mixes. This combination provides for optimum carbon burnout with a broad variety of fuels.

Low NO_x Emissions

Emissions of nitrous oxides (NO_x) are very low with a Foster Wheeler CFB boiler since they operate at low furnace temperatures that essentially eliminates the formation of thermally generated NO_x, a major source of NO_x.

Elimination of Slagging

The low combustion temperature of the CFB technology virtually eliminates slag formation in the furnace and reduces the volatilization of alkali salts. This eliminates the high cost and maintenance expense of furnace sootblowers. Operating at such low temperatures also means that boiler corrosion and convective surface fouling is reduced.

High Turndown

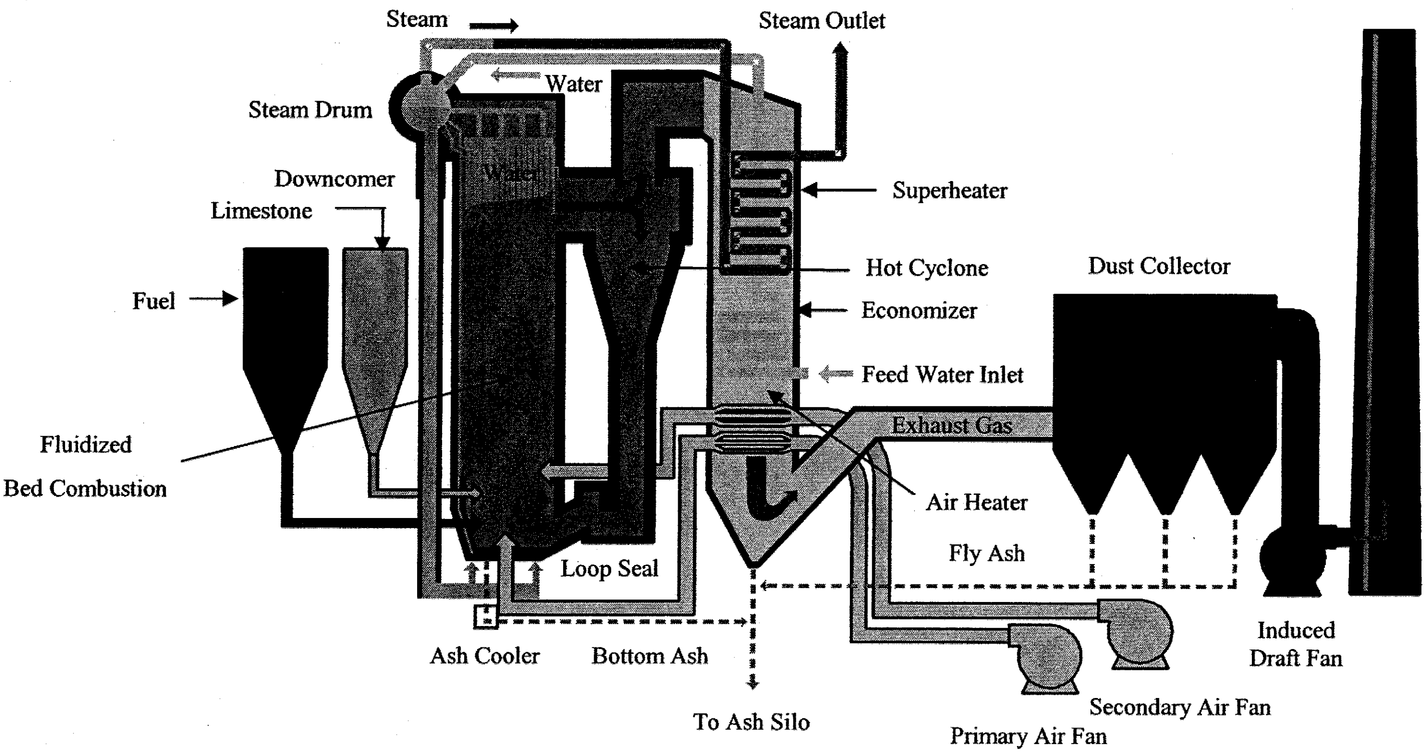
Foster Wheeler CFB technology has repeatedly demonstrated high turndown capability. Foster Wheeler's CFBs also can be used for load cycling to match the normal daily-demand curve.

High Availability

Foster Wheeler CFB boilers are simple and designed for reliability. Key components such as the fuel, limestone, and ash removal systems are designed for complete redundancy. Foster Wheeler CFB boilers do not require pulverizers for fuel preparation, and have simple, reliable fuel feeding. These features combine to produce exceptional boiler availability.

Easy to Operate and Maintain

The same elements that make Foster Wheeler CFB boilers highly reliable also make them simple to operate and maintain. There are fewer things that can go wrong. Also, maintenance costs for a Foster Wheeler CFB are low. CFB units typically have only two weeks (or less) set aside each year for planned maintenance outages.


Steam
Steam Outlet
Water
Steam Drum
Water
Downcomer
Limestone
Superheater
Hot Cyclone
Dust Collector
Fuel
Economizer
Feed Water Inlet
Exhaust Gas
Fluidized
Bed Combustion
Air Heater
Fly Ash
Loop Seal
Induced
Draft Fan
Ash Cooler
Bottom Ash
To Ash Silo
Secondary Air Fan
Primary Air Fan

SECTION 3.0

SCOPE OF SUPPLY

General Description

A scope of work and supply for the proposed CFB boiler is included below. This scope reflects Foster Wheeler's standard design practice for the intended equipment use. Termination points for the proposed boilers are included at the end of this section.

Scope of Supply (per Boiler)

	Supplied by FWNAC	Supplied by Others
Fluidized Bed Furnace	X	
Particle Separators, Loopseals and Solids Return Lines	X	
Heat Recovery Area	X	
Spray Attemperators with Controls	X	
Flues, Ducts, Dampers & Pneumatic Actuators	X	
Refractory Material Supply	X	
Economizer	X	
Airheaters (Tubular Type)	X	
Structural Support Steel	X	
Platforms, Stairways and Handrails	X	
Ignition System	X	
Vent and Drain Valves	X	
Safety Valves	X	
Feed Stop and Check Valves	X	
Miscellaneous Boiler Valves and Trim	X	
Fuel Feed System	X	
Limestone Feed System	X	
Primary Air Fan, and Silencer	X	
Secondary Air Fan, and Silencer	X	
Induced Draft Fan		X
Fan Motor Drives	X	
Loopseal Blower and Motor Drive	X	
Steam Sootblowers	X	
Bottom Ash Extraction and Cooling	X	
Pulse Jet Type Baghouse		X
Insulation and Lagging	Spec	X
Prime Painting	X	
Foundations and Anchor Bolts		X

	Supplied by FWNAC	Supplied by Others
Motor Control Center/Electrical Switchgear/Power Wiring		X
Plant DCS		X
Combustion Controls and Furnace Safety System	Engrg	X
Field Instruments		X
Service Air Piping		X
Instrument Air Piping		X
Cooling Water Piping		X
Startup Fuel Piping		X
Interconnecting Wiring and Tubing, Including Cable Trays/Conduits		X
Fuel & Limestone Receiving, Preparation and Conveying Systems		X
Fuel & Limestone Storage Bunkers	X	
Spent Ash Conveying and Storage		X
Feedwater, Water Treatment, Sampling and Blowdown Systems		X
Stack and Breeching		X
Stack Continuous Emissions Monitoring Systems		X
Steam, Feedwater, and Misc. Piping and Valves Outside Terminal Points		X
Civil and Architectural Site Work		X
Building Enclosure and Steel		X
Lubricants, Startup Materials, Fuels		X
Feed and Disposal of Hydrotest/Boilout Fluids		X
Finish Painting		X
SNCR	X	

Terminal Points

Fuels and Limestone

a. Fuel: Inlet of fuel bunkers.

b. Limestone: Inlet of limestone silo.

c. Start-up Fuel: Connections at burner skid local to start-up burners.

Steam/Water

a. Superheater/Reheater: Inlet/outlet headers approximately 6 feet from the boiler lagging.

b. Safety Valves: Outlet of safety valve vent stack above roof steel.

c. Electromatic Relief (or Startup) Valve: Outlet of the valve silencer above roof steel.

d. Vents: Outlet of second Boiler Code valve located at top of steel.

e. Drains: Outlet of second Boiler Code valve. The first valve will be close connected to the source with the second valve located above the operating floor level.

f. Economizer Inlet: Inlet to the feedwater stop/check valve, approximately 6 feet from the economizer inlet header.

g. Desuperheater Spray Water: Inlet to the desuperheat station isolation valves.

h. Cooling Water: At equipment inlet and outlet connections requiring cooling water.

i. Chemical Feed: Isolation valve at drum connection.

j. Sampling Connections: Outlet of second valve close connected to sample connection.

Air

a. Instrument Air: At equipment connections requiring instrument air.

b. Service Air: At equipment connections requiring service air.

Ash

a. Flyash: Outlet flange of airheater hoppers.

b. Bottom Ash: Outlet of rotary flow control valve below bottom ash coolers.

Ducts

a. Air: Inlet to silencers mounted on air fans.

b. Flue Gas: Outlet of airheater

Electrical and Instrumentation

a. Motor terminals.

b. Boiler field instrumentation terminals (where provided).

c. Local control panel input and output (where provided).

d. Boiler metal thermocouple terminals in local terminal boxes. All other thermocouples will terminate at the thermocouple head connection.

SECTION 4.0

DESIGN FEATURES

The proposed CFB contains several key design features that were developed based on Foster Wheeler's industry-leading experience and which are designed to minimize total life-cycle costs. These features are described below;

- Arrowhead Fluidizing Nozzles (Figure 4-1)

These are the fluidizing nozzles installed in the floor of the furnace that distribute the primary air over the furnace cross-section. The arrowhead nozzles are designed to provide proper air distribution with minimum pressure drop while avoiding back-sifting of bed material into the air plenum below the furnace floor.

- Furnace Wall Tube Kick-out (Figure 4-2)

The furnce tube kick-out is designed to avoid erosion at the interface between the refractory-covered lower furnace and the bare-tube upper furnace. Early units had experienced erosion at this interface caused by bed material flowing down the wall, hitting the interface and eroding the furnace tube locally. The kick-out design avoids this erosion by pulling the interface back away from the plane of the down-flowing solids.

- Wingwalls (see Figure 4-3)

Wingwalls are used to provide the additional furnace heat transfer surface area needed beyond the furnace walls themselves, to maintain furnace temperature at the desired 1550-1650F range for proper performance. The only alternate to wingwalls is an external heat exchanger, a bubbling bed containing one or more tube bundles and where solids collected by the separator are passed through the heat exchanger and back to the furnace. Wingwalls are clearly a more simple and maintenance-free design.

- Compact Separator (Figure 4-4)

The Compact separator performs the function of the cyclone separator in a CFB, collecting the bed material entrained from the upper furnace for recycle back to the lower furnace. The Compact separator is an octagonal cyclone-type collector which is formed from water-cooled tube panels. The octagonal configuration allows more machine fabrication than the previous round configuration, while preserving all the benefits of a water-cooled collector as compared to a plate/refractory cyclone, which are;

- reduced refractory maintenance - the water-cooled configuration requires only a 1 inch thick refractory lining for erosion protection, much thinner than the 12-16 inch thick lining required with the plate/refractory configuration. The thin lining is much more durable than a thick lining, saving considerable refractory maintenance costs
- reduced refractory weight – the reduced refractory weight also reduces the amount of structural steel and foundation required for support
- reduced fuel costs – with the water-cooled configuration, an external layer of insulation and lagging can be used, which reduces heat loss (and so fuel costs) compared to the plate/refractory configuration which cannot be externally insulated.

- Reduced expansion joints – the water-cooled separator is cooled with the same fluid that cools the furnace, so there is no differential thermal expansion between separator and furnace, as there is with a plate/refractory cyclone. This reduces the number of expansion joints in the system, along with the associated maintenance.

- Stripper/Cooler (Figure 4-5)

The stripper/cooler cools the bottom ash to a temperature acceptable to the ash handling system while recovering a majority of the sensible heat, all with no moving parts in the hot ash stream. The stripper/cooler is a bubbling bed with multiple chambers that fluidizes the bottom ash with primary air and passes the ash from chamber to chamber from ash inlet to outlet. The heat from the ash is transferred to the fluidizing air that is ducted back to the furnace as overfire air, thus recovering the heat. A rotary valve with a variable speed drive is located in the ash outlet line, to control the bottom ash flowrate. The stripper/cooler has much lower maintenance requirements than the water-cooled screws which have been used for cooling bottom ash.

All of the above design features have been proven in Foster Wheeler CFB's for at least 10 years.

Figure 4-1

Arrowhead Air Nozzle On Water Cooled Grid

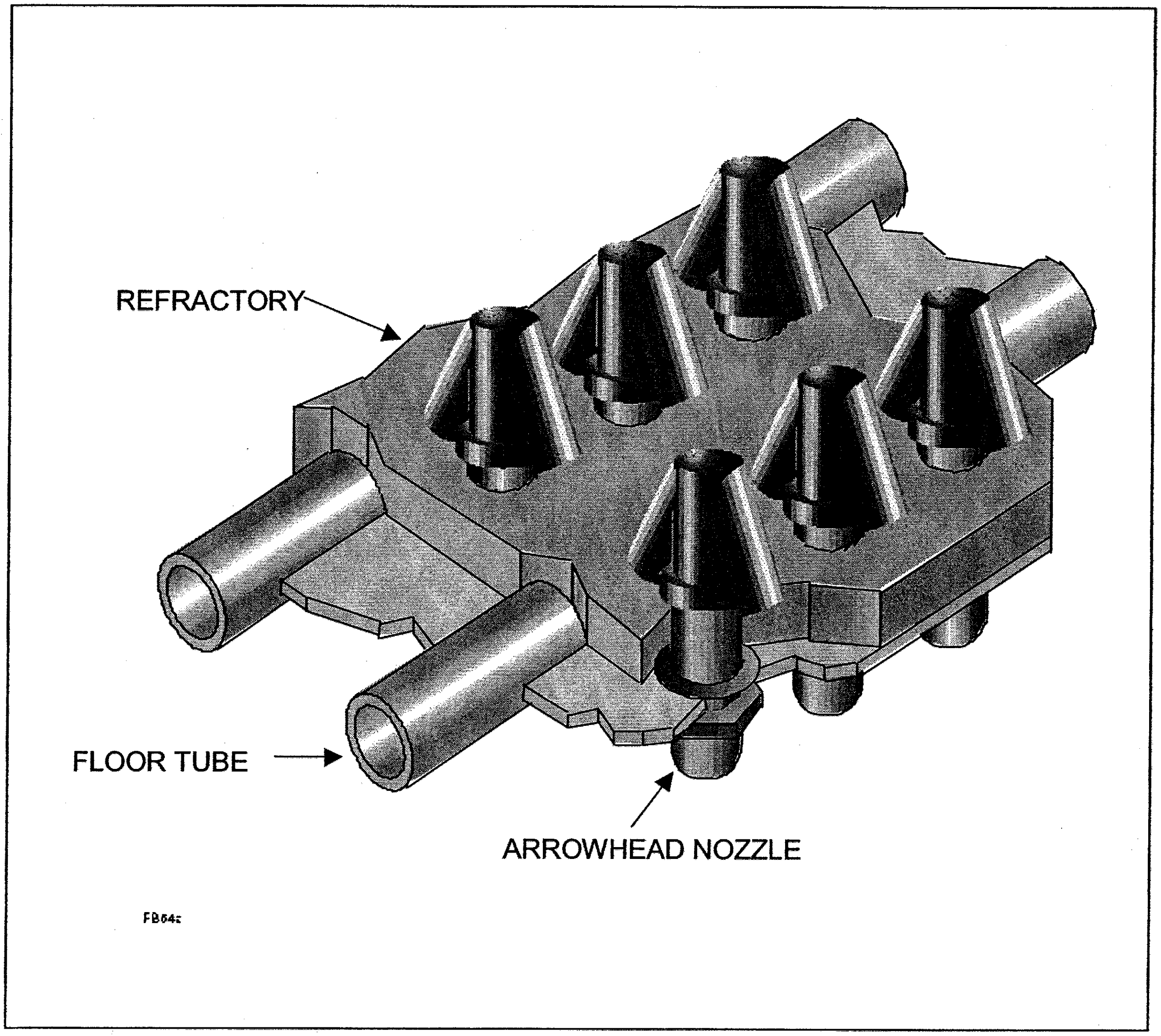


Figure 4-2
Furnace Kick-Out Tube Design

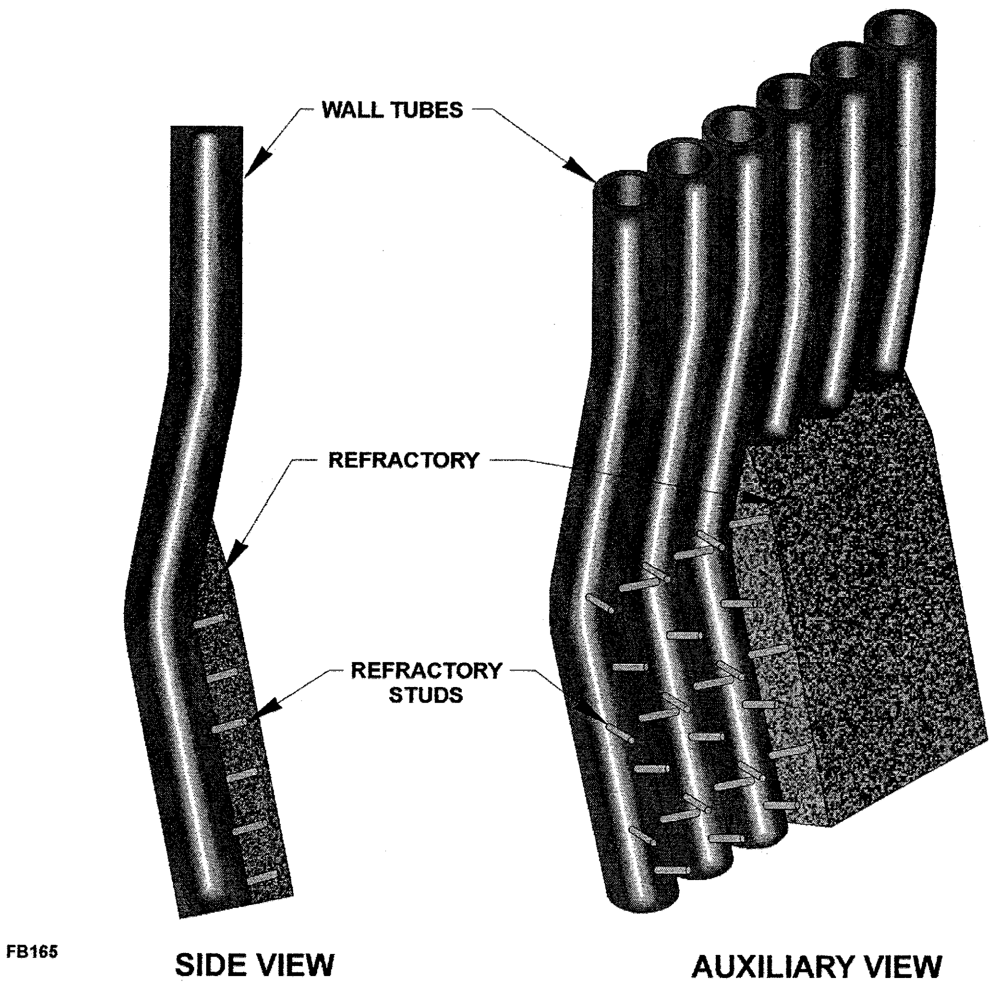


Figure 4-3

Furnace Wing Wall Arrangement

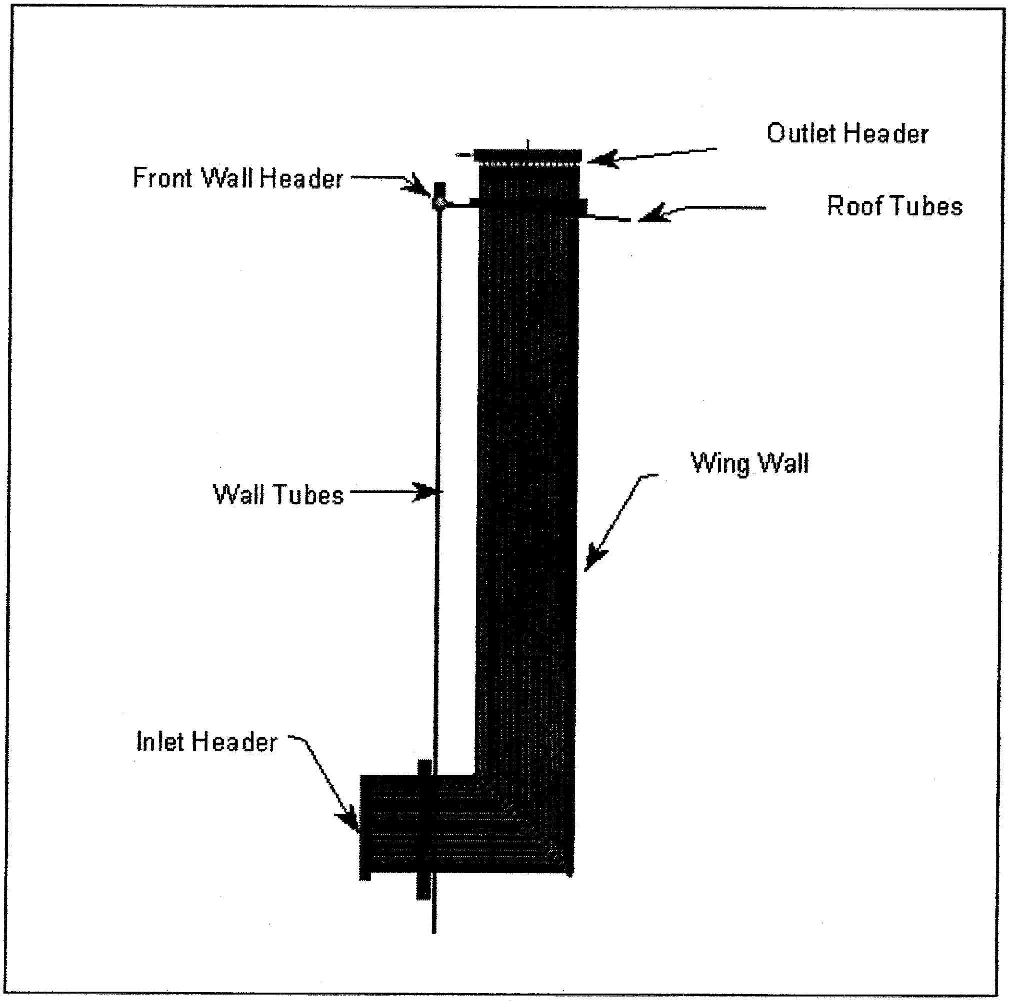


Figure 4-4

Compact Separator

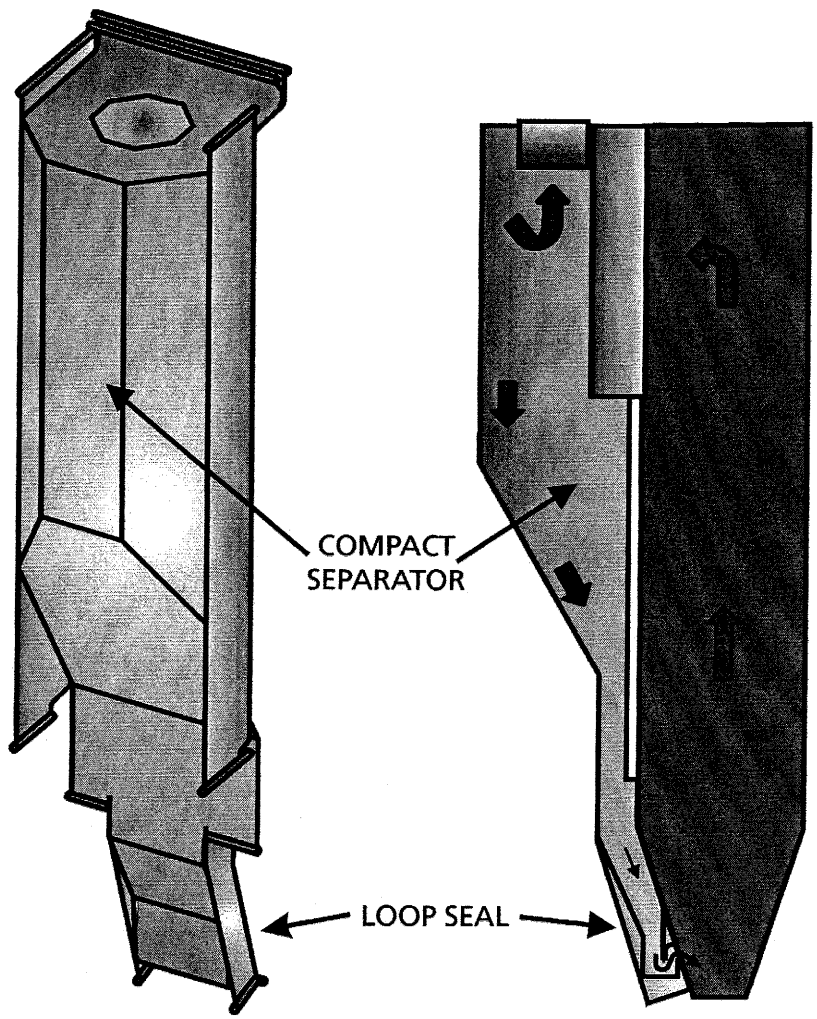
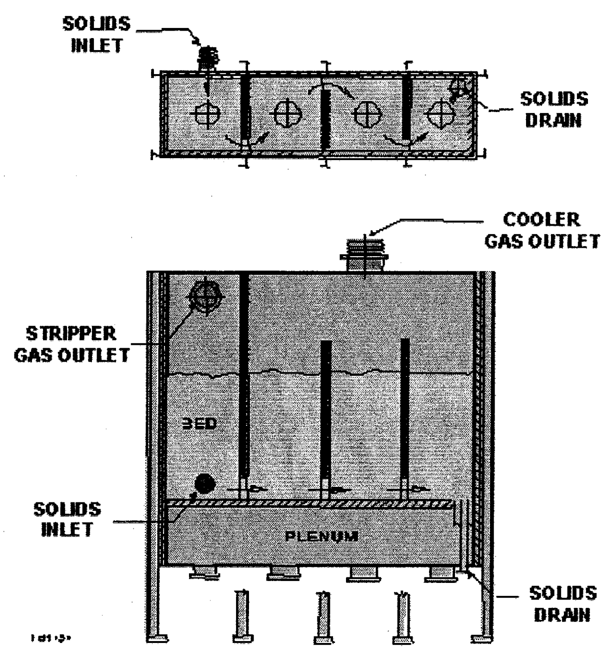


Figure 4-5
Stripper Cooler



- Simple Air Cooling
- No Moving Parts
- Returns Fine Coal & Limestone to Bed
- Improves Efficiency and Limestone Usage
- Simple Casing/ Refractory Design
- Proven Design

(Std_19)

SECTION 5.0

TECHNICAL DATA/PREDICTED PERFORMANCE

Steam Conditions	CASE A	CASE B	CASE C
Main Steam Flow, pph	716,800	578,900	731,400
Main Steam Pressure, psia	1,900	1,600	1,000
Main Steam Temperature, °F	1,005	1,005	905
Reheat Steam Flow, pph	644,700	--	--
Reheat Steam Pressure, psia	517	--	--
Reheat Steam Temperature, °F	1,005	--	--
Feedwater Temperature, °F	475	420	420
Boiler Efficiency (% HHv)	88.5	88.5	88.5
Performance (100% MCR)			
Fuel, lb/hr	79,000	57,600	70,130
Limestone, lb/hr	14,850	10,820	13,180
Ca/S	2.0	2.0	2.0
Air, lb/hr	919,875	670,470	816,500
Flue Gas, lb/hr	991,400	722,600	880,000
Ash, lb/hr	22,400	16,300	19,850
Bottom Ash, %	20	20	20
Aqueous Ammonia (19% NH3), lb/hr	569	415	505
XS Air, %	20	20	20
Stack Temp, F	300	300	300
Auxiliary Power, kw	3,700	2,750	3,300
NOx, lb/mmBTU	0.10	0.10	0.10
SOx, lb/mmBTU	0.23 (95%)	0.23 (95%)	0.23 (95%)
CO, lb/mmBTU (@ MCR)	0.15	0.15	0.15
VOC. lb/mmBTU (@MCR)	0.005	0.005	0.005

FUEL ANALYSES

This budgetary proposal is based on the Pittsburgh No. 8 Fuel Analysis as reported by Stanley Consultants in their January 4, 2005 transmittal.

TYPICAL FW DELIVERY SCHEDULE

SUBJECT TO CONFIRMATION AT TIME OF AWARD

BASED ON PREVAILING MATERIAL AVAILABILITY AND SHOP CAPACITY

	Months from NTP
Structural Steel	10-12
Drum	13-15
Furnace	13-19
Cyclone	14-17
Airheater	15-18
Ash Cooler	16-19
Convection Pass	16-22
Fans	17-22
Feeders	17-22
Refractory	20-23

TYPICAL ARRANGEMENT DRAWINGS

General Arrangement drawings are provided in a separate file, in AutoCad format

For Case A – the steam generator would be about 90% of the dimensions shown.

For Case B – the steam generator would be about 70% of the dimensions shown.

For Case C – the steam generator would be about 80% of the dimensions shown.

SECTION 6.0

BUDGETARY COST ESTIMATE

The budgetary cost estimate to design and furnish one (1) FWNA Circulating Fluidized Bed (CFB) boiler, designed to fire the fuel specified and generate the steam conditions as summarized in Section 5:

Design and Supply

Case A – 716,800 pph main @ 1900 psia Steam Reheat Unit:

$31,000,000

(Thirty One Million U.S. Dollars)

Case B – 578,900 pph main steam @ 1600 psia non-Reheat Unit:

$24,000,000

(Twenty Four Million U.S. Dollars)

Case C – 731,400 pph main steam @ 1000 psia non-Reheat Unit:

$28,500,000

(Twenty Eight Million, Five Hundred Thousand U.S. Dollars)

This budgetary estimate is based on the following clarifications:

1. The above estimate is based on scope of supply as specified in Section 3 of this proposal.

2. The above estimate does not include allowance for taxes, tariffs, insurance, permits, bonds and environmental or other impact studies.

3. The estimate includes allowances for technical services and technical supervision to support erection, startup assistance and performance testing. Direct supervision of erection labor is not included. Training of plant personnel, plus the supply of operations and maintenance manuals are also included.

4. The above estimate is based on delivery of goods, DDP site (per Incoterms).

5. The above estimate is based on a 1st Quarter 2005 notice to proceed (NTP). Complete delivery of the equipment will be approximately twenty four (24) months after NTP and commercial operation will be approximately thirty three (33) months after NTP.

6. This budgetary proposal is for your information only and is not an offer to sell. Accordingly, all work performed and/or decisions made based on this proposal shall be at the entire risk and obligation of the user.

January 4, 2005

Mr. Merle Flandermeyer
Siemens Westinghouse Power Corporation, Inc.
Orlando, Florida

Subject: City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade

Dear Mr. Patel:

Stanley Consultants is performing an evaluation for the City of Columbia, Missouri which includes comparing alternatives to upgrade their power generating capability at the Columbia site. We are seeking budget pricing and supporting information for steam turbine/generators from Siemens Westinghouse to prepare an opinion of probable cost in this phase of work. The following two options will be evaluated:

Option 1: 100 MW Net Electrical Unit Output
This option will require a steam turbine/generator output of 108,958 kW. We have calculated a main steam supply of 714,600 lb/hr at 1,800 psia/1000 F, with a single reheat at 642,000 lb/hr, 509 psia/1000 F.

Option 2: 70 MW Net Electrical Output
This requires a steam turbine/generator output of 76,268 kW. The main steam supply is 501,500 lb/hr at 1,800 psia/ 1000 F, with a single reheat flow rate of 457,600 lb/hr 509 psia/1000 F.

We would appreciate receiving information from Siemens Westinghouse to assist with this effort. Please provide budgetary pricing to deliver a steam turbine/generator unit for each option. An optional price to receive and install the unit would also be appreciated.

Information Required:

Provide the following information for both options.

- Heat Balances – provide supporting heat balances for the 100 percent, guarantee, and valves wide open (VWO), and 5 percent overpressure load cases as well as an exhaust loss curve for the proposed low pressure turbine.
- Detailed list of the scope of supply.
- Budget price.

- General arrangement drawings, clearances and weights including skids and panels.
- Descriptions of the major equipment items supplied.
- List of similar applications with owners contact information and conditions.
- Description of the control system.
- Description of the excitation system.
- Approximate delivery time.

Scope:

Steam turbine/generator and auxiliaries:

1. Steam Turbine
2. Generator
3. Turbine/generator control system
4. Turbine/generator supervisory control system
5. Main and reheat valves, control valves, stop valves, intercept valves, turbine drain system valves and actuators
6. Lube Oil System (Tank, pumps, filters, coolers, piping, controls, instrumentation)
7. Shaft sealing system (Gland condensers, vacuum and air removal)
8. Generator cooling system
9. Generator neutral grounding equipment
10. Generator relay protection system
11. Generator excitation system
12. Interconnecting piping
13. Insulation for supplied piping and components
14. Acoustic control
15. Instrumentation

Cycle Conditions:

Base your sizing calculations on the following cycle conditions and basis:

- Exhaust pressure, 1.5" hg abs.
- The cycle will have two high pressure shell and tube feedwater heaters downstream of the boiler feed pump. The boiler feed pump will take suction from a direct contact deaerator. There will be three low pressure shell and tube feedwater heaters. Conditions are attached.
- Design criteria:
    1. Feedwater heater shells will operate at 4% below the turbine extraction flange pressure.
    2. Assume no enthalpy loss in the extraction piping.
    3. All gland seal and leak-off steam shall be accounted for in the heat balance diagrams.
    4. Mechanical vacuum pumps will be used.

5. Reheat system pressure drop will be 10% of the high-pressure turbine exhaust pressure.
6. The Boiler Feed Pump is motor driven.
7. The site is in Columbia, Missouri, elevation about 900 feet above mean sea level.

Schedule:

Budgetary information required from General Electric	January 19, 2005
Evaluation completed	May 1, 2005
Project release date	December 1, 2005

Your cooperation is greatly appreciated. Please do not hesitate to call me at (563) 264-6463 if you have any questions.

Sincerely,

Gary A. Wilkinson, P.E.
Project Manager
Stanley Consultants, Inc.

cc. Project File

SIEMENS

January 20, 2005

Gary Wilkinson
Stanley Consultants, Inc.

Subject: Budget Proposal for your City of Columbia project.
SIT Inc. Ref. – I2-07-00081-01

ALTERNATIVE 100 MW REHEAT with a dual-body steam turbine

Dear Mr. Wilkinson

Referring to e-mail of January 5, 2005, regarding the City of Columbia project, we submit the following estimate for a standard Siemens Industrial Turbomachinery Inc's (SITI) type SST-PAC-900RH steam turbine generator unit:

Performance:	Please refer to separate heat balances *"Performance 100 MW reheat City of Columbia I2-07-00081-01 a050118.pdf"*
Price Estimate:	$ 14,400,000. Delivered DDP jobsite (loading not included)
Delivery Time:	Approximately 15 months after order, subject to intervening sales.

Scope of Supply:
Steam Turbine, speed reduction gear and 3,600 rpm TEWAC generator (with terminal boxes, measuring transformers, surge protection and high resistance grounding), complete with turbine heat insulation blankets, gland steam system with leak-off condenser, complete lube oil system, emergency stop and control valves, hydraulic system, instrumentation and a complete stand-alone digital turbine generator control system (governor, AVR, monitoring of temperatures, pressures, vibrations, etc., alarms and turbine safety trips) with Color Monitor / Keyboard operator interface and an event printer.

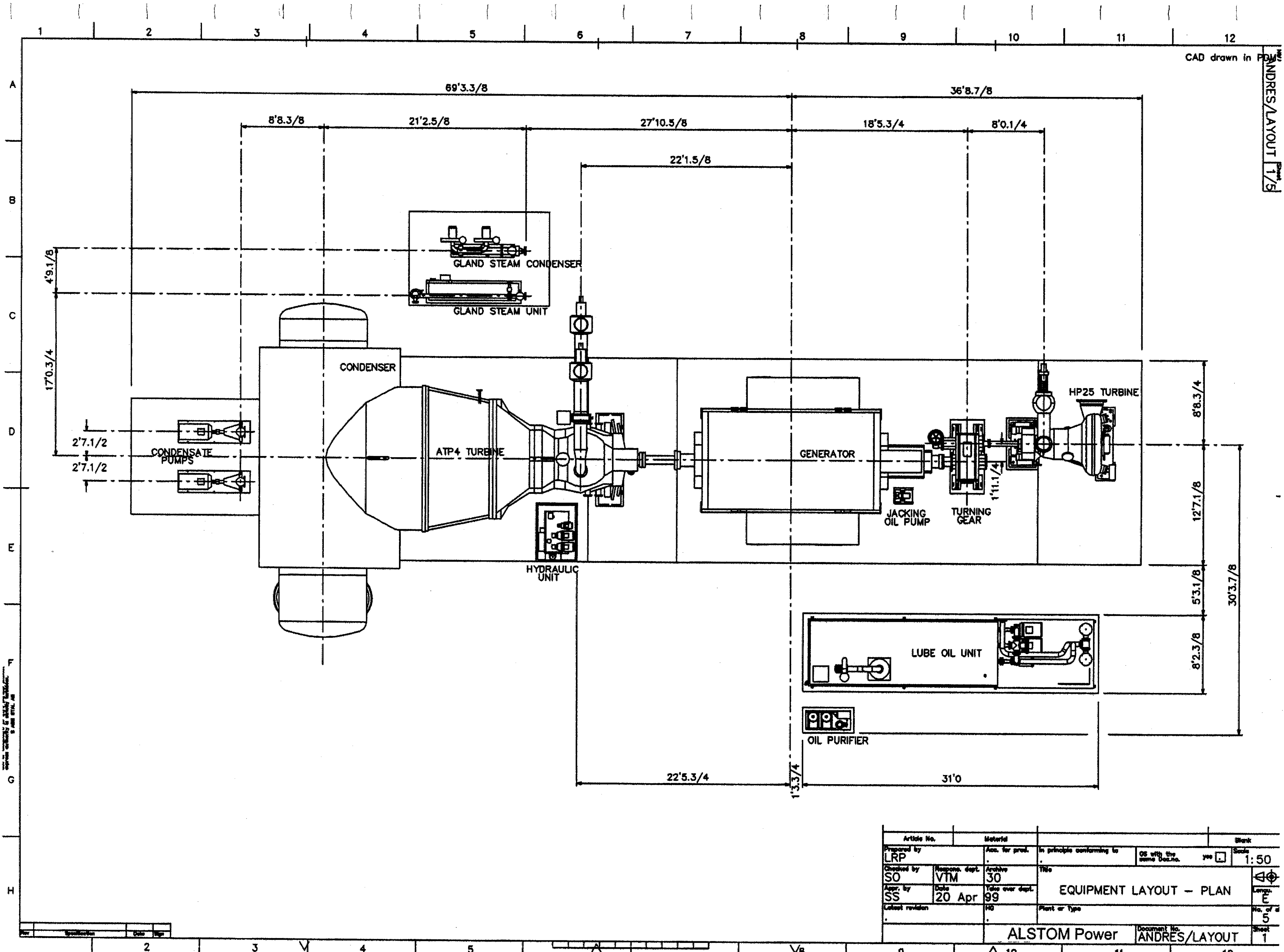
Main Exclusions:
Condenser system, by-pass systems, generator protection relays, generator breaker, spare parts for operation and technical advisors (for erection, commissioning and training) are not included in the Scope at this time.

SIEMENS

If you have any questions, after review of this information, please don't hesitate to contact us.

Sincerely Yours,

John Lindstrom
Steam Turbine Marketing Manager
Siemens Industrial Turbomachinery, Inc.
Phone: +1 281 856 4471 (wk)


CAD drawn in PDMS
ANDRES/LAYOUT
Sheet 1/5
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8'8.3/8
21'2.5/8
27'10.5/8
18'5.3/4
8'0.1/4
22'1.5/8
4'9.1/8
17'0.3/4
2'7.1/2
2'7.1/2
GLAND STEAM CONDENSER
GLAND STEAM UNIT
CONDENSER
CONDENSATE PUMPS
ATP4 TURBINE
HYDRAULIC UNIT
GENERATOR
JACKING OIL PUMP
TURNING GEAR
1'11.1/4
HP25 TURBINE
8'8.3/4
12'7.1/8
5'3.1/8
8'2.3/8
30'3.7/8
LUBE OIL UNIT
OIL PURIFIER
22'5.3/4
1'3.3/4
31'0
Prepared by LRP
Checked by SO
Respons. dept. VTM
Archive 30
Appr. by SS
Date 20 Apr
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EQUIPMENT LAYOUT – PLAN
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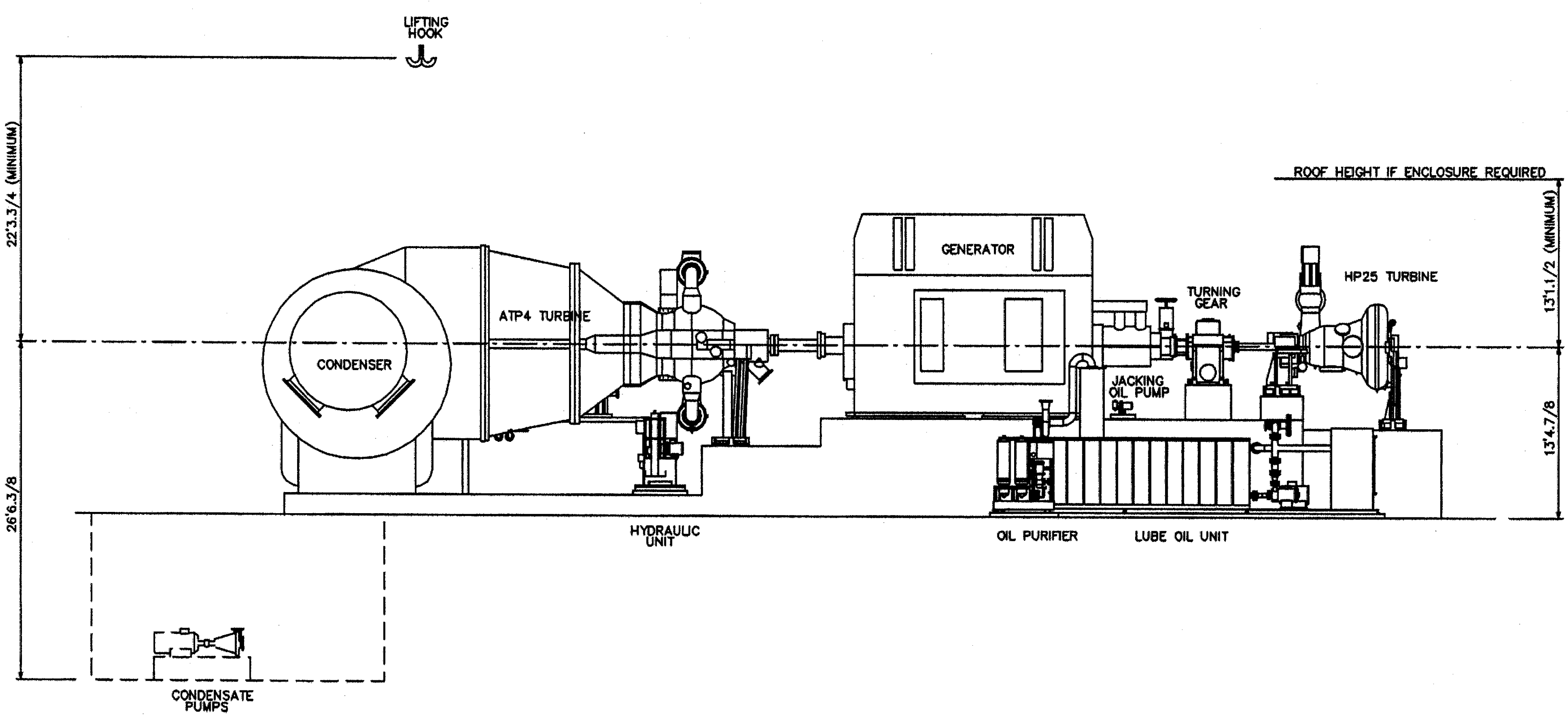
ALSTOM Power
Document No. ANDRES/LAYOUT
Sheet 1



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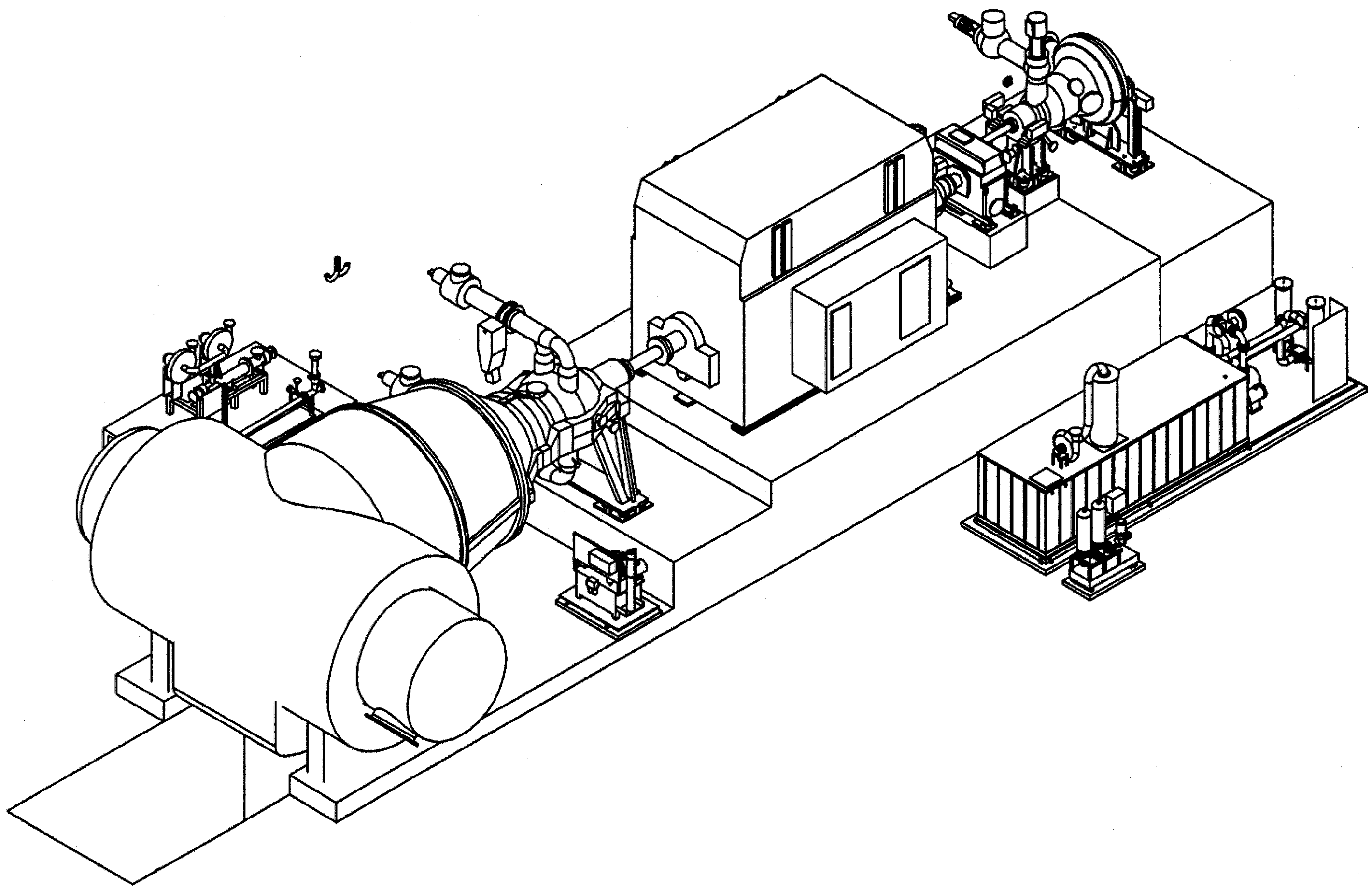
Appr. by SS / Date 20 Apr	Take over dept. 99		
Latest revision	HG	Plant or Type	No. of sh 5
	ALSTOM Power	Document No. ANDRES/LAYOUT	Sheet 2



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Appr. by SS	Date 20 Apr	Take over dept. 99			
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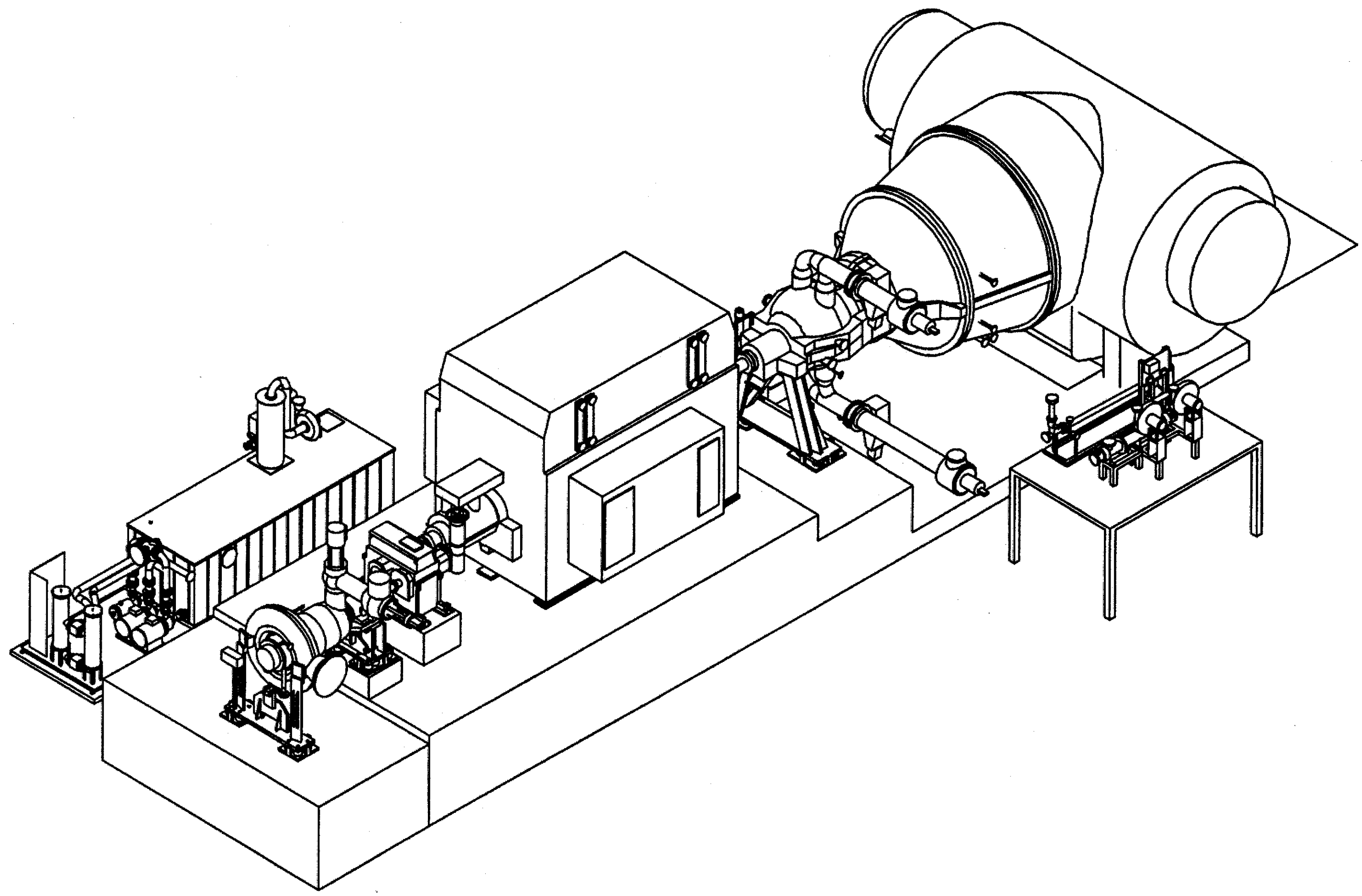
		ALSTOM Power		Document No. ANDRES/LAYOUT	Sheet 4

CAD drawn in PDM

ANDRES/LAYOUT Sheet 4/5

CAD drawn in PGM

ANDRES/LAYOUT Sheet 5/5



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			ALSTOM Power	Document No. ANDRES/LAYOUT	Sheet 5

Rev	Specification	Date	Sign

SIEMENS

January 20, 2005

Gary Wilkinson
Stanley Consultants, Inc.

Subject: Budget Proposal for your City of Columbia project.
SIT Inc. Ref. – I2-07-00081-01

ALTERNATIVE 70 MW NON-REHEAT with a single-body steam turbine

Dear Mr. Wilkinson

Referring to e-mail of January 5, 2005, regarding the City of Columbia project, we submit the following estimate for a standard Siemens Industrial Turbomachinery Inc's (SITI) type SST-PAC-900 steam turbine generator unit:

Performance:	Please refer to separate heat balances *"Performance 70MW 1-module City of Columbia I2-07-00081-01 b050119.pdf"*
Price Estimate:	$ 10,300,000. Delivered DDP jobsite (loading not included)
Delivery Time:	Approximately 15 months after order, subject to intervening sales.

Scope of Supply:
Steam Turbine, speed reduction gear and 3,600 rpm TEWAC generator (with terminal boxes, measuring transformers, surge protection and high resistance grounding), complete with turbine heat insulation blankets, gland steam system with leak-off condenser, complete lube oil system, emergency stop and control valves, hydraulic system, instrumentation and a complete stand-alone digital turbine generator control system (governor, AVR, monitoring of temperatures, pressures, vibrations, etc., alarms and turbine safety trips) with Color Monitor / Keyboard operator interface and an event printer.

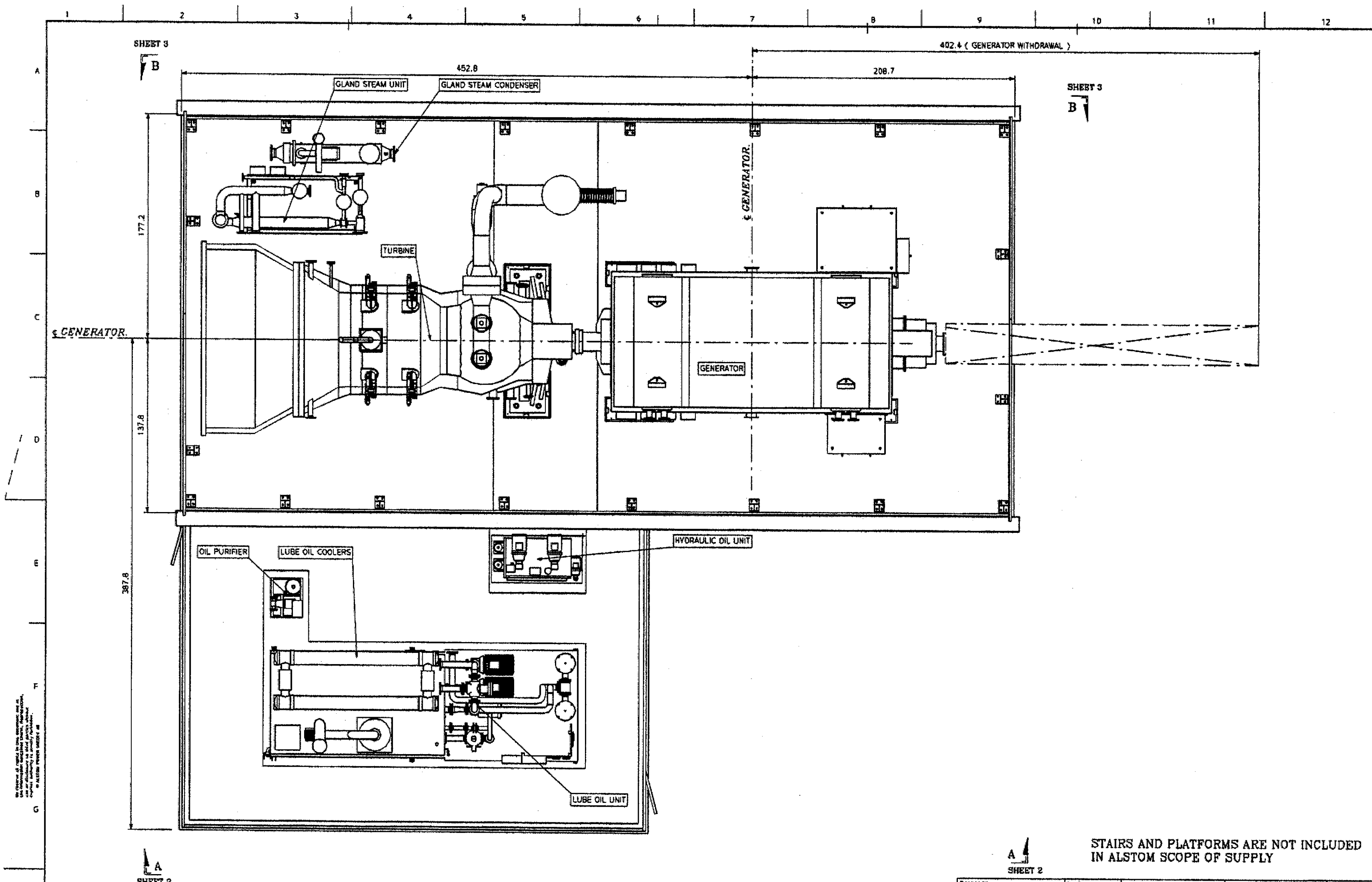
Main Exclusions:
Condenser system, by-pass systems, generator protection relays, generator breaker, spare parts for operation and technical advisors (for erection, commissioning and training) are not included in the Scope at this time.

SIEMENS

If you have any questions, after review of this information, please don't hesitate to contact us.

Sincerely Yours,

John Lindstrom
Steam Turbine Marketing Manager
Siemens Industrial Turbomachinery, Inc.
Phone: +1 281 856 4471 (wk)



ALL MEASURES IN INCHES

STAIRS AND PLATFORMS ARE NOT INCLUDED
IN ALSTOM SCOPE OF SUPPLY

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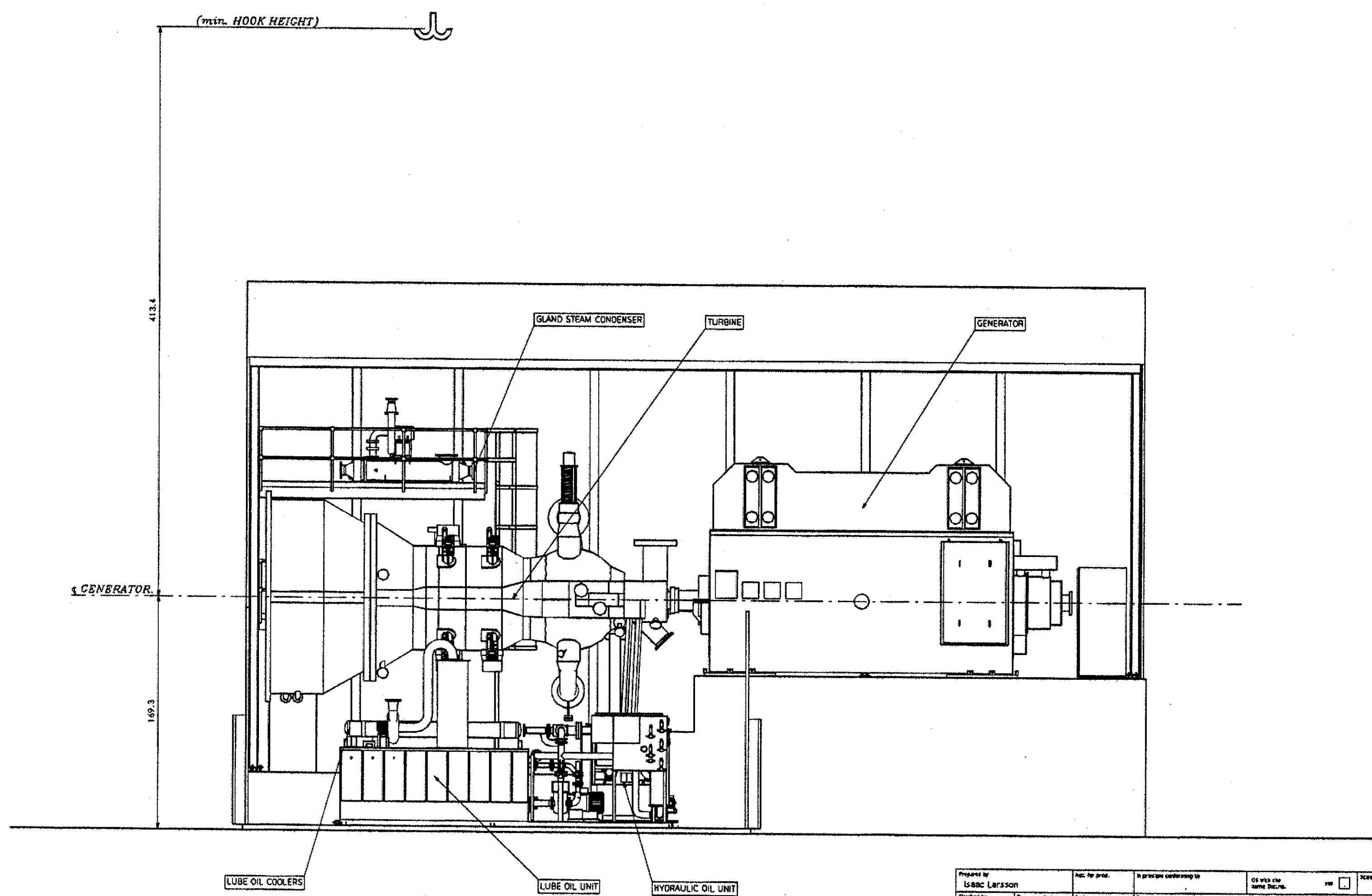

ALL MEASURES IN INCHES

STAIRS AND PLATFORMS ARE NOT INCLUDED
IN ALSTOM SCOPE OF SUPPLY

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ALSTOM	ALSTOM Power Sweden AB		Y02099

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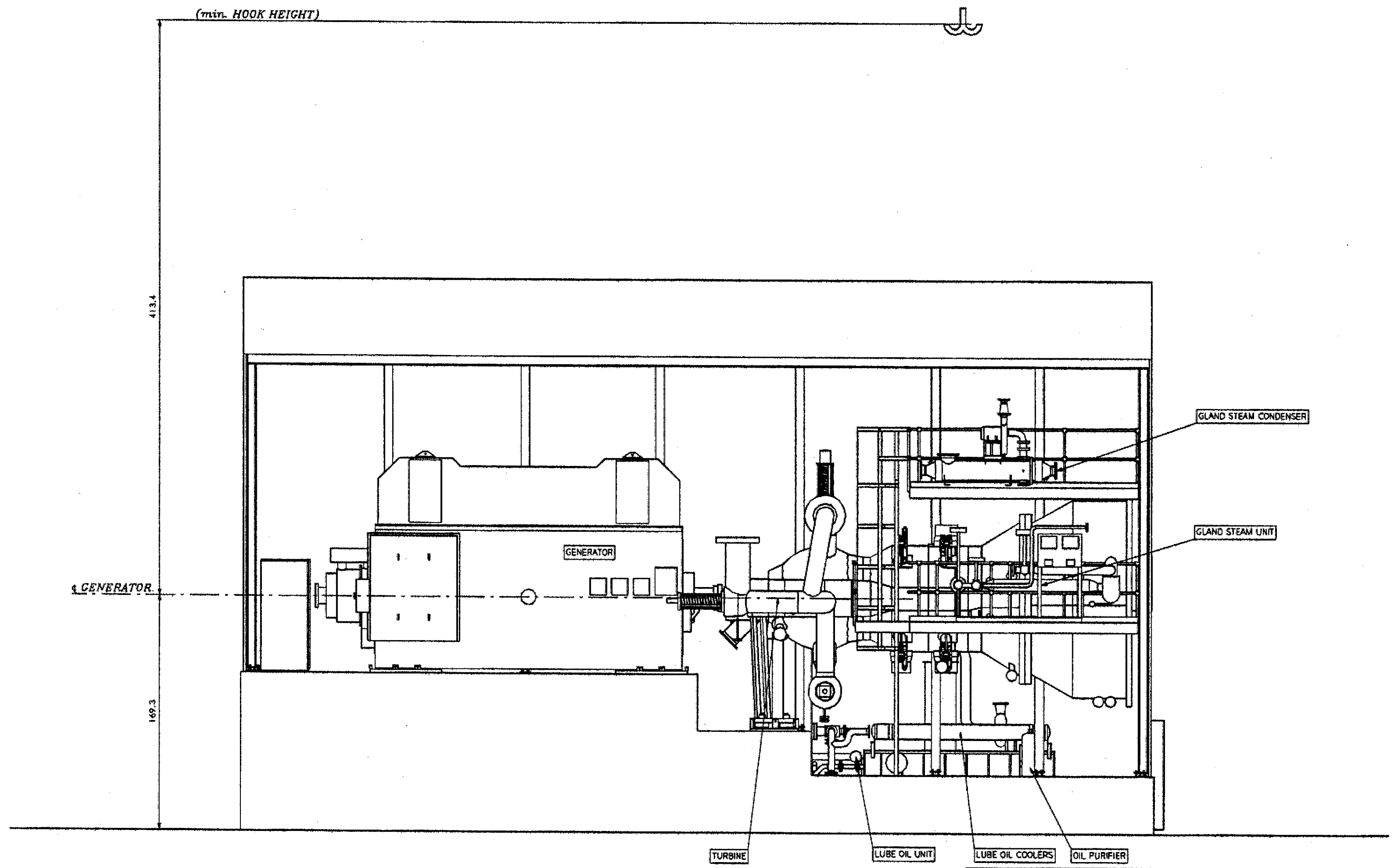

ALL MEASURES IN INCHES

STAIRS AND PLATFORMS ARE NOT INCLUDED
IN ALSTOM SCOPE OF SUPPLY

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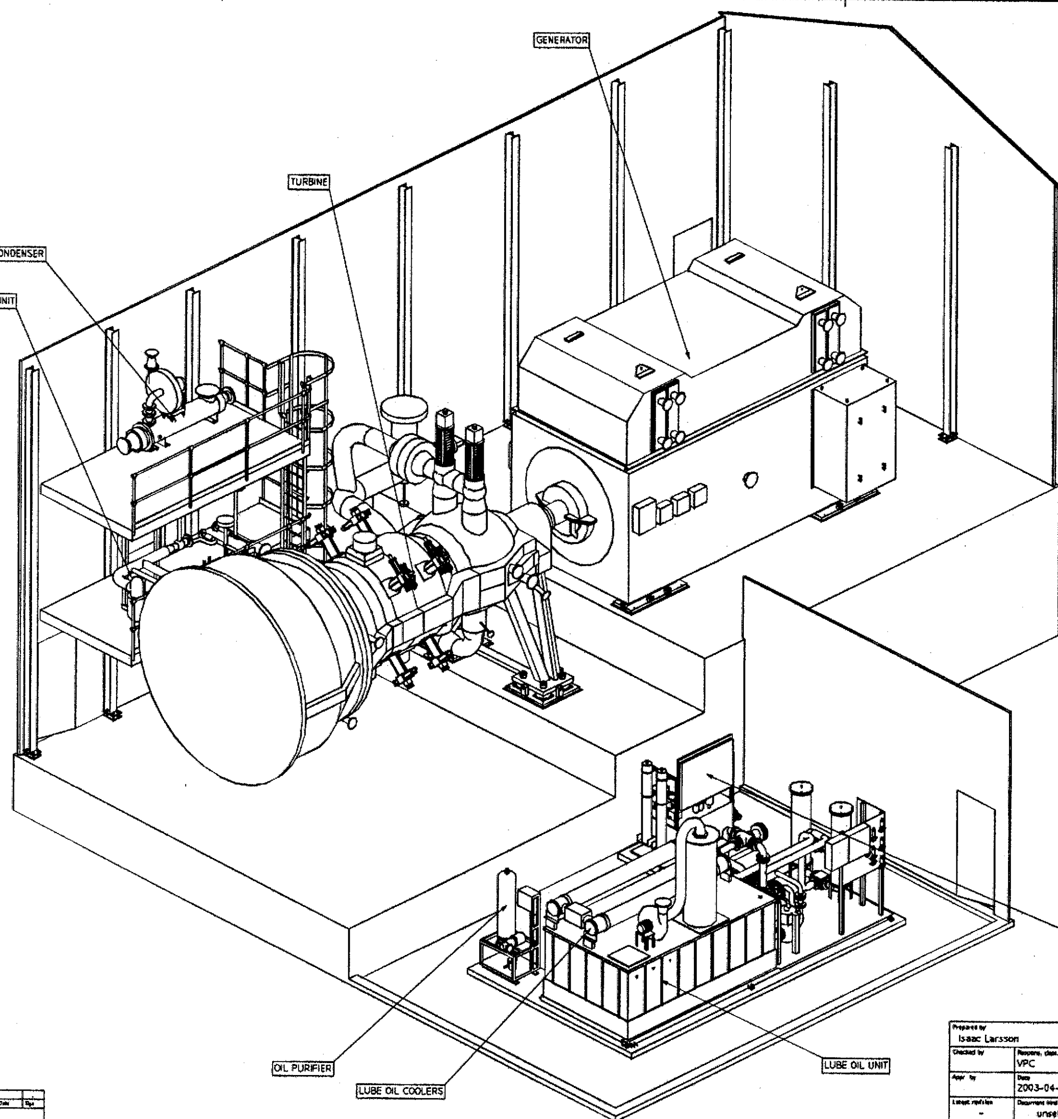

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Latest revision: -	Document kind: unset		Plant or Type: ST.Francisville
ALSTOM	ALSTOM Power Sweden AB		Document No.: Y02099

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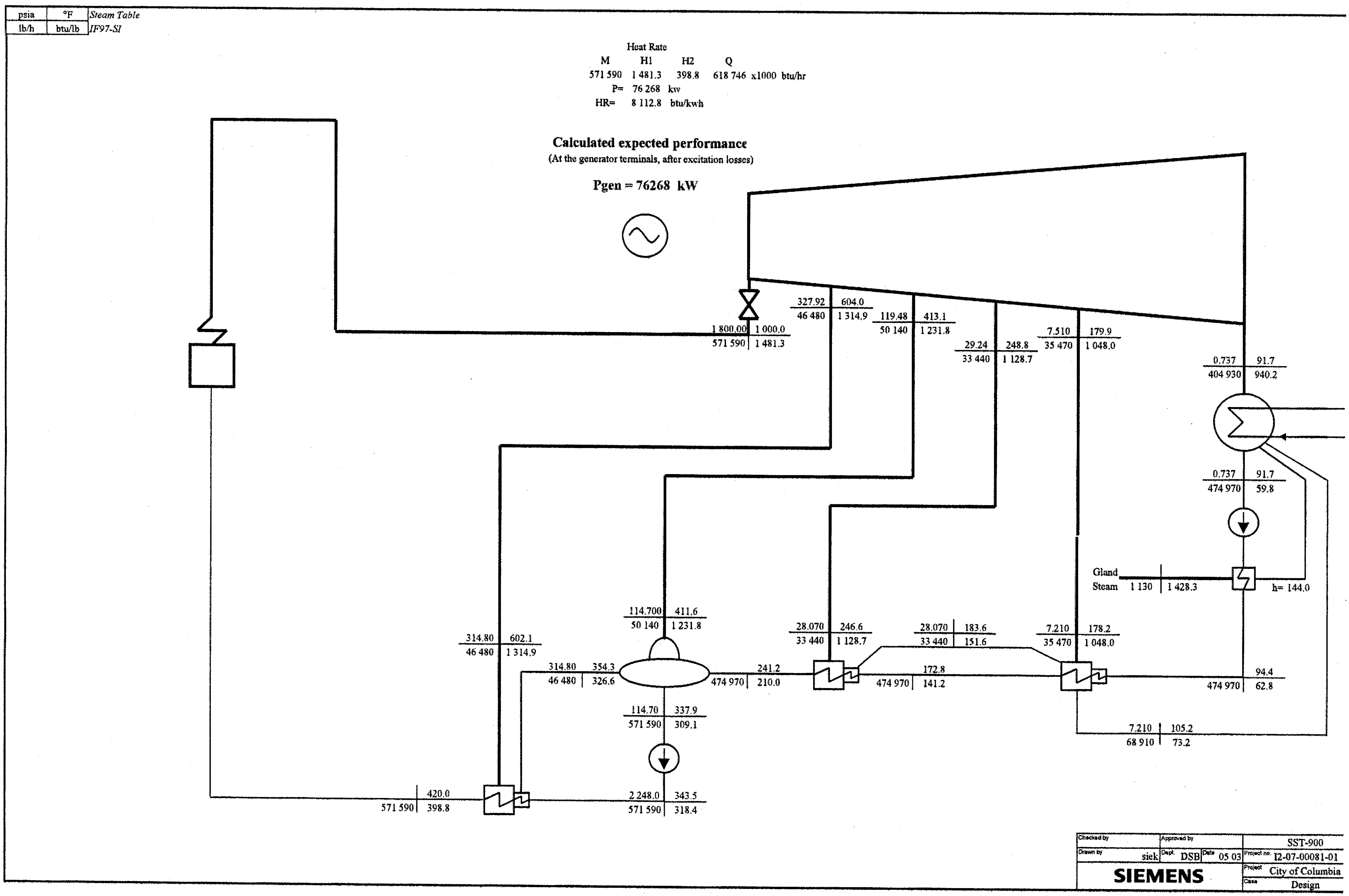

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SIEMENS

January 20, 2005

Gary Wilkinson
Stanley Consultants, Inc.

Subject: Budget Proposal for your City of Columbia project.
SIT Inc. Ref. – I2-07-00081-01

ALTERNATIVE 70 MW NON-REHEAT with a dual-body steam turbine

Dear Mr. Wilkinson

Referring to e-mail of January 5, 2005, regarding the City of Columbia project, we submit the following estimate for a standard Siemens Industrial Turbomachinery Inc's (SITI) type SST-PAC-700 steam turbine generator unit:

Performance:	Please refer to separate heat balances *"Performance 70MW 2-module City of Columbia I2-07-00081-01 b050119.pdf"*
Price Estimate:	$ 11,000,000. Delivered DDP jobsite (loading not included)
Delivery Time:	Approximately 15 months after order, subject to intervening sales.

Scope of Supply:
Steam Turbine, speed reduction gear and 3,600 rpm TEWAC generator (with terminal boxes, measuring transformers, surge protection and high resistance grounding), complete with turbine heat insulation blankets, gland steam system with leak-off condenser, complete lube oil system, emergency stop and control valves, hydraulic system, instrumentation and a complete stand-alone digital turbine generator control system (governor, AVR, monitoring of temperatures, pressures, vibrations, etc., alarms and turbine safety trips) with Color Monitor / Keyboard operator interface and an event printer.

Main Exclusions:
Condenser system, by-pass systems, generator protection relays, generator breaker, spare parts for operation and technical advisors (for erection, commissioning and training) are not included in the Scope at this time.

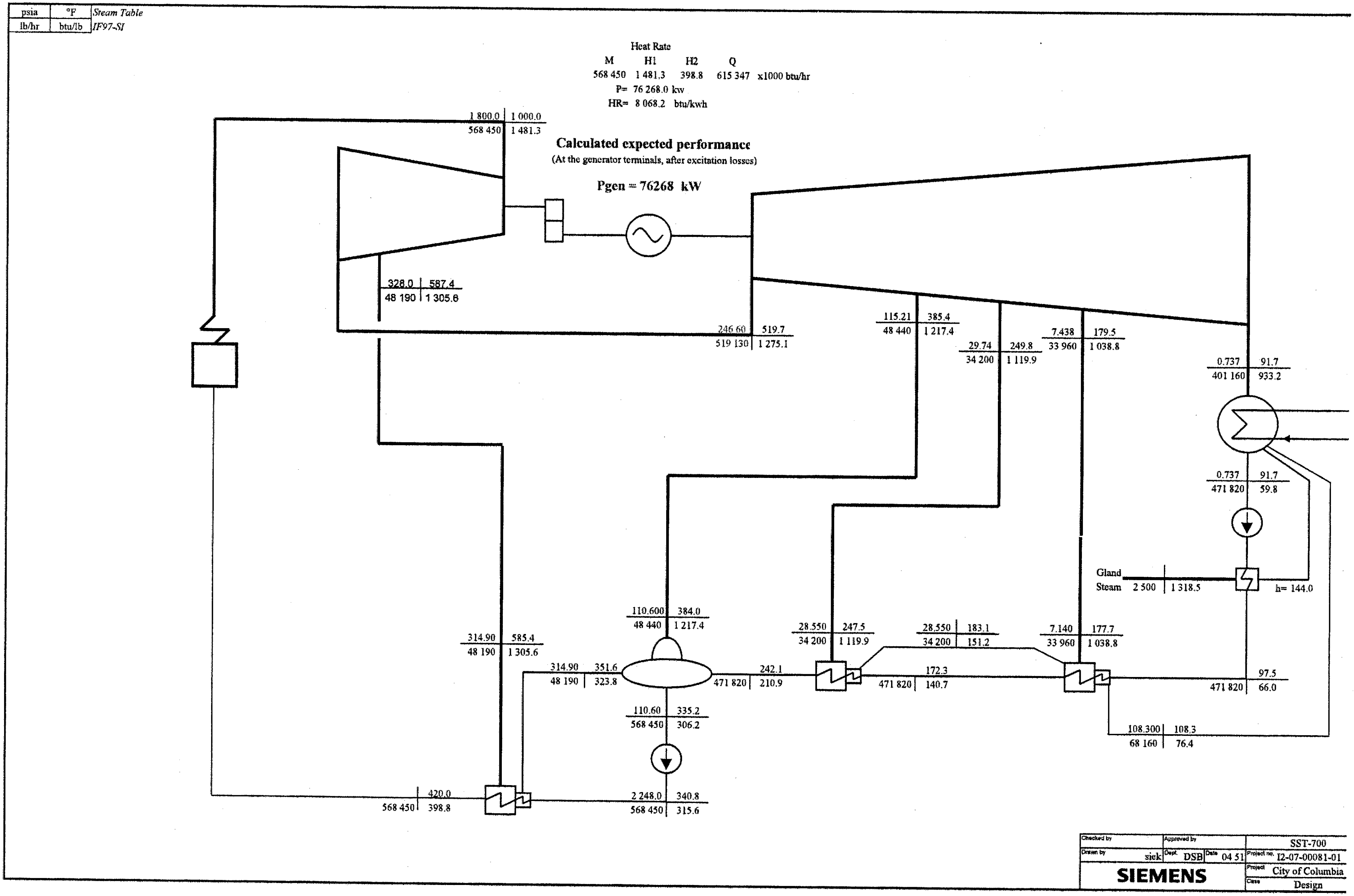
Siemens Industrial Turbomachinery, Inc.
10730 Telge Road
Houston, Texas 77095

SIEMENS

If you have any questions, after review of this information, please don't hesitate to contact us.

Sincerely Yours,

John Lindstrom
Steam Turbine Marketing Manager
Siemens Industrial Turbomachinery, Inc.
Phone: +1 281 856 4471 (wk)



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January 14, 2005

Mr. John Greco
FMC

Subject: City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade

Dear Mr. Greco:

Stanley Consultants is performing an evaluation for the City of Columbia, Missouri which includes comparing alternatives to upgrade their power generating capability at the Columbia site. We are seeking budget pricing and supporting information for Coal Handling Systems to prepare an opinion of probable cost in this phase of work. We would appreciate receiving information from FMC to assist with this effort.

This letter and attachments outline the three alternates being considered and the coal handling concepts that support them. Our intention is to review these guidelines with you to establish working concepts and have FMC provide budget information.

Coal Handling and Storage Description
The existing power plant is located on a 25 acre site in the City of Columbia, Missouri. Refer to the attached site plan. Three alternates are being evaluated to increase the power generating capability at the site. The basic coal handling requirements for each alternate are given in the attachment.

<u>Alternate No. 1</u>:
Build a new 100 MW, coal fired power plant with a new Circulating Fluidized Bed Boiler, CFB, and steam turbine/generator to the north of the existing plant. The coal pile will be located in the northeast quadrant of the site. Existing rail spurs will be extended to the north.

<u>Alternate No. 2</u>:
Initially a new 70 MW, coal fired power plant will be built in the same location. A second CFB Boiler would be built to provide steam to repower the existing steam turbine/generators existing at the plant.

<u>Alternate No. 3</u>:
The 70 MW, coal fired power plant described in the initial phase of alternate no. 2 would be constructed. Existing stoker fired boilers would be upgraded for continued use. In this case two different coals will be fired, one for the CFB boiler and the second for the stoker fired boilers.

Basic parameters effecting the coal handling and storage requirements of these alternates are given in the attachment. The coal storage capacity will be increased from the present operations and located in an enclosure to reduce the potential for fugitive dust and to control storm water run-off. The conceptual site plan configurations are shown in the attached Site Plan Sketches.

Scope of Supply

Stanley Consultants is seeking budgetary information for engineering, equipment and installation of complete systems including: receiving, handling, dust control, car thawing, storage enclosure, reclaim and delivering coal to silos provided by others. All electrical, controls and civil/structural work should preferably be included. Any work that is outside your normal scope of supply should be clearly identified. The major components and systems to be included are as follows:

- Extend track for two rails approximately 375 ft each.
- Car thawing shed and heating system.
- New bottom dump unloading hopper(s).
- Conveyor to stack-out complete with pulleys, idlers, belts, motors, etc.
- Stack out system.
- Reclaim system.
- Active coal storage enclosure with support steel for the stack-out and reclaim systems.
- Conveyors to the coal silos. (Silos supplied by others.)
- Tripper to fill silos.
- Control system.
- Coal sampling.
- Option: Rotary car dumper with building and dust collector.

The following work is not included:

- Alternative fuel storage and handling systems. (The plant is considering burning less than 5% of its heat input supplementing coal as petroleum coke, waste wood, or tire derived fuel.)
- Coal silos.
- Limestone storage and handling systems.
- Limestone silos.
- Locomotive and coal rail cars.

Information required with your budgetary pricing:

Provide budgetary pricing for the complete systems described with supporting assumptions. The following information is needed for each option:

- Detailed list of the scope of supply.
- Budget pricing with major components identified.
- Conceptual general arrangement drawings and layout for major components.
- Descriptions of the major equipment items supplied.

- Description of the control system.
- Motor list or estimated auxiliary power consumption.
- Approximate delivery time.

Schedule:
Your budgetary information is needed by Friday, February 4, 2005. The City of Columbia, Water and Light Department expects to make a decision to proceed with the accepted approach by December 1, 2005.

Your cooperation is greatly appreciated. Please do not hesitate to call me at (563) 264-6463, if you have any questions.

Sincerely,

Gary A. Wilkinson, P.E.
Project Manager
Stanley Consultants, Inc.

Attachments:
Site Plan Sketch
Coal Analysis
Coal Handling and Storage Summary

cc. Project File

City of Columbia
Department of Water and Light

Power Plant Upgrade and Rehabilitation Project
Stanley Consultants, Inc.
Project No: 17788

January 19, 2004

Coal Handling and Storage: Summary for all Alternatives

	Alternate No. 1	Alternate No. 2		Alternate No. 3	
Plant Size	New 100 MW CFB Boiler	New 70 MW CFB Boiler and Repowered ST/G No.5, 7	New 80 MWe CFB Boiler Repowering Existing Steam Turb-Gen. No. 5, 7	New 70 MW CFB Boiler	Upgraded Existing Stoker Fired Boilers No. 6, 7
Heat input to CFB Boiler, MMBtu/hr	963.7	725.2	884.8	725.2	n/a
Net Plant Heat Rate, Btu/kWh	9,646	10,365	11,075	10,365	12,000
Coal:	Pittsburgh No. 8	Pittsburgh No. 8	Pittsburgh No. 8	Pittsburgh No. 8	Existing Stoker Coal
Heating Value, HHV, Btu/lb	12,450	12,450	12,450	12,450	14001
Coal Handling:					
Coal burn rate, ton/hr	38.74	29.4	35.58	29.4	16.5
30 day storage, tons	25,100	10,030	23,060	10,030	7,603
Rectangular Pile: (Note 1)					(Note 5)
width (max.), ft. (Note 2)	150'	150'	150'	150'	150'
length, ft.	246'	186'	225	186'	75'
height, ft. (Note 3)	54'	54'	54'	54'	54'
Coal Cars: (Note 4)					
Cars per week at full load					
operation, cars/wk	65.1	49.3	59.8	49.3	22.2
Number of 12 car trains handled per week	5.4	4.1	5.0	4.1	1.8

Notes:
1. Equivalent rectangular pile shown for comparison.
2. Maximum pile width, in the east-west direction, is 150' based on the site arrangement shown.
3. Cooresponds to a free standing pile with 36 degree sides. The enclosure will influence the pile shape.
4. Assume 100 ton capacity cars. CWL operates their own locomotives.
5. Two segregated coal piles will be required for alternate 3.
6. A coal density of 50 lb/cf was used for analysis.
7. Refer to the Coal Analysis attached.

Stackout:	aggressive	average			
Position/Dump 100 ton car/min.	5 min	10 min			
Dump 12 cars in	1 hr	2 hr			
Stack out rate					
100 ton/5 min x 60min/hr =					
Reclaim:					
Coal Silo Size, ton (8 hr capacity)	310	235	285	235	132
Fill Silo, hr	2	2	2	2	2
Reclaim rate, ton/hr	155	118	142	118	66
Total Reclaim, by Alternate	155	260		118	66
Belt width					
Belt volume					
Belt speed					

FMC Material Handling Systems
FMC Technologies Inc.
400 Highpoint Drive
Chalfont PA 18914

Phone 215 822 4300
Fax 215 822 4520

FMC EnergySystems

February 15, 2005

Stanley Consultants, Inc.
225 Iowa Avenue
Muscatine, IA 52761

cc: J. Allada
A. Doehl
B. Fielder
A. Garvin
Writer
File – 51215

Attention: Gary A. Wilkinson, P.E.
Project Manager

Subject: City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade
Bid Date: February 4, 2005
FMC Energy Systems Budget Proposal No. 51215

Gentlemen:

We are pleased to submit a preliminary budget proposal for the design and supply of your system based on the data you provided

Our proposal details the equipment being offered and we trust it meets with your approval.

Should additional information be required, please do not hesitate to contact us at the address shown above or telephone me directly at (215)822-4393. My e-mail address is: john.greco@fmcti.com.

Please review the "Equipment Description" and "Work and Items Not Included in this Proposal" for a clear definition of "FMC Energy Systems Scope of Work" for this project.

Thank you for the opportunity of quoting on your equipment. We trust our Proposal will receive your favorable consideration.

Very truly yours,

John Greco
Marketing & Sales Manager
Conveying and Processing Equipment

amg/51215.doc/Enclosure

FMC EnergySystems

Budget Proposal
For

Stanley Consultant, Inc.
Muscatine, Iowa

City of Columbia, Missouri

Department of Waster and Light

Power Plant Rehabilitation and Upgrade

FMC Energy Systems Budget Proposal No. 51215

February 15, 2005

FMC EnergySystems

FMC Material Handling Systems

BUDGET PROPOSAL

PROPOSAL NUMBER: 51215 DATE: February 15, 2005

TO: Stanley Consultant, Inc.
225 Iowa Avenue
Muscatine, IA 52761

ATTENTION: Mr. Gary A. Wilkinson, P.E.
Project Manager

SUBJECT: City of Columbia, Missouri
Department of Water and Light
Power Plant Rehabilitation and Upgrade
Bid Date: February 4, 2005

FROM: John Greco
Marketing & Sales Manager
Conveyor & Processing Equipment
Material Handling Systems
FMC Technologies, Inc.
400 Highpoint Drive
Chalfont, PA 18914 U.S.A.
Phone: 215-822-4393
Fax: 215-822-4520
E-mail: john.greco@fmcti.com

SECTION 1

Gentlemen:

1.01 We, FMC Technologies, Inc., A Delaware corporation, acting through its FMC Material Handling Systems Business Unit of FMC Energy Systems, propose and hereby offer to contract with your company, in accordance with the specifications and subject to the terms and conditions stated herein, to furnish and sell certain equipment to you.

1.02 The equipment will conform substantially to the technical specifications and descriptions contained in the following documents:

Stanley Consultant e-mail dated January 19, 2005, except as noted or modified herein.

1.03 The equipment and items shall be of the following description and specifications:

EQUIPMENT DESCRIPTION

COAL HANDLING SYSTEM - **ALTERNATE NO. 1 (A)**

FMC Energy Systems proposes to furnish one (1) Coal Handling System as follows:

One (1)	Rail Track Extension - 375' Length
One (1)	Rail Car Unloading Shed/Enclosure
One (1)	Rail Car Thaw Shed
One (1)	Rail Car Thawing System
One (1)	Rail Car Unloading Hopper
One (1)	Isolation Gate, Pin Type
One (1)	48" wide x 40'-0" long Belt Feeder No. BF-1, 300 STPH Maximum Capacity with VFD (4:1)
One (1)	Sump Pump (Duplex Type) for the Unloading Pit, Including Associated Piping up to the Tunnel Entrance
One (1)	Lot of Ventilation Equipment for the Unloading Pit and Conveyor Tunnel, Including Supply and Exhaust Fans
One (1)	30" wide Coal Conveyor No. C-1, 300 STPH Capacity 430'-0" long x 115'-0" lift
One (1)	30" Belt Scale on Conveyor No. C-1, ±0.5% Accuracy
One (1)	As-Received Sampling System for Conveyor No. C-1, 2-Stage Type
One (1)	36" wide Tripper Coal Conveyor No. C-2, 300 STPH Capacity 275'-0" long
One (1)	36" Traveling Tripper on Conveyor No. C-2, Motorized Type, Two-Way Discharge, Including Power and Control Cable Reel/Festoon System, Rails, Manual Rail Clamp, Rail Stops
One (1)	Coal Storage Building, 150'-0" wide x 340'-0" long x 80'-0" High – A Frame Type, Capacity 25,000 Tons, Including an Extension for Conveyor Nos. C-1/2 Transfer
One (1)	Lot of Ventilation Equipment for the Coal Storage Building

Three (3)	Below Ground Reclaim Hoppers Each with Grizzly, 20 Ton Capacity
Three (3)	Manually Operated Slide Gates, Dewatering Type
Three (3)	36" Belt Feeders Nos. BF-2, BF-3 & BF-4, 155 STPH Maximum Capacity Each x 10'-0" long with VFD (4:1) and Manually Operated Bed Depth Gates
Three (3)	Access Platforms for the Belt Feeders
One (1)	24" wide Horizontal Reclaim Coal Conveyor No. C-3, 155 STPH Capacity, 270'-0" long
One (1)	24" Magnetic Separator, to be Mounted on Conveyor No. C-3, In-Line, Self-Cleaning Type
One (1)	Tramp Iron Chute and Container at Grade
One (1)	Sump Pump (Duplex Type) for the Reclaim Pit, Including Associated Piping up to the Tunnel Entrance
One (1)	Lot of Ventilation Equipment for the Reclaim and Conveyor Tunnel, Including Supply and Exhaust Fans
One (1)	24" Wide Coal Conveyor No. C-4, 155 STPH Capacity, 750'-0" long with 200'-0" lift
One (1)	24" Wide Belt Scale on the Coal Conveyor No. C-4, ±0.5% Accuracy
One (1)	As-Fired Sampling System for Conveyor No. C-4, 2-Stage Type
One (1)	Transfer Tower No. TT1, 25' x 25' x 220'-0" high, Enclosed Type (Upper Portion Only)
One (1)	Lot of Ventilation Equipment for Transfer Tower No. TT1
One (1)	30" wide Tripper Belt Coal Conveyor No. C-5, 155 STPH Capacity, 130'-0" long
One (1)	24" Traveling Tripper on Conveyor No. C-5, Motorized Type, One-Way Discharge, Including Power and Control Cable Reel/Festoon System, Seal Belt with Plow, Rails, Manual Rail Clamp, Rail Stops
One (1)	Lot of Level Detection System for the Coal Silo – High and High-High
One (1)	Coal Receiving Area Dust Suppression System

One (1) Coal Storage Area Dust Suppression System

One (1) Coal Silo Area Dust Collection System. The System will collect dust at the conveyor transfer and loading points above the silos

One (1) Lot of Belt conveyors as specified herein shall be complete with, conveyor frames and supports, impact tables, carrying, return and training idlers, belting, belt cleaners, motor and reducer drives, pulleys, holdbacks, take-ups and electrical and control components

One (1) Chutework for all conveyor transfer and discharge areas

One (1) Monorails, monorail support steel and trolley-hoists as required

One (1) Electrical, instrumentation and control equipment and devices as defined as follows:

- Design and furnish controls system (Allen-Bradley PLC System) hardware, instruments and equipment necessary and essential for safe, reliable and continuous monitoring and control of the Coal Handling System. The instruments and equipment shall include, transmitters, level detection equipment, plug chute switches, belt misalignment switches, zero speed switches, position switches, final control elements, belt speed switches, product sensing probe/tilt probes, emergency stop pull cord switches and signal converters.
- Local-Auto-Jog pushbuttons.
- Emergency stop pull cords for all conveyors.

One (1) All structural and miscellaneous steel including stairs, ladders and platforms as defined herein

One (1) FMC Energy Systems' standard shop prime and finish painting for equipment and structural steel

One (1) One set of any special operating and maintenance tools and devices as required

One (1) Lot of Documentation as specified

One (1) Lot of Electrical grounding connections, between Sellers furnished equipment and FMC Energy Systems furnished structures

One (1)	Lot of lining materials for all hoppers, and chute work, and skirtboards, including all attachment hardware and fixtures
One (1)	Lot of design services to provide structural steel and foundation loads that will be transmitted to the Owner's foundations, and Owner furnished steel structures (Boiler Building)
One (1)	All walkways, platforms, stairs, and ladders required for accessing equipment proposed in this proposal
One (1)	Lot of nuts, bolts, fasteners, gaskets, and sealants required for the assembly and installation of the equipment being supplied
One (1)	Lot of safety guards and cages as necessary to protect personnel from operating, rotating, and falling equipment
One (1)	Lot of all required warning horns and safety signs
One (1)	Lot of all drive mechanisms, couplings and electric motors
One (1)	Lot of training of operating personnel (classroom and on the job)
One (1)	Lot of Technical field assistance services during erection, start-up, and commissioning of the equipment being supplied (per diem additional, if needed).
One (1)	Lot of touch-up paint for field application – 100 Gallons (General Purpose)

COAL HANDLING SYSTEM – ALTERNATE No. 2

NOTE: All items are the same as those listed for Alternate 1 except for the following <u>additions and/or modifications</u>

One (1)	Lot of Items for Extension of Tripper Coal Conveyor No. C-2 by 10'-0"
One (1)	Lot of Items for Extension of Tripper Travel by 10'-0"
One (1)	Lot of Items for Extension of Coal Storage Building by 10'-0"
One (1)	Lot of Additional Ventilation Equipment for the Extension of the Coal Storage Building by 10'-0"
One (1)	Lot of Items for Extension of Reclaim Coal Conveyor No. C-3 by 10'-0"

COAL HANDLING SYSTEM – ALTERNATE No. 3

NOTE: All items are the same as those listed for Alternate 1 except for the following <u>additions and/or modifications</u>

One (1)	Lot of Items for Extension of Tripper Coal Conveyor No. C-3 by 80'-0"
One (1)	Lot of Items for Extension of Tripper Travel by 80'-0"
One (1)	Lot of Items for Extension of Coal Storage Building by 80'-0"
One (1)	Lot of Additional Ventilation Equipment for the Extension of the Coal Storage Building by 80'-0"
One (1)	Below Grade Reclaim Hopper with Grizzly, 20 Ton Capacity
One (1)	Manually Operated Slide Gate, Dewatering Type
One (1)	36" Belt Feeder No. BF-5, 155 STPH Maximum Capacity, 10'-0" Long with VFD (4:1) and Manually Operated Bed Depth Gate
One (1)	Access Platform for the Belt Feeder
One (1)	Lot of Items for Extension of Reclaim Coal Conveyor No. C-3 by 80'-0"

SPARE PARTS FOR ONE (1) YEAR NORMAL OPERATION

The list of spare parts for one (1) year of normal operation of the proposed equipment will be prepared Per the final equipment selection based on detailed design and submitted for customer's use in the following format.

START-UP MANDATORY INSTALLATION, COMMISSIONING SPARE PARTS, AND CONSUMABLES				
No.	Description/Part Number	Qty.	Unit Price ($)	Total Price ($)

DRAWINGS

We will furnish general arrangement drawings of the equipment to assist you in its installation.

WORK AND ITEMS NOT INCLUDED IN THIS PROPOSAL

1. Any item not specifically mentioned as being included.

TECHNICAL CLARIFICATIONS

	Spec. No./Dwg. No.	Page No.	Article No.	Clarification
1				We are in general compliance with the specifications provided with the inquiry.
2.	Scope of Supply		Option	Rotary car dumper with building and dust collector: We have not quoted the rotary car dumper option since it is very expensive for an unloading system rated at 300 STPH.
3.	Scope of Supply			We have included two (2) belt scales with an accuracy of ±0.5% for payment to the coal supplier and internal inventory purposes.
4.	Scope of Supply			We have included magnetic separator on Conveyor No. C-3 for ferrous metal separation.

STANDARD SHOP ASSEMBLY: STRUCTURAL STEEL, CONVEYOR STEEL, ARCHITECTURAL ITEMS (AS APPLICABLE)

NOTE: The following is FMC Energy Systems, FMC Material Handling Systems Standard Shop Assembly instructions. This will be updated based on the final Scope of Work.

A. Mechanical Equipment

1. Conveyor drives will be shipped shop assembled, complete with the motor, high speed coupling, low speed coupling half (when applicable), coupling guards, and gear reducer installed on a fabricated steel drive base. Components will be shop aligned, but final alignments **must be verified on site and adjusted prior to energizing any equipment.**

2. Pulley drums will be shop assembled to their shafts, including pillow block bearings and one (1) half of low speed coupling (when applicable), and shipped as complete assemblies.

3. Conveyor troughing idlers are shipped with the idler rolls shop installed in the support frames. Conveyor return idlers are shipped with the support end brackets loose for field installation. All idlers are field installed to the conveyor frames and trusses.

4. Miscellaneous equipment such as magnetic separators, belt scales, as-fired sampling system, belt cleaners, etc. will be shipped direct from their respective manufacturers and packaged and shipped per their standards for field assembly and installation.

5. All mechanical items will be shipped without final lubricating oil to satisfy shipping regulations. Items requiring grease will be greased prior to shipping. Long term storage instructions will be furnished for proper maintenance of equipment during storage.

6. Traveling Belt Trippers, when supplied, will be shipped assembled as follows, shipping limitations permitting:

   Wheels will be shipped installed on axles, with bearings and sprockets, and mounted to the tripper frame.

   Drives will be installed on tripper frame, including motor, reducer, jack shaft with sprockets and bearings, and drive chains. Chains should be re-lubricated prior to energizing equipment. Reducer should be filled with the appropriate lubricant, and to the correct level, on site.

   Pulleys with shafts and bearings will be shop installed to the tripper frame.

Chute assemblies, idlers, guards, belt cleaners, and platforms and ladders (if supplied) will all be shipped loose for field installation.

All electrical switches will be shipped loose for field installation.

7. Belt Feeders will be shipped assembled as follows (shipping limitations permitting):

   Idlers, endless belting, pulley assemblies, belt cleaners and plows, will be shop installed onto the feeder frame.

   Discharge chute, hoods, skirtboards and supports will ship loose for field installation.

   All electrical switches will be shipped loose for field installation.

B. Electrical Equipment

8. Electrical switches, switch brackets and associated hardware will be shipped loose separately for field installation.

9. Electrical equipment, such as PLC, CCTV equipment, etc. will be shipped in manufacturer's standard assemblies.

C. Conveyor Steel

10. Head chute will be shipped with liners and access doors shop installed.

11. Transfer chutes will be shipped with liners and access doors shop installed.

12. Conveyor stringers sections will be shop fabricated as 20 feet long weldments. Support legs or posts will be shipped loose for field installation. Conveyor covers or hoods, when required, will be shipped loose for field installation.

13. Loading skirts will be shop fabricated with support brackets welded to the skirtboards. Skirt support posts and cover plates are shipped loose for field installation. Liner plates will be shop installed to the skirtboards using bolts or plug welds, as specified. Skirtboard rubber seals are shipped loose for field installation.

14. Pulley and take-up guards will be shipped as shop fabricated panels. Each guard panel will have expanded metal shop welded to an angle frame.

15. Vertical gravity take-up carriages will be shipped as shop fabrications with the pulley support frame and counterweight box assembled. The pulley, shaft, and bearing assembly will ship loose for field installation. Counterweight materials also ship separately, when supplied.

D. Structural Steel and Architectural Items

16. Conveyor galleries: side panels will be of shop welded construction and shipped in maximum sizes within standard shipping limitations. Oversized sections will be of field bolted design and construction. Cross members connecting the two (2) sides panels will be shipped loose for field bolting.

    Roofing and siding materials will be shipped in manufacturer's standard sizes for field cutting and assembly.

17. Bents will be of shop welded construction and shipped in maximum sizes within standard shipping limitations. Oversized sections will be of field bolted constructions.

18. Miscellaneous platforms will be of field bolted construction.

19. Expansion plates will be field installed.

20. Handrail will be shop welded to posts and shipped in approximately 18'-0" sections.

21. Walkway materials will be shipped in 20'-0" to 30'-0" lengths with tagged sections for field mounting. Stair treads will be field mounted and stair stringers will be shipped loose.

22. Hopper and surge bin will be shipped in maximum size sub-assemblies (with liners shop installed) for field assembly and welding.

23. Grizzlies will be shipped in maximum sub-assemblies for field installation.

24. Transfer towers and crusher building will be of bolted construction. Columns, beams, etc. will be prepared in the shop (gusset plates, holes, etc.) for field bolting.

25. Ladders will be shipped in approximately 20'-0" sections

26. Grab (single) handrail will be shipped in approximately 18'-0" sections.

SHORT TERM STORAGE (LESS THAN SIX [6] MONTHS) (AS APPLICABLE)

1. Structural steel may be stored outside; however, steel must be blocked and elevated above mud and rain puddles.
2. Structural and miscellaneous steel is to be examined prior to storage for paint damage in shipping. Damaged paint is to be repainted prior to storage.
3. Machinery is to be stored indoors in a heated and dry enclosure.
4. Prior to shipment, all non-painted machined parts are to be coated with a rust inhibitive grease.
5. Electrical motors and switches are to be stored indoors in a heated and dry enclosure. After initial inspection, electrical switches are to be resealed in original package.
6. Conveyor belting to be stored out of the sunlight.

NOTE: These instructions will be updated per specific equipment supplier's instructions (equipment selected per final design after contract award) and submitted for customer use.

LONG TERM STORAGE (MORE THAN SIX [6] MONTHS) (AS APPLICABLE)

7. Structural and miscellaneous steel is to receive a finish coat of paint (if not applied in the shop).
8. Machinery to receive periodic inspection (every 4 months) by manufacturer's representative. All non-painted machined parts which after inspection, show signs of corrosion, will be cleaned and receive re-application of rust inhibitive coating.
9. Electrical motors are to be rotated periodically (4 to 6 months). Reducers are to be filled with oil. All machinery with rotating shafts are to be rotated periodically (2 to 3 months).
10. Electrical switches are to be inspected periodically for damage to packaging. Prior to electrical equipment connection, all electrical contacts are to be visually inspected and cleaned.
11. Prior to placing machinery on-line, it must be inspected, cleaned and lubricated. Any seals deteriorated in storage are to be replaced at this time.

NOTE: These instructions will be updated per specific equipment supplier's instructions (equipment selected per final design after contract award) and submitted for customer use.

1.04 TIME OF DELIVERY: We agree to furnish arrangement and foundation drawings approximately 12 - 16 weeks after customer's acceptance of this Proposal, provided that the customer submits all information necessary for us to prosecute the work within 10 days after customer acceptance of the Proposal. We further agree to ship the equipment covered by the Proposal approximately 40 - 50 weeks after receipt of customer's formal approval of the drawings. Customer is expected to approve drawings within 2 weeks from the date of submittal.

1.05 TERMS OF PAYMENT: Payments are due net 30 days and are to be made in accordance with the following:

10% on submittal of general arrangement drawings for approval;
15% on procurement of belt scale, magnetic separator, idlers;
5% on procurement of dust collection system, drives;
20% on procurement of fabricated steel;
50% on progress payments for shipments based on the value of each shipment, or ready to ship, if customer is not ready to receive. FMC Energy Systems will submit price breakdown prior to shipment.

Installation:

(NOTE: Installation prices quoted below are for **installing FMC Energy Systems furnished items only**.

5% on Mobilization;

Monthly Progress Payments based on completion of construction activities within the month throughout the entire construction period.

NOTE: Schedule of values for construction activities comprising the total contract amount for construction will be submitted prior to commencement of work.

In the event that a purchase order is awarded to FMC Technologies, payments should be forwarded to:

FMC Technologies, MHS
P.O. Box 8500-1585
Philadelphia, Pennsylvania 19178.
(ABA No. 547505259, Account No. 2000010969090)

1.06 BUDGET PURCHASE PRICE: The budget price for the equipment covered in this Proposal shall be:

	Engineering & Materials ($)	Freight To Jobsite ($)	Installation ($)
Alternate No. 1	7,050,000.00	350,000.00	3,330,000.00
Alternate No. 2	7,100,000.00	355,000.00	3,355,000.00
Alternate No. 3	7,620,000.00	380,000.00	3,600,000.00

Approximate delivery time: 12 to 13 months.

The budget prices quoted are:
- a: based on U.S. Dollars,
- b: do not include taxes of any kind,
- c. are based on shipment before December 31, 2006.

(For Shipments Beyond December 31, 2006, prices are to be escalated.)

Price breakdown (if any) is for accounting purposes only.

1.07 FABRICATED AND MISCELLANEOUS STEEL ITEMS – ESCALATION FORMULA:

Given the current instability of the steel market relative to

- rising prices,
- validity on steel quotes,
- mill price surcharges, and
- even steel availability, the prices in this proposal are subject to adjustment based on the actual steel market pricing and conditions at the time of our procurement of fabricated steel as follows:

Notations: "A" Amount included in the base bid for steel raw materials based on an average U.S. market steel price at the time of quoting this project.

"B" Average U.S. market steel price (unit price) for steel raw materials at the time of quoting this project.

"C" Average U.S. market steel price (unit price) for steel raw materials at the time of procurement of steel raw material by the steel fabricator. **

An amount of US$ "A" * is included in the base bid for steel raw material based on an average U.S. market steel price of US$ "B" /lb. This amount will be escalated based on actual average U.S. market steel price at the time of procurement of steel by the steel fabricator ("C") as follows:

Escalation Amount ={US$ [("C"/$ ""B") x $ "A"] – US$ "A" }
(Values for "A" & "B" will be submitted with the Firm Price Proposal.)

NOTES: 1. * $ "A" corresponds to the value of the steel raw material in the base bid. This amount ($ "A") will be adjusted per the final scope of supply, i.e. base bid + revisions to base bid based on the options exercised by the customer. This information will be provided to the customer at the time of contract award.

2. ** FMC Energy Systems will furnish copies of the purchase orders for the steel raw materials for calculating the average U.S. market steel price of steel raw materials (total price of all purchase orders/total weight of all purchase orders). This information will be furnished during the contract execution phase, i.e. at the time of procuring the steel raw materials.

The prices quoted are net F.O.B. jobsite.

3.02 ACCEPTANCE OF PROPOSAL: Budget price and delivery date shall be subject to revision.

We thank you for your interest in FMC Energy Systems and look forward to assisting you with this interesting and challenging project. If the foregoing meets with your approval and properly expresses the work you wish us to perform, please indicate your acceptance by signing the space provided and returning one copy of this Proposal.

No terms, other than those in this offer, will be accepted, except by mutual agreement.

3.03 ORDER OF ACCEPTANCE: Acceptance of any order resulting from this offer will be predicated on a financial review, Seller's approval and receipt of a copy of any performance payment bonds on the project. Information made available in advance would facilitate that review.

FOR: FMC Technologies, Inc.
FMC Material Handling Systems

By: ______________________
John Greco
Marketing and Sales Manager

PURCHASER'S ACCEPTANCE	SELLER'S APPROVAL
Accepted this _______ day of _______,	Accepted this ______ day of _____,
20____ , at ____________________	20____ , at ______________________
______________________________ Customer	
By: ____________________________ Name	By: __________________________ Name
______________________________ Title	__________________________ Title

COMMUNICATION INFORMATION

Chalfont, Pennsylvania 18914
Telephone Number: 215-822-4300
Telefax Number: 215-822-4520

February 1, 2005

IAC
INDUSTRIAL ACCESSORIES COMPANY
4800 LAMAR AVE.
MISSION, KS 66202
Office 913-384-5511
Sales 800-334-7431
Fax 913-384-6577
Email: iaccorp@iac-intl.com
Web Site: www.iac-intl.com

Gary Wilkinson, P.E. E-mail: wilkinsongary@stanleygroup.com
Stanley Consultants, Inc.

Subject: **City of Columbia, Missouri**
Department of Water and Light
Power Plant Rehabilitation and Upgrade
IAC Proposal No. S020105-01:S018

Dear Gary:

IAC is pleased to submit our budget proposal for the IAC "M"- Pulse Baghouse with 19.5 ft long, Ryton, Filter Bags for the above referenced project. We have included the equipment in accordance to your specification and as detailed the same in the foregoing proposal.

IAC has proposed removable roof access doors with split cages and a Penthouse type weather enclosure. The design of the Baghouse utilizes a panel construction. We have recently received two orders for similar design Baghouses for Circulating Fluidized Boilers.

I am provided the following additional comments:

1. We have proposed on-line cleaning. For maintenance, one compartment can be isolated and the remaining compartments will remain will continue to clean on an on-line basis.
2. The inlet and outlet plenums are integrated with common walls.
3. Structural legs to grade are provided. The clearance below the hopper flange to the bottom of the support steel base plate will be 5'-0".
4. Ladder access is provided to the Penthouse. Stair access provided as an option.
5. Insulation and lagging will be provided and field installed, by others.
6. 50 Spare bags are priced separately.
7. Pricing for Compressor / Receiver / Filter and Drier are provided as an option.
8. PLC will be AB SLC-505/4 with a Panel View. Pricing provided as an option.
9. Hopper Heaters are provided as a n option. Capacity will be 4KW per Hopper.
10. Freight to Job-site is provided as an option.

IAC appreciates the opportunity to provide this bid and we look forward to meeting with you to discuss this proposal in more detail.

Please review the attached proposal and if you have any questions, please feel free to call.

Best regards,

Pramodh Nijhawan
VP
Cell: (865) 300-3401

CC: Mr. Glenn Smith IAC

IAC Proposal No. S020105-01; SN018
February 1, 2005

Power Plant Rehabilitation and Upgrade

Submitted to

Stanley Consultants

For

City of Columbia, MO
Department of Water & Light

Prepared by:

Pramodh Nijhawan

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1.0 DESIGN REQUIREMENTS

Baghouse design w/19'-6" long Bags.

Specification requirements:

a. The Bulk Density of the flyash is 60 lbs./cu.ft. (volumetric); and 100 lbs./cu.ft. (structural)
b. Product Temperature is 340 F (Max).
c. Inlet Dampers to be manual butterfly; Outlet Dampers to be pneumatically operated Poppet Dampers
d. Bags to be 16/17 oz., Ryton.
e. Filter Bag Cages to be split cage design with 10 / 12 Vertical Wire and 11 gage construction; galvanized.
f. 2 ½" / 3" Double Diaphram Valve
g. Design Pressure to be for +/- 25 inwg.
h. Outlet Emission to be equal or less than 0.015 lbs/mmBtu of heat input (0.0054 Gr/ACF)
i. Hoppers to have 55 valley angle
j. Photohelic gauge, DP transmitter, to provide "demand" cleaning
k. Baghouse to be designed for On-Line Cleaning capabilities.
l. Off line maintenance provided for.

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2.0 SCOPE OF SUPPLY

A. BAGHOUSE

IAC will provide the following equipment and services. All external, mild steel surfaces that are to be field insulated, will receive surface preparation in accordance with SSPC-SP1/SP3 and one coat primer. All non-insulated surfaces will receive surface preparation in accordance with SSPC-SP1/SP6 and one rust-inhibiting primer (1.5 DFT) and one finish coat of paint (1.3 DFT.) All standard buy-out items will be furnished with manufacturer's recommended coating/painting.

The following items are **not** included:

1. Insulation and Cladding Materials.
2. Cladding materials for the Penthouse/Weather Enclosure.
3. Compressor(s); Drier(s) and Filter(s)
4. Items as listed in Section 4, of this Proposal.

Baghouse specification are as follows:

CITY OF COLUMBIA APPLICATION:	OPTION 1 100 Mwe CFB	OPTION 2 70 Mwe CFB	OPTION 3 REPOWERING
NUMBER REQUIRED/APPLICATION:	**1**	**1**	**1**
BAGHOUSE:	**IAC "M" PULSE**	**IAC "M" PULSE**	**IAC "M" PULSE**
IAC MODEL NUMBER	**6 X 234TB-BHT-500**	**6 X 234TB-BHT-360**	**6 X 234TB-BHT-440**
FLOW TO BAGHOUSE:			
ACFM	317,300	231,300	281,600
NORMALTEMP (F)	300	300	300
MAXIMUM TEMP (F)	400	400	400
PLAN VIEW DIMENSIONS:			
WIDTH (Bw)	47.0	45.5	46.5
LENGTH (Bl)	55.0	41.0	49.0
INDIVIDUAL COMPARTMENT			
WIDTH ALONG BLOW-PIPE (FT):	17.00	17.00	17.00
LENGTH (ALONG HEADER):	18.33	13.67	16.33
DUST BULK DENSITY (PCF)			
VOLUMETRIC BASIS	50	50	50
STRUCTURAL DESIGN BASIS	90	90	90
INLET LOADING (LBS/HR)	17,920	13,040	15,880
INLET LOADING (GR/ACF)	6.59	6.59	6.59
INLET PRESSURE (INWG)	-10	-10	-10
FF DESIGN PRESSURE - (INWG)	+/- 25	+/- 25	+/- 25

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# OF COMPTS	6	6	6
ROWS OF COMPARTMENTS	2	2	2
COMPT DESIGN	Common Wall	Common Wall	Common Wall
BAG ACCESS	Penthouse	Penthouse	Penthouse
COMPRESSED AIR MANIFOLD	12" Diameter	12" Diameter	12" Diameter
VALVES/COMPARTMENT	25	18	22
CONSTRUCTION			
CASING	3/16"	3/16"	3/16"
HOPPER	3/16"	3/16"	3/16"
TUBE SHEET	1/4"	1/4"	1/4"
HOPPER DESIGN			
SHAPE	Pyramidal	Pyramidal	Pyramidal
SIDE ANGLE (MIN)	60	60	60
HOPPER DISCHARGE VALVE	Slide Gate	Slide Gate	Slide Gate
SUPPORT STEEL CLEARANCE			
HOPPER FLANGE TO GRADE	5'-0"	5'-0"	5'-0"
MAIN & SECONDARY EGRESS	2 Ladders	2 Ladders	2 Ladders
INSTRUEMENTATION/OTHER			
HOPPER LEVEL DETECTOR	Yes	Yes	Yes
HOPPER HEATERS (OPTIONAL)	4 KW	4 KW	4 KW
BAG FABRIC - CHOICES:	Ryton	Ryton	Ryton
BAG WEIGHT (OZ/YD2)	16	16	16
CAGE	Mild Steel Split Cage	Mild Steel Split Cage	Mild Steel Split Cage
CAGE CONSTRUCTION	12 Vertical Wire; 11 GA Wire	12 Vertical Wire; 11 GA Wire	12 Vertical Wire; 11 GA Wire
VENTURIUS	None	None	None
BAGS/COMPT	500	360	440
BAGS/BLOW PIPE	20	20	20
ROWS OF BAGS/COMPT	25	18	22
NOMINAL BAG SIZE	6" D X 19'-6" long	6" D X 19'-6" long	6" D X 19'-6" long
GROSS CLOTH AREA/BAG (SQ. FT)	30.63	30.63	30.63
CLOTH AREA/COMPT (SQ. FT)	15317	11028	13479
METHOD OF CLEANING	On-Line	On-Line	On-Line
A/C RATIO (OPERATING):			
GROSS (FPM)	3.45	3.50	3.48
NET-1 (FPM)	4.14	4.19	4.18
INLET/OUTLET PLENUM - WIDTH (FT)	13.0	11.5	12.5
INLET/OUTLET PLENUM - HEIGHT (FT)	7.0	5.7	6.4
OUTLET DAMPERS	Poppet Damper	Poppet Damper	Poppet Damper
DAMPER OPERATOR	Pneumatic	Pneumatic	Pneumatic
DAMPER DIAMETER SIZE (FT)	5.25	4.50	5.00

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INLET DAMPERS	Manual Butterfly	Manual Butterfly	Manual Butterfly
DAMPER OPERATOR	Chain Operated	Chain Operated	Chain Operated
DAMPER SIZE			
HEIGHT (FT)	4	4	4
LENGTH (FT)	9	6	8
WEIGHTS:			
MODLES AND PLENUMS (LBS)	331,939	283,470	311,074
SUPPORT STEEL (LBS)	39,498	39,498	39498
EXPECTED PERFORMANCE:			
OUTLET LOADING (GR/SCF)	0.0078	0.0078	0.0078
OUTLET LOADING (GR/ACF)	0.0054	0.0054	0.0054
OUTLET LOADING (LBS/MMBTU)	0.015	0.015	0.015
AVERAGE PRESSURE DROP	6	6	6
MAXIMUM PRESSURE DROP	8	8	8
CLEANING COMPRESSED AIR			
DRY & FILTERED (PSI)	50 - 70	50 - 70	50 - 70
CF PER PULSE	18.38	18.38	18.38
AVE CFM CONSUMPTION:			
ON-LINE - 20 SECS. PULSE INTERVAL	331	331	331
TIME/CLEAN ALL BAGS/COMPTS (MINS)	8.33	6.00	7.33

NOTES:
1. Average Pressure Drop is expected to be 6 to 8 inwg AND Max to be 10 inwg.
2. On-Line Cleaning: One row is cleaned in each compartment simultaneously.
3. Cleaning will be initiated by Pressure Drop sensing across the Baghouse.

OPTIONAL EQUIPMENT:

1. Expansion Joints — At inlet and outlet plenum interface.
2. Stair Tower — One Stairtower to replace one access ladder.
3. Hopper Level Probe: Six (6) Capicatance Type High Level Device
4. Hopper Heater: Six (6) - 4 KW/Module Heater Elements
5. Compressors: Two (one spare) 400 ICFM with 100 HP Motor with 1 Receiver and 1 Dessicant Drier and Filter
6. Panel View (A/B): Operator interface station at Baghouse MCC Room.

COMMENTS ON CONSTRUCTION:

1. Baghouse Insulation required sq.ft.: 7,500 sq. ft.

2. Additional lagging:
   a. Penthouse Enclosure sq.ft.: 4,458 sq. ft.
   b. Hopper Enclosure sq.ft.: 3,195 sq. ft.

3.0 PERFORMANCE

Flue gas is drawn into the baghouse (inlet manifold, which spans the length of the baghouse). Particulate laden flue gases are ducted the hoppers at the bottom of each compartment. The particulate laden flue gases, under negative pressure from the I.D. fans, are pulled upward into the compartments through the filter bags. As the gas passes through the filter bags to exit the baghouse, the particulate matter deposits on the interior of the filter bags. The clean gas is drawn upward to an outlet manifold, then through the I.D. fan to be discharged into the atmosphere through a stack.

All material collected in each hopper is continuously discharged at the bottom through a pneumatic conveying system to an ash storage area.

3.1 PERFORMANCE TESTS

3.1.1 TESTING PROVISIONS

1. The particulate emissions will be determined in accordance with EPA Test Procedures as set forth in CFR Title 40, Chapter 1, Part 60. The mass solid particulate emissions shall be determined by EPA Test Method 17 with heated probe (dry catch only.)

2. During particulate emission testing, the differential pressure transmitter/recorder will be marked to indicate the start and completion of testing. These recordings will be averaged and serve as compliance data for the guaranteed pressure drop. Prior to testing, all lines and probes attached to the differential pressure sensor must be purged and cleaned. Pressure readings must be calibrated against a certified 'U'-tube manometer.

3.2 OPERATING CONDITIONS

The baghouse design/operating conditions are stipulated under section 1, Design Basis. Performance fuels are as stated in customer's specification.

3.3 PERFORMANCE GUARANTEES

The performance guarantees shall be as stipulated below:

3.3.1 SOLID PARTICULATE EMISSION

The proposed equipment, at time of testing (within 60 days after erection is complete, but not later than 120 days after completing erection), will comply with the specified total particulate emission rate of not more than 0.0054GR/ACF (0.015 lbs/mmBtu)

3.3.2 PRESSURE DROP

The integrated average pressure drop across the baghouse (inlet flange to outlet flange) with all compartments in service and with the cleaning cycle in automatic, will not exceed 6 inwg. The maximum pressure drop across the baghouse will not exceed 8 inwg.

3.3.3 BAGLIFE

IAC guarantees the service life of the original filter bags for 12 months from initial operation defined as the date when gas first enters the baghouse or from ninety (90) days after completion of bag installation, whichever occurs first. Bags which fail in excess of the attrition allowance will be replaced material only, on a pro-rata basis, for material supply contract (F.O.B. shipping point) from commencement of the guarantee period. Normal bag attrition is 5% per year.

Owner shall advise Seller in writing within forty eight (48) hours of any failures observed. Upon receiving such notice, Seller will, at its own expense, review the operating records, diagnose the nature of the failure, and replace those bags that have failed under the provisions of this warranty. Owner shall reimburse Seller for costs incurred to perform the analysis if such is indicated that this warranty does not apply.

Recording devices for such parameters as inlet temperatures and pressure drop will be maintained by Owner along with logs of all maintenance operations, bag failures, temperature excursions, excessive pressure drops, etc., any unusual changes in baghouse operation, and potential cause will be reported within forty eight (48) hours to designated Seller personnel. Seller reserves the right to make on-site inspections of the baghouse at any time.

Seller will be entitled to substitute filter bags of a different description than those indicated herein as experience and/or development deems it proper. Substituted filter bags will be equal or better quality than those originally provided.

The foregoing provisions constitute Seller's sole obligation and liability and Owner's exclusive remedy under this Bag Life Warranty. This warranty is in substitution for and in lieu of any and all warranties, expressed, implied or statutory, including warranties or merchantability and fitness for a particular purpose.

3.4 GUARANTEE PROVISIONS

The Guarantees set forth herein are subject to the following provisions:

1. The equipment shall be operated and maintained according to Seller's guidelines, good engineering/operation principles, and Seller's Maintenance and Operating Manual.
2. All replacement parts shall be of Seller's manufacture or supply.
3. Ash level within the collector hopper must never exceed design limits.

3.5 EQUIPMENT REMEDY

If prior to the expiration of the Guarantee Period set forth herein, Seller received written notice from the Owner that the equipment fails to meet the above Performance Guarantee (as determined by results of the Field Performance Testing Methods stated herein), Seller agrees to provide all necessary material in accordance with the F.O.B. terms of the contract for modifications or corrections to the equipment in order to meet the Performance Guarantees.

3.6 THE PERFORMANCE GUARANTEES SET FORTH IN THIS SECTION ARE THE SOLE PERFORMANCE GUARANTEES MADE BY THE CONTRACTOR WITH RESPECT TO THE EQUIPMENT AND NO OTHER WARRANTIES OR GUARANTEES OF PERFORMANCE, WHETHER STATUTORY, WRITTEN, ORAL, EXPRESSED OR IMPLIED BY LAW SHALL APPLY. THE OWNER'S EXCLUSIVE REMEDY AND THE CONTRACTOR'S SOLE OBLIGATION FOR FAILURE TO MEET THE PERFORMANCE GUARANTEES SHALL BE THOSE STATED IN THIS SECTION.

4.0 WORK BY PURCHASER/CLIENT

The following items are not included in the IAC scope of supply and are to be furnished, as required, by others.

1. MCC, as required.
2. Civil drawings, as required. Loads will be provided.
3. 4160/480 Volts, 3 Phase, 60 Hz Power feeds as needed.
4. Compressed and instrument air supply, as needed. Air to be dry and filtered. Provided as an option. Optional Price provided.
5. Compressed air piping, as required.
6. Unloading and Installation at Job Site.
7. Two electric or pneumatic Hoists for lifting the roof top doors
8. Expansion joints at the inlet/outlet plenum. Optional Price provided.
9. Bulk material as follows:
   - A. Electrical conduits, trays, wires and supports as required.
   - B. Local disconnects, as required.
   - C. Low voltage wiring and light fixtures.
   - D. Interconnecting air piping materials.
   - E. Insulation materials, as required.
   - F. Lagging/Cladding for all insulated surfaces and for the Penthouse enclosure.
   - G. Gutters and downspouts for the Penthouse enclosure.
10. Hopper enclosure. Provided as an option.
11. Broken Bag Detector and/or opacity meter
12. Subgrade electrical grid and lightning protectors, as needed.
13. Area lighting, transformers & panel boards, as needed.
14. Welding receptacles, as needed.
15. Field finish and touch up painting, as needed.
16. Performance testing.
17. Trenches & sumps for area drainage.
18. Initial equipment lubrication.
19. All items specifically not included.
20. Freight. Estimate provided as an option.
21. Sales and Use Taxes, licenses, and permits

5.0 PRICING AND SCHEDULE

Base Price for One IAC "M" Pulse Baghouse:

A.	Option 1;	6x234TB-BHT-500:S6:	$ 1,049,071
B.	Option 2;	6x234TB-BHT-360:S6:	$ 855,956
C.	Option 3;	6x234TB-BHT-400:S6:	$ 966,163

Base Price includes:

1. One Six (6) compartment Baghouse System
2. Integrated Inlet and Outlet Plenums.
3. 16 oz Ryton Bags and galvanized cages.
4. Six (6) Inlet Butterfly Dampers.
5. Six (6) Outlet Poppet Dampers.
6. Support legs - 60" clearance below hopper flange
7. Demand Cleaning, 4-20 mA signal
8. Penthouse framing.
9. Two (2) Ladders for Penthouse access.

Optional Prices not included in Base Prices above:

1.	Expansion Joints: A. At inlet plenum B. At outlet plenum	$ 13,316
2.	50 Spare Bags:	$ 3,866
3.	One Stair Tower and deduct one Ladder:	$ 35,800
4.	Six Hopper Heater (4KW per Hopper):	$ 13,500
5.	Six Hopper Level Probes:	$ 5,500
6.	Two (2) 400 SCFM Compressor w/100HP Motor and with One Filter and Drier:	$ 74,750
7.	One 3,000 gallon (401 cfm storage) Receiver; with pressure regulator:	$ 19,728
8.	PLC, SLC 505, I/O NEMA 4; A/B Panel View::	$ 16,720
9.	Two (2) 9" Baghouse Screw Conveyors and Two (2) Rotary Air Locks:	$ 19,500
10.	Estimated Freight to Job-site:	$ 60,000

Price Notes:

1. Quotation price validity is based on current raw material costs. Orders will be reviewed at time of order receipt for price and material availability. Price adjustments, if necessary, will be made at that time.
2. IAC can provide Non-Union Mill-rights for mechanical installation.

SCHEDULE

DOCUMENTS FOR APPROVAL	DAYS AFTER ORDER
GA's:	15
P&ID's:	15
Loading Diagram:	15

DOCUMENTS FOR INFORMATION	
O&M Manuals:	30 Days before shipment
Spare Parts List:	30 Days before shipment

PROJECT DELIVERY SCHEDULE

ACTIVITY	MONTHS AFTER NTP
Award/Release	0 (NTP)
Engineering:	Month 0 thru Month 3
Start Delivery:	Month 4 AFTER NTP Complete Month 7

PROJECT SCHEDULE

ACTIVITY	DATE
Award/Release	12/31/05
Start Installation	5/01/06
Start Tie-in/Outage:	12/01/06

IAC
INDUSTRIAL ACCESSORIES COMPANY
4800 LAMAR AVE.
MISSION, KS 66202
Office 913-384-5511
Sales 800-334-7431
Fax 913-384-6577
Email: iaccorp@iac-intl.com

IAC SERVICE ENGINEER – PER DIEM RATE SHEET

The rates below are effective from the date shown above and are subject to change without notice.

Normal working hours are from 8:00 a.m. to 5:00 p.m. Monday through Friday with one (1) hour for lunch. Minimum billing will be four (4) hours plus any incurred expenses.

Daily and Hourly Rates - U.S. Dollars		
	Engineer	
	Daily (8 hrs.)	Hourly
Monday - Friday After 8 & up to 12 hours (Over 12 hours)	$933.00	$117.00 $175.00 $233.00
Saturday (up to 12 hours) (Over 12 hours) Sunday & Holidays Per hour - 4 hr. minimum	$1,400.00	$175.00 $233.00 $233.00

Travel Time:
The buyer shall pay for travel time incurred as a result of service work. Travel time is defined as actual time spent by our Service Personnel while traveling to and from the job site for the purpose of doing the contracted work. The rates for travel time shall be the same as the charges noted above working time, stand-by time, and travel shall be combined to calculate the total charges.

Travel Expense:
The Buyer shall reimburse the Seller for transportation expenses incurred in traveling to and from the job site. If a company or a personal car is used, travel expenses shall be calculated at $0.50 per mile. If public transportation is used, travel expenses shall be the actual cost of air transportation, bus, tax, and/or rental car.

Living Expenses:
Meals, lodging, and incidental expenses will be charged at cost.

Stand-By Time:
Stand by time is defined as time, during which Seller's personnel is available for work, but is not working because of circumstances beyond Seller's control. The stand by time shall be charged as working time. Local living expenses shall be invoiced to the buyer for normal weekend days when no work is performed and the Seller's personnel is not on call.

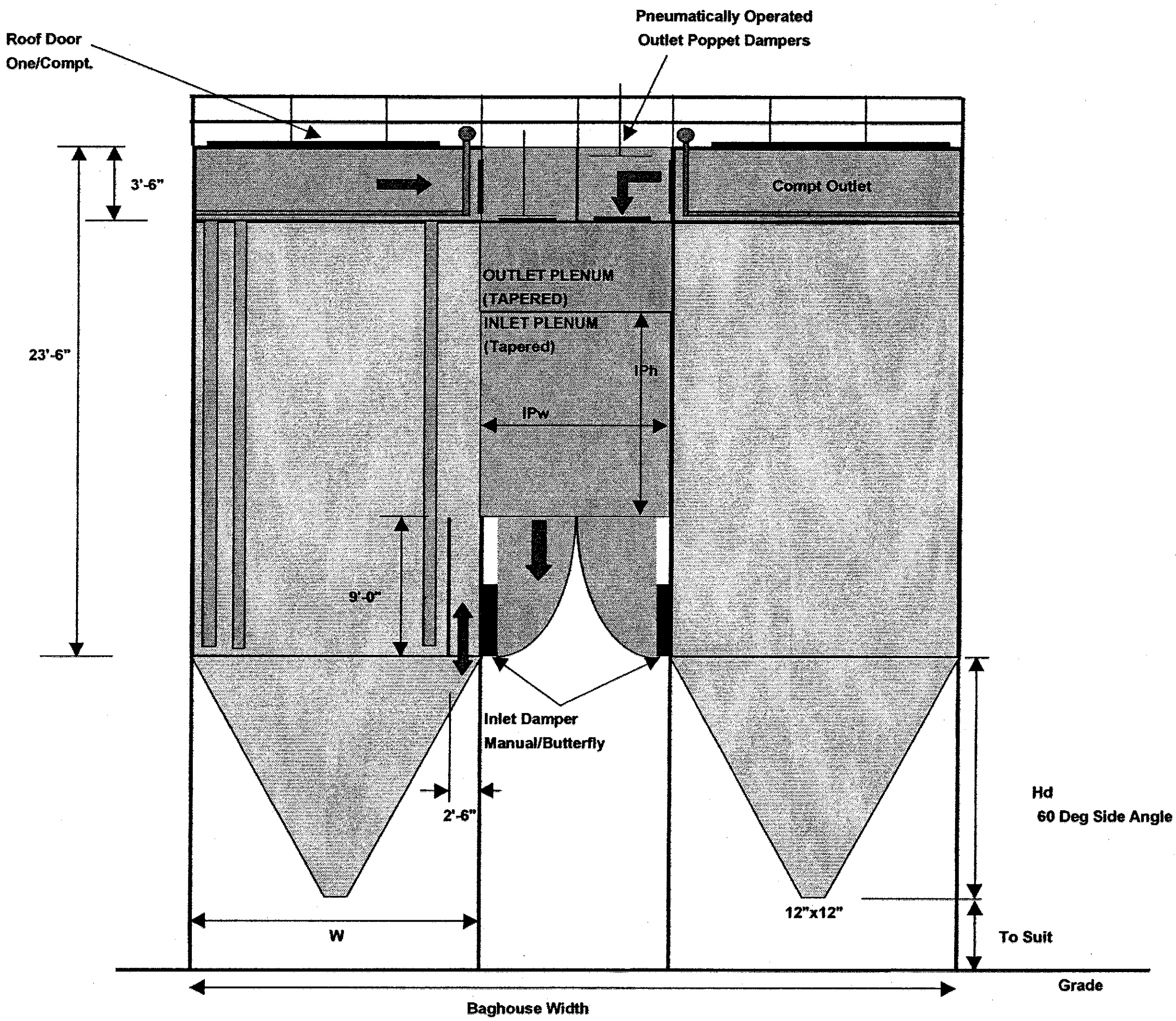
Relief Trip:
If the scope of the work requires that IAC personnel remains at the job site for extended periods, the service person shall be entitled to one (1) return trip home every third weekend. The Buyer shall be liable for all transportation expenses, but will not be charged for travel time for the relief trip.

2/1/2005

IAC
MISSION, KS

STANLEY CONSULTANTS
CITY OF COLUMBIA
IAC "M" PULSE MODEL

Condition		Flow	Temp	IAC M-PULSE Baghouse
Option 1	100 Mwe	317,300 acfm	300 F	6 X 234TB-BHT-500:S6
Option 2	70 Mwe	231,300 acfm	300 F	6 X 234TB-BHT-360:S6
Option 3	Repwr	281,600 acfm	300 F	6 X 234TB-BHT-440:S6



ELEVATION - TYPICAL SECTION THRU COMPARTMENT

Note:
1. Design of Inlet/Outlet Plenum is preliminary
2. The Header will be 12" Diameter (min).
3. Pulse Valves 2 1/2" min.
4. Valve attachement to Header will be either threaded 90 degrees or Full Immersion Header will be utilized.
5. Baghouse will be common wall design.

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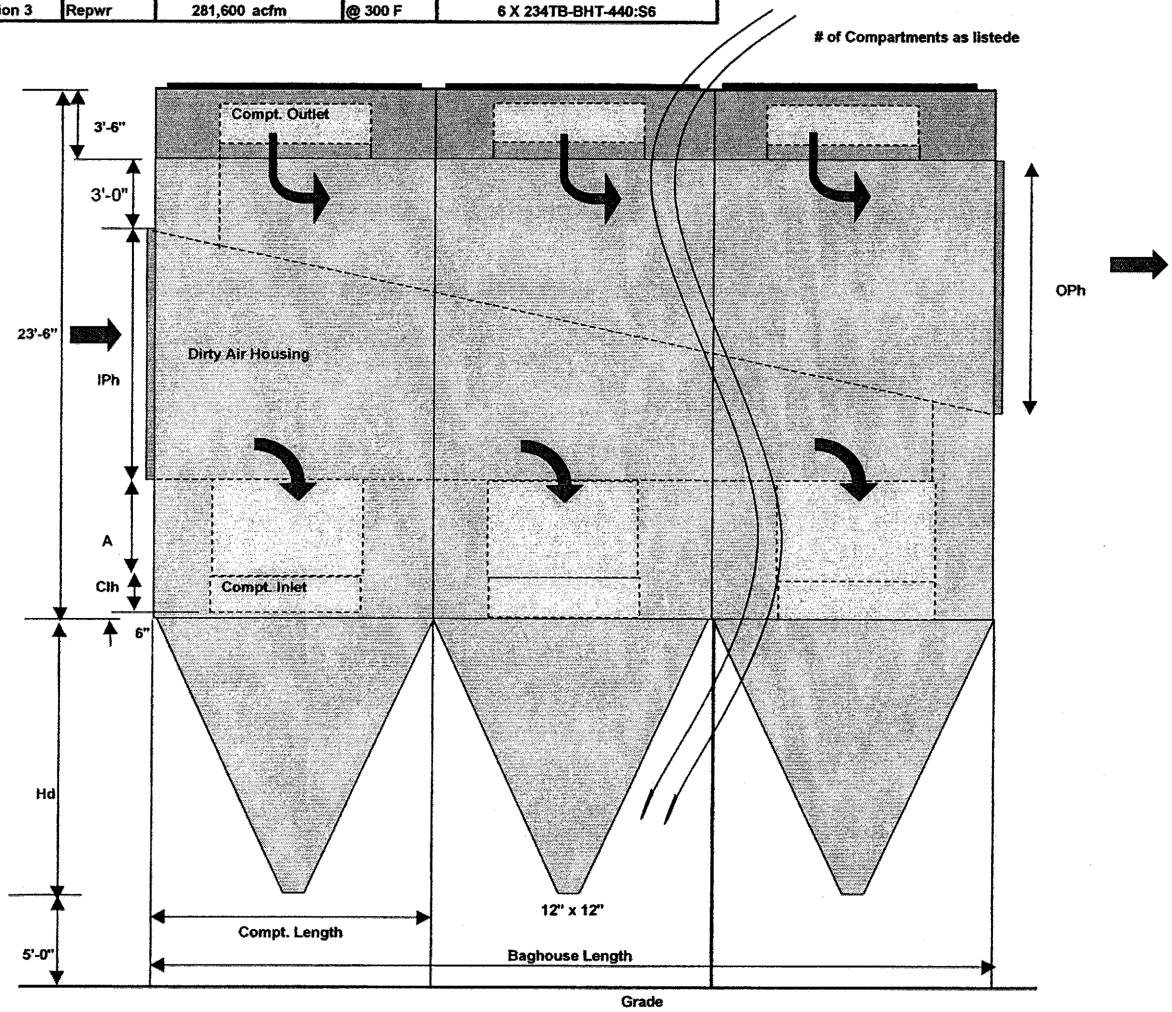
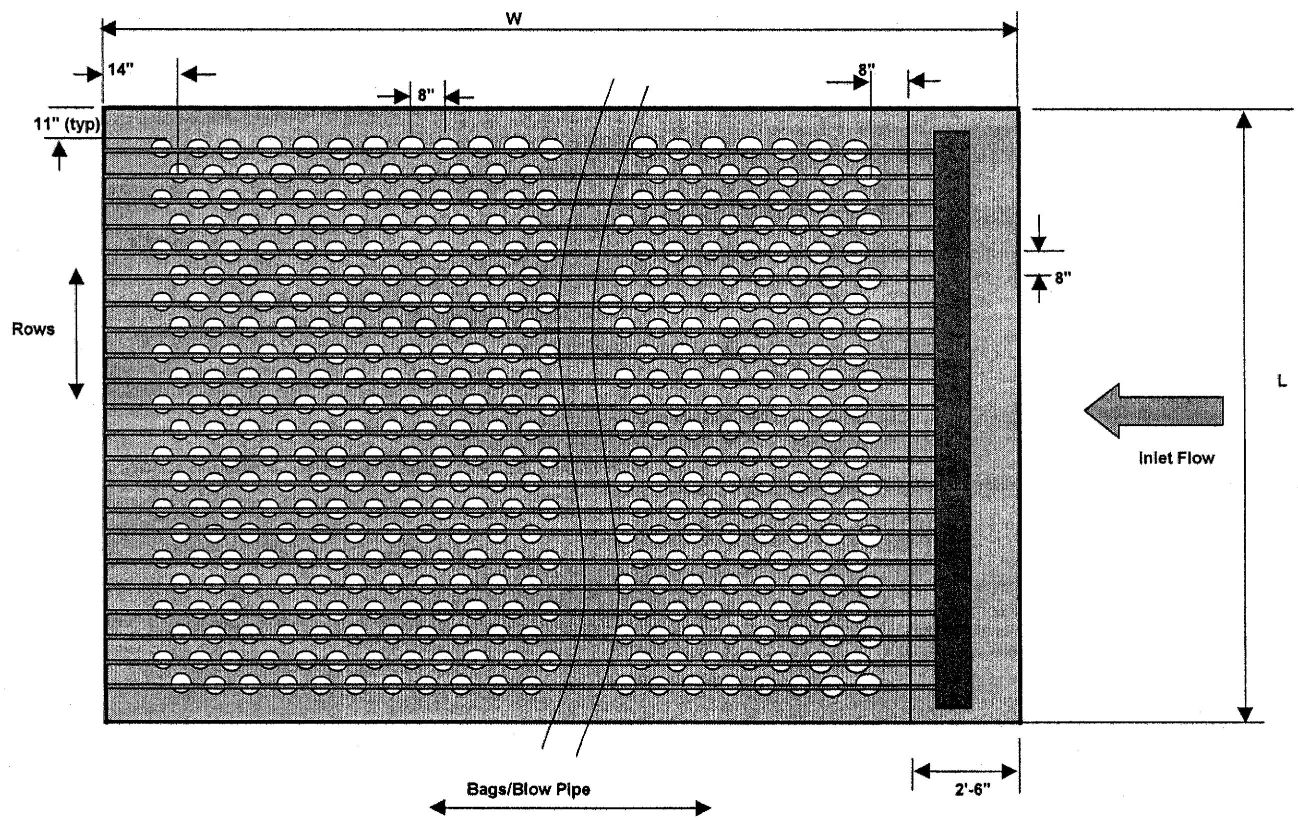


SIDE ELEVATION

		100 Mwe OPT 1	70 Mwe OPT 2	REPWR OPT 3
# Compartments		6	6	6
Compts in a row		3	3	3
Flow:	acfm	317,300	231,300	281,600
Plenum Velocity	fpm	3,500	3,500	3,500
Plenum Width	ft	13.0	11.5	12.5
Plenum Height (IPh)	ft	7.0	5.7	6.4
Plenum Height (OPh)	ft	7.0	5.7	6.4
A	ft	5.5	6.8	6.1
Hd	ft	15.0	13.9	13.9
Compt Inlet Height	ft	4	4	4
Compartment Width	ft	17.00	17.00	17.00
Compartment Length	ft	18.33	13.67	16.33
Baghouse Width	ft	47.0	45.5	46.5
Baghouse Length	ft	55.0	41.0	49.0

STANLEY CONSULTANTS
CITY OF COLUMBIA
IAC "M" PULSE MODEL



NOTE: Tube sheet dimensions are approximate. Internal stiffners for common wall construction may extend width.

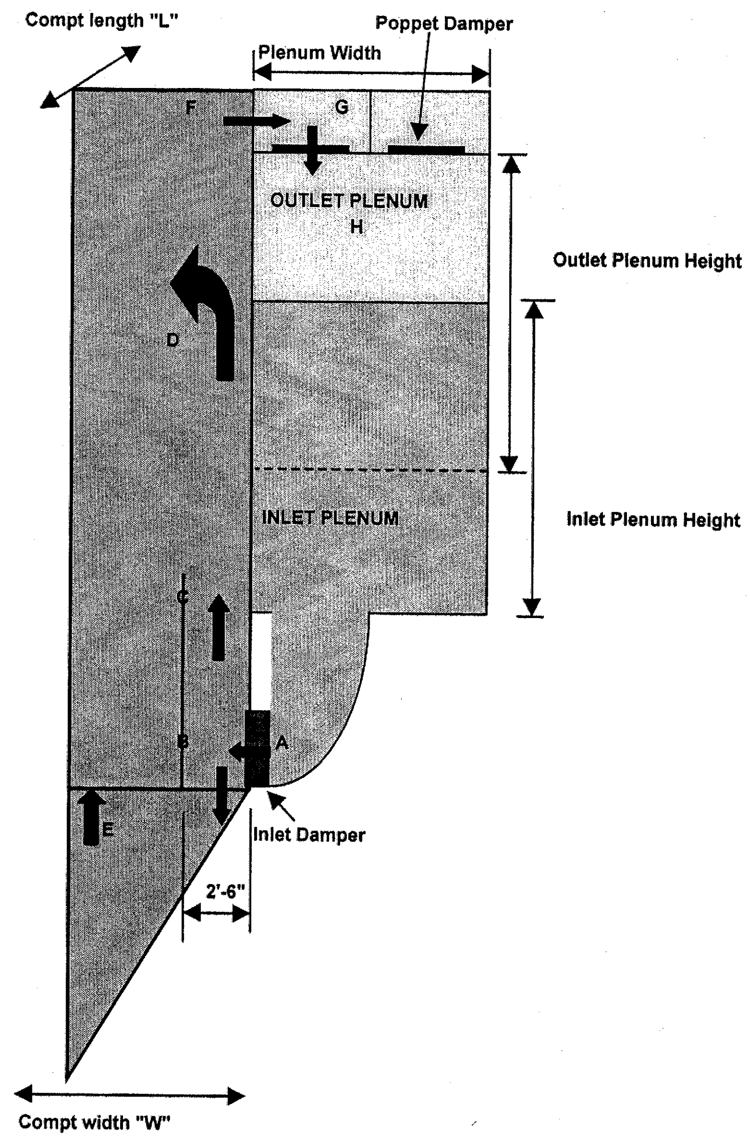
PROJECT	100 Mwe OPT 1	70 Mwe OPT 2	REPWR OPT 3
BAGS/COMPT	500	360	440
# ROWS	25	18	22
BAGS/BLOWPIPE	20	20	20
W (FT)	17.00	17.00	17.00
L (FT)	18.33	13.67	16.33

2/1/2005

IAC
MISSION, KS

STANLEY CONSULTANTS
CITY OF COLUMBIA
IAC "M" PULSE MODEL

			100 Mwe OPT 1	70 Mwe OPT 2	REPWR OPT 3
Flow:		acfm	317,300	231,300	281,600
# of Compts.			6	6	6
Flow to One Compt.		acfm	52,883	38,550	46,933
W		ft	17.0	17.0	17.0
L		ft	18.3	13.7	16.3
Inlet Damper-Height		ft	4	4	4
Inlet Damper-Width		ft	8.81	6.43	7.82
Compt. Outlet - Height		ft	2.5	2.5	2.5
Compt. Outlet - Width		ft	11.8	8.6	10.4
Poppet Damper Size		in.	63	54	60
Inlet/Outlet Plenum Width		ft	13.0	11.5	12.5
Inlet/Outlet Plenum Height		ft	7.0	5.7	6.4
VELOCITY PROFILE:					
	Inlet Plenum:	fpm	3500	3500	3500
A	Across Inlet Damper	fpm	1500	1500	1500
B	40% Flow to Hopper	fpm	462	451	460
C	60% Flow to Casing	fpm	692	677	690
D	In to Upper Casing	fpm	157	154	157
E	From Hopper	fpm	80	78	79
F	Exit from Compt	fpm	1800	1800	1800
G	Across Poppet	fpm	2443	2424	2390
H	Outlet Plenum:	fpm	3500	3500	3500



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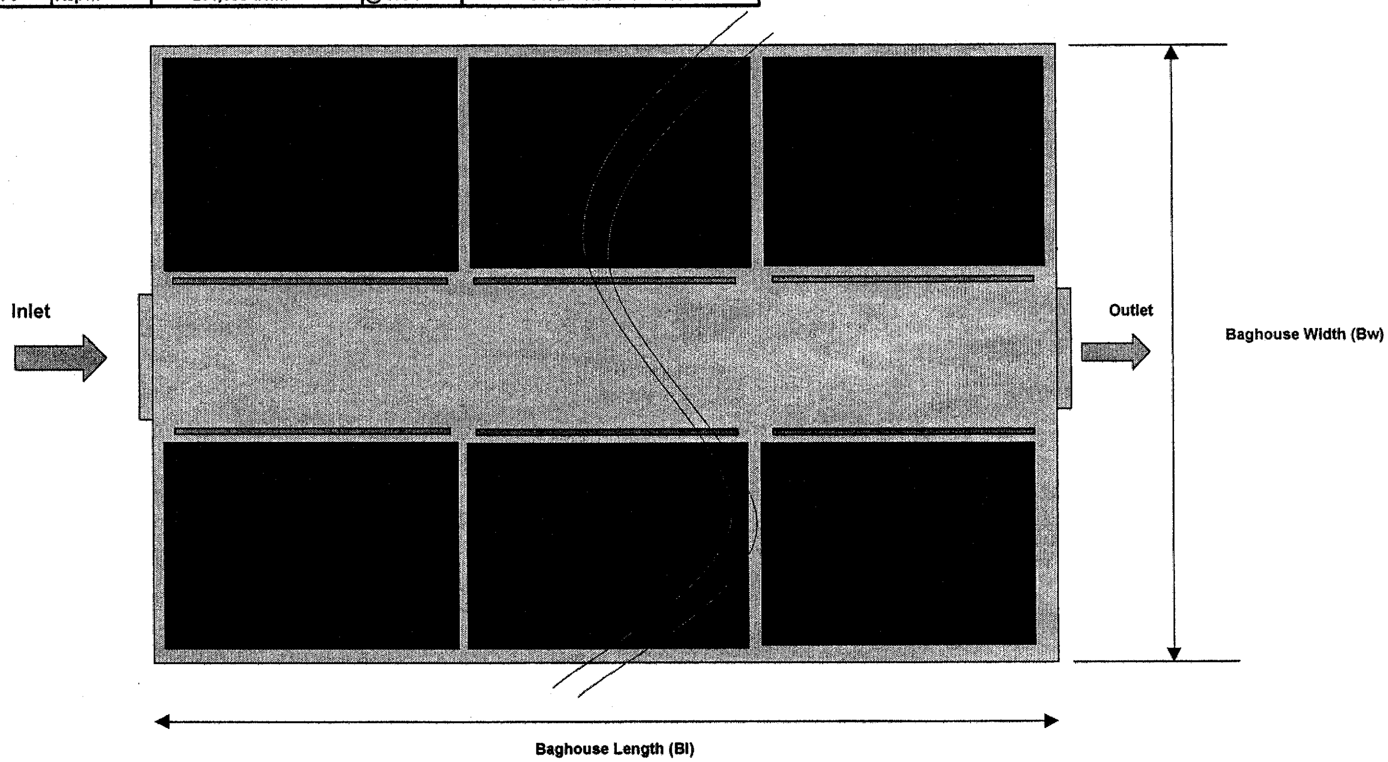

		100 Mwe OPT 1	70 Mwe OPT 2	REPWR OPT 3
# Compartments		6	12	12
Flow:	acfm	175,001	441,450	382,590
Compartment Width	ft	17.00	17.00	17.00
Compartment Length	ft	18.33	13.67	16.33
Baghouse Width	ft	47.0	45.5	46.5
Baghouse Length	ft	55.0	41.0	49.0

24 January 2005

Mr. John Johnson
Account Manager
Utility Automation
ABB, Inc.
416 Avena Court
Naperville, IL 60565
630.767.0549 (voice)
630.369.8711 (fax)

Dear Mr. Johnson:

Subject: DCS Budgetary Price Proposal
City of Columbia
Department of Water and Light
Power Plant Rehabilitation and Upgrade
Columbia, MO.

Stanley Consultants, Inc. is performing an evaluation for the City of Columbia, Missouri which includes comparing alternatives to upgrade their power generating capability at the Columbia site. We are seeking budget pricing and supporting information for a Digital Control System (DCS) from ABB to prepare an opinion of probable cost in this phase of work.

<u>Background</u>
The existing plant does not currently have a DCS. Equipment is controlled via local control stations and single loop controllers.
Boilers:

- Boiler No. 6: Springfield, coal-fired balanced draft design, stoker-feeder, installed 1957, similar rating as Boiler No. 7.
- Boiler No. 7: Erie City Iron Works, coal-fired balanced draft design, stoker-feeder, installed 1965, produces 175,000 pph @ 875 psig and 900 °F.
- Boiler No. 8: Babcock & Wilcox, natural gas-fired, 310,000 pph @ 880 psig and 900°F.

Steam Turbine Generators:

- ST No. 5: Westinghouse, installed 1957, 16.5 MW.
- ST No. 7: Westinghouse, installed 1965, 22.5 MW.
- ST No. 8: General Electric, installed 1970, 35.0 MW.

Combustion Turbine: Westinghouse Model W171G, natural gas-fired, 15.5 MW.

The following three options will be evaluated:

Option 1: New 100 MW Net Electrical Output Plant

Major equipment:

- Steam Turbine – Siemens type SST-PAC-900RH. Includes complete stand-alone digital turbine generator control system (governor, AVR, monitoring of temperatures, pressures, vibrations, etc., alarms and turbine safety trips) with color monitor/keyboard operator interface and an event printer.
- Circulating Fluidized Bed (CFB) Boiler - 705,000 lb/hr at 1,800 psia/1000 °F steam. Manufacturers include Aker Kvaerner, Alstom, and Foster-Wheeler.
- Bag House – Includes PLC control system.
- Coal Handling – Includes control system.
- Balance of plant equipment.
- Existing equipment: Boiler No. 8, ST No. 8, Combustion Turbine, and associated Balance of Plant (BOP) equipment to interface with DCS. Assume range of DCS control to include complete control to selected monitoring of key process parameters only.

Option 2: New 70 MW Net Electrical Output and Repower Existing Steam Turbines with New Boiler

Phase 1 major equipment:

- Steam Turbine – Siemens type SST-PAC-900RH. Includes complete stand-alone digital turbine generator control system (governor, AVR, monitoring of temperatures, pressures, vibrations, etc., alarms and turbine safety trips) with color monitor/keyboard operator interface and an event printer.
- CFB Boiler - 496,000 lb/hr at 1,800 psia/1000 °F steam. Manufacturers include Aker Kvaerner, Alstom, and Foster-Wheeler.
- Bag House – Includes PLC control system.
- Coal Handling – Includes control system.
- Balance of plant equipment.

Phase 2 major equipment:

- CFB Boiler – 766,600 lb/hr at 1,800 psia/1000 °F steam. Manufacturers include Aker Kvaerner, Alstom, and Foster-Wheeler.
- Bag House – Includes PLC control system.
- Coal Handling – Includes control system.
- Existing equipment: New CFB Boiler will re-power existing Steam Turbines No. 5, 7, and 8 and utilize existing associated BOP equipment. Assume range of DCS control to include complete control to selected monitoring of key process parameters only.

Option 3: New 70 MW Net Electrical Output and Repower Existing Steam Turbines with existing Boilers

Phase 1 major equipment:

- Steam Turbine – Siemens type SST-PAC-900RH. Includes complete stand-alone digital turbine generator control system (governor, AVR, monitoring of temperatures, pressures, vibrations, etc., alarms and turbine safety trips) with color monitor/keyboard operator interface and an event printer.
- CFB Boiler - 496,000 lb/hr at 1,800 psia/1000 °F steam. Manufacturers include Aker Kvaerner, Alstom, and Foster-Wheeler.
- Bag House – Includes PLC control system.
- Coal Handling – Includes control system.
- Balance of plant equipment.

Phase 2 major equipment:

- Existing equipment: Existing Boilers No. 6, 7, and 8 will re-power existing Steam Turbines No. 5, 7, and 8 and utilize existing associated BOP equipment. Assume range of DCS control to include complete control to selected monitoring of key process parameters only.

Scope of Supply:
The following should be included:

- Software
- Hardware (control panels, operator workstations, IO modules, etc.)
- Programming and configuration
- System startup assistance
- Estimated Input/Output counts (both hardwired and serial)
- Training
- Schedule
- Breakout pricing for interfacing with new and existing equipment options.

Commercial operation is anticipated in 2008.

I look forward to receiving the budgetary price proposal at your earliest convenience, but no later than February 15, 2005. Please contact me with any questions.

Sincerely,

Wayne E. Hanno, P.E.
Stanley Consultants, Inc.
225 Iowa Avenue
Muscatine, Iowa 52761
563.264.6207 (voice)
563.264.6658 (fax)
hannowayne@stanleygroup.com

INTRODUCTION

ABB Inc. is pleased to offer this budgetary proposal for the Columbia project

BASIS OF ENGINEERING

The System Pricing for this proposal is based on ABB's type B-4 engineering services. ABB Inc. will implement and test the operator's console configuration and module configuration control logic as defined by the Engineer. The engineering services offered are as described in the Scope of Supply documents (See Engineering Services).

SYSTEM PRICING

Base System – Option 1

ABB Enterprise Management and Control System, as described in this scope of supply to include new Circulating Fluid Bed Boiler (705,000 #/hr.) complete with balance of plant and foreign device interfaces. And approximately (150) I/O for boiler #8, steam turbine #8, combustion turbine inclusive of all of the necessary hardware, software, engineering, project management, field service, & FOB Job Site $770, 000.00

Base System – Option 2

Phase 1 –

ABB Enterprise Management and Control System, as described in this scope of supply to include new Circulating Fluid Bed Boiler (496,000 # /hr.) complete with balance of plant and foreign device interfaces inclusive of all of the necessary hardware, software, engineering, project management, field service, & FOB Job Site.. $700, 000.00

Phase 2 –

ABB Enterprise Management and Control System, as described in this scope of supply to include new Circulating Fluid Bed Boiler (766,000 #/hr.) complete with balance of plant and foreign device interfaces and approximately (150) I/O for turbines 5,7, and 8 inclusive of all of the necessary hardware, software, engineering, project management, field service, & FOB Job Site.. $770, 000.00

Base System – Option 3

Phase 1 –

ABB Enterprise Management and Control System, as described in this scope of supply to include new Circulating Fluid Bed Boiler (496,000 # /hr.) complete with balance of plant and foreign device interfaces inclusive of all of the necessary hardware, software, engineering, project management, field service, & FOB Job Site...$700, 000.00

Phase 2 –

ABB Enterprise Management and Control System, as described in this scope of supply to include approximately (200) I/O for boilers 6,7 and 8 plus turbines 5,7, and 8 inclusive of all of the necessary hardware, software, engineering, project management, field service, & FOB Job Site...$100, 000.00

Option Pricing

Training

Item	Description	
On-site Operator Training	Four – Two Day Training Classes	$20,000.00
Engineer Training – Factory	Configuration Techniques – 1 Student	$2,500.00
Engineer Training – Factory	Operator Console – 1 Student	$5,000.00

COMMERCIAL

Terms and Conditions of Sale

ABB Inc.'s terms and conditions are attached for your review.

Payment Milestones

- 20% Upon Hardware Submittal
- 20% Upon Software Submittal
- 20% Upon Start of FAT
- 20% Upon Delivery
- 20% Upon System Acceptance assumed to be not greater than six (6) months from shipment.

Schedule

Project schedule will be mutually agreed upon by owner, owner's engineer and ABB. Approximately 12 – 13 months after receipt of complete data.

Delivery

ABB's Proposal is based on shipment FOB Job Site.

Taxes & Duties

The pricing does not include any taxes or duties that may be charged by any governmental authority. ABB Inc. shall be reimbursed for any such taxes, duties, etc. that it may pay on the work or equipment covered by any order resulting from this proposal.

Language

The prices and job schedules indicated within this proposal are based upon all contract documentation being in the English language unless otherwise not

Confidentiality

The information contained in this proposal is proprietary to ABB and may not be disclosed to any third party or company without the written consent of ABB Inc. – Wickliffe, Ohio USA.

INTRODUCTION

The Enterprise Management and Control System strategy is orchestrated via four powerful, integrated classes of technology:

CONTROL — A comprehensive set of traditional process, regulatory, and sequence control services and I/O interfaces.

HUMAN SYSTEM INTERFACES — A dynamic range of console products for accessing and viewing data from multiple operating environments, from process control and I/O to plant and enterprise information.

SYSTEM ENGINEERING TOOLS — An integrated set of engineering, operation, and maintenance tools designed to support the total automation project, including planning, configuration management, commissioning, and system documentation.

•

Controllers

The controllers collect process I/O, perform control algorithms and output control signals to process level devices. They also import and export process data from and to other controllers or other system nodes, and accept control commands from operators and computers connected to the network.

Input / Output

The purpose of the I/O is to provide the pathway between the process field signals and the Controllers. Input modules receive process signals, condition and digitize them (for analog inputs), then transmit them to the Controllers. Once the Controller has executed its control algorithm, it transmits digitized values to the output modules and blocks, where they are converted into output signals.

I/O Termination System

The proposal includes ABB's standard termination for all inputs and outputs.

Table 1 – Process I/O Count Summary for CFB & BOP areas

I/O Description	Summary of Total Point Count
	Configured I/O
AI (4-20 mA) System Powered	300
AI (RTD/ Thermocouple)	300
AO (4-20 mA) System Powered	100
SOE (System Powered)	100
DI (System Powered)	700
DO (120 VAC) Dry Contact	300
Totals	1800
Total I/O with 20% Spare	2100

Deleted: 219

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Deleted: 1,670

Foreign Device Interface (FDI)

Any Enterprise Management and Control Systems has the capability to communicate with virtually any device or third party system through RS232C or RS485 serial communications interfaces. FDI's will permit foreign control system monitoring and supervisory control. FDI points required for graphic displays, logs, alarm features, and other functions must be defined and submitted within the point data list.

Table 2 – Foreign Device Interface Proposal Summary

Interface	Tags	Device Protocol	DCS Interface	Qty	Redundant	Media
Boiler Fuel Safety & BMS	*150*	RS485	Modbus	1	*Yes*	*Fiber*
Baghouse Control System	*100*	RS485	Modbus	1	*No*	*Fiber*
Sootblower System	*100*	RS485	Modbus	1	*No*	*Fiber*
Generator Metering System	*100*	RS485	Modbus	1	*No*	*Electric*
Ash Handling	*100*	RS485	Modbus	1	*No*	*Fiber*
Siemens Turbine Controls	*300*	RS485	Modbus	1	*Yes*	*Electric*

Deleted: *109*

Deleted: RS485

Deleted: Modbus

Deleted: 1

Deleted: *No*

Deleted: *Electric*

Deleted: Mitsubishi Turbine Control System.

Modular Power System

The Modular Power System provides power for system and I/O modules, power factor correction, extensive monitoring functions, and on-line replaceable components. The power system is designed to operate with 2N-power redundancy.

Table 3 – Modular Power System Proposal Summary

Item	Supplied by:	Comments
System Power	*ABB*	*2N Redundant Module Power System*
Main Power	*Client*	*Two (2) 120 VAC Power Sources for control cabinets*
Field Power	*ABB & Client*	*All I/O points are system powered with the exception of the digital output contacts.*

System Cabinets

Enclosures used in the Enterprise Management and Control System are a full feature industrial application enclosure system designed for flexibility across the ABB product line.

System enclosures also provide environmental flexibility by offering a variety of environmental classifications that meet NEMA 1 (IP23), NEMA 12 (IP55), and NEMA 4 (IP56) ratings.

Note 1. Each Cabinet Bay is 2200mm H X 600mm W X 800 mm D.

HUMAN SYSTEM INTERFACE –

Operate IT Process Portal is a versatile series of human system interfaces (HSI) that provide users with dynamic access to plant-wide or enterprise-wide information. The Process Portal series offers far more than just a way for operators to interact with machines. This powerful HSI provides an interface to all data within the enterprise.

The HSI is available in a variety of platform and packaging designs, utilizing a client/server architecture for support of any plant network configuration. The Operate IT Human System Interface is a Windows NT based desktop PC station. The operator-process interface functions and features users expect have been further enhanced with the look and feel of Windows NT operating system software. The full functionality and design attributes of Process Portal result in a human system interface that is easy to learn, easy to use, easy to configure, and low in cost of ownership.

The hardware platform for the Process Portal HSI includes the following minimum specifications:

- 2.66 GHz Pentium IV Processor
- 512 MB RAM
- 1 - 20 GB Hard Disk (EIDE)
- One (1) 3.5" Floppy Disk
- 4X DVD+RW/+R
- Dual Video Graphics Card
- 101-Key QWERTY Keyboard, 2 Button Mouse
- MS Windows NT and Excel 2002
- 2 Serial Ports, 1 Parallel Port
- 10/100 TX PCI
- Two - 20.1" LCD Monitors per Workstation

NOTE: Due to rapidly evolving technology, the above specifications are subject to change without notice.

SYSTEM ENGINEERING TOOLS

The System Engineering and Maintenance Tools provide a comprehensive set of engineering and maintenance tools for the Enterprise Management and Control System. The Tools offer client/server architecture, and utilize Pentium processors for both applications.

The System Engineering Tools hardware and software capabilities include:

- 2.66 GHz Pentium IV Processor
- 512 MB RAM
- 1 - 80 GB Hard Disk (EIDE)
- One (1) 3.5" Floppy Disk
- 4X DVD+RW/+R
- Graphics Card
- 101-Key QWERTY Keyboard, 2 Button Mouse
- MS Windows NT and Excel 2002
- 2 Serial Ports, 1 Parallel Port
- 10/100 TX PCI
- One - 20.1" LCD Monitors per Workstation

CONSOLE SUPPORT EQUIPMENT

Table 4 - Printer Proposal Summary

Printer	Quantity	Comments
Color Printer	*1*	*Hewlett Packard HP 5500DN Color Laser Jet – 11 X 17*
Color Printer	*1*	*Hewlett Packard HP 4600N Color Laser Jet – 8 ½ X 11*

OPERATION AND MAINTENANCE MANUALS

Table 5 – Instruction Manuals

Instruction Manuals
Three (3) hard copy sets and One (1) electronic versions of the instruction manuals will be provided with the project.

FIELD SERVICE

ABB's proposal includes 50 Field Service days including 5 trips and living expenses. Field Service per diem is based on Eight (8) hour days, five days a week M-F, during normal working hours. For a description of the services provided please refer to Tab 6 Field Service Installation, Start-up and Commissioning Support.

PERSONNEL TRAINING

Training is provided optionally for operations and engineering personnel.

Deleted: ¶

ENGINEERING SERVICES

Hardware Assembly

ABB will assemble the System cabinets. Assembly includes the mounting of equipment (modules, power, terminations, etc.) into standard ABB enclosures and wiring of power and communications channels located within the cabinets.

Table 6 - Hardware Assembly Proposal Summary

Proposed Scope of Work	**Provided by ABB within this Proposal**		
System Assembly	*Yes*		
Data requirements for performing Scope of Work	**Required for ABB to perform work**	**To be provided by ABB**	**To be provided by Customer**
I/O Types and Power Source Listing	*Yes*	*No*	*Yes*
Cabinet Arrangement Drawing	*Yes*	*Yes*	*No*
External Connection Drawing	*Yes*	*Yes*	*No*
Documentation options	**To be provided by ABB within scope of this Proposal**		
Cabinet Outline Drawings	*Yes*		
As built Cabinet Arrangement Drawings	*Yes*		
As built Power Distribution Drawings	*Yes*		
Standard Product Instructions	*Yes*		

Definitions

Cabinet Arrangement Drawings graphically display the physical location of controller modules, I/O modules, and terminations inside of the cabinets. Cabling diagrams and a bill of materials are also included on the drawings that are prepared with System Engineering Tools software package.

Cabinet Power Distribution Drawings detail module and I/O power cabling throughout the cabinet.

External Connection Drawings detail the configuration of I/O Modules and Termination Units.

Control Configuration

System controllers are configured to execute a defined control strategy. Complete controller execution includes: the scanning of input signals, generation of control actions based on the configured control strategy, and the output of those actions to a final control element. Controller configurations consist mainly of arrangements of ABB Function Codes, prepared and downloaded using ABB's System Engineering Tools software package.

Table 7 –Base Regulatory Control Configuration Proposal Summary

Proposed Scope of Work	Provided by ABB within this proposal
Controller Configuration	*YES*
Data requirements for performing Scope of Work	To be provided by Customer
Completed I/O Data Base Files[1]	*YES*
Logic Diagrams[2, 4]	*YES*
P&ID Drawings	*For Information Only, if Available*
Schematics	*For Information Only, if Available*
Process/Logic Descriptions[3, 4]	*YES*
Documentation options	To be provided by ABB within the scope of this Proposal
As built Configuration Drawings	*Yes*
As built Termination Assignments	*Yes*
Final Controller Configuration Files	*Yes*

[1] This information is to be provided in electronic format. For a description of ABB's I/O database format, please refer to the *I/O Database Management Guide* located in this proposal.

[2] The Engineer is to be responsible for the definition of the plant's operating philosophy, including the operation of the Modulating Control Loops. ABB intends to use predetermined standard device logic macros for Discrete Device Logic control. The macros will be approved by the Engineer during the detailed design phase. ABB requires Flow Logic Diagrams (steering logic) for all Discrete Device Control loops that require permissive, trip, or override logic within the system.

[3] Configuration for Modulating Control Loops will be implemented in ABB's function code format from functional descriptions and simplified functional logic diagrams to be provided by the Engineer. These narratives should describe permissives and protective interlock functions as well as auto/manual operation.

[4] ABB will provide Drive Level Control for all devices including manual control as well as the necessary logic to implement protective overrides, permissives, and process automation.

Definitions

P&ID Drawings are Piping & Instrumentation Diagrams in industry standard (ISA) format. Process/Logic Descriptions are a text/narrative version of detailed logic diagrams. Configuration Drawings are graphic representations of the Function Code arrangements. Module Configuration Files are electronic files of the Configuration Drawings.

Operator Console Configuration

Operator Consoles are configured to display, document and archive process data and provide for control interaction with the operator. Displays can include graphic screens representing plant devices, trends of process and calculated data, alarm summaries, etc. all of which contain live process data. The primary configuration elements of the operator console are the tag database and graphics configuration. Other major configuration elements include display hierarchies, logging, archival storage, alarm management and password security. Configurations are prepared using ABB console configuration software packages.

Table 8 - Operator Console Configuration Proposal Summary

Proposed Scope of Work	**Provided by ABB within this Proposal**		
Operator Console Configuration	*Yes*		
Basis for Proposal	**Quantities and/or Comments**		
Tags	*5,000*		
General Process Overview Displays	*100*		
Overview Menus	*6*		
Maintenance Reports	*1*		
Event Logs	*1*		
Periodic Logs	*1*		
Trend Logs	*5*		
Trip Logs	*5*		
Data requirements for performing Scope of Work	**Required for ABB to perform work**	**To be provided by ABB**	**To be provided by Customer[1]**
Display (Process, Trends, Faceplates, Overviews, Alarm Summaries, System Status) Definition	*Yes*	*No*	*Yes[2]*
Display Configuration on ABB Engineering Workstation	*Yes*	*Yes*	*No*
Log (Trend, Trip, Event) Definition	*Yes*	*No*	*Yes*
Log Configuration	*Yes*	*Yes*	*No*
Alarm Management Definition	*Yes*	*No*	*Yes*
Alarm Management Implementation	*Yes*	*Yes*	*No*
Password Security Definition	*Yes*	*No*	*Yes*
Password Security Implementation	*Yes*	*Yes*	*No*
Documentation	**Provided by ABB**		
Console Configuration Files	*Yes*		

[1] To be provided by the customer in consultation with ABB Inc for Base Controls.
[2] Display engineering and implementation will be based on a predetermined set of standards.

Definitions

Display Definition is sketches of desired graphics on ABB Worksheets for final implementation. Trend Definition involves defining types, resolution, retention time, etc. Log Definition involves defining types, variables, parameters, etc. Alarm Management/Password Security Definition involves defining the desired functionality.

System Test

ABB provides four (4) standard levels of DCS testing. The first level is a simple power-up test which insures that all System controllers and I/O modules will acknowledge operation under power. Second is a functional test of 100% of the used I/O points. The third level is preparation for a system functional test by the customer or designee. This level includes staging of the system and loading of customer supplied module and console configurations. Fourth is a complete functional test of the interconnected system. Level 4 testing includes rough flowing of the control logic.

Table 9 - System Test Proposal Summary

Proposed Scope of Work	Provided by ABB within this Proposal		
Power and Ground Test	*Yes*		
Power-Up Controllers	*Yes*		
Power-Up Consoles	*Yes*		
Verification of Module Operation	*Yes*		
Verification of Console Operation	*Yes*		
Verification of System Communications	*Yes*		
Load Controller Configuration	*Yes*		
Load Console Configuration	*Yes*		
Test Module Configuration	*Yes*		
Test Console Configuration	*Yes*		
Closed Loop Testing	*Yes*		
Basis for Proposal	Quantities and/or Comments		
Checkout Location	*15 days of FAT at Wickliffe, Ohio*		
Data requirements for performing Scope of Work	Required for ABB to perform work	To be provided by ABB	To be provided by Customer
Overall system layout drawings	*Yes*	*Yes*	*No*
Cabinet arrangement drawings	*Yes*	*Yes*	*No*
Power distribution drawings	*Yes*	*Yes*	*No*
Configuration drawings	*Yes*	*Yes*	*No*
Termination assignments	*Yes*	*Yes*	*No*
Controller Configuration Files	*Yes*	*Yes*	*No*
Console Configuration Files	*Yes*	*Yes*	*No*
Documentation options	To be provided by ABB within the scope of this Proposal		
Formal documentation of results for above tests	*Yes*		

Appendix E

Concept Team

MEETING NOTES

No. 002

Date: December 21, 2004

Place: Columbia, MO

Project/Purpose: City of Columbia
Department of Water and Light
Power Plant Rehabilitation Upgrade and/or Expansion Project

Attendees:

CWL:	Stanley:
Tad Johnsen	Russ Price
Daniel Dasho	Marc Elliott
Michael Schmitz	Jim Hodina
Jim Windsor	Bruce King
Michael Willingham	Wayne Hanno
John Gerke	Jim Townsend

Notes By: Gary Wilkinson

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have an questions, additions, or comments, please contact the writer immediately. If we do not hear from you, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

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1. Introductions were made and individual expectations for the Concept Team Meeting were expressed. The project objectives of seeking cost effective onsite generating schemes which meet environmental requirements that can be evaluated against other opportunities confronting CWL were agreed to. This Concept Team Meeting sought to define the alternatives to be further evaluated during this study.

2. The project schedule was discussed. Due to the lack of vendor response over the holiday period Stanley Consultants presented an updated schedule showing the final report submitted by May 13, 2005. Dan Dasho requested the report prior to the May 1, 2005 Council meeting.

3. The stakeholders impacted by this potential project, their requirements and expectations were discussed. This listing is attached to these notes.

4. The alternatives which were agreed to be further developed are defined as follows:

   Option 1:
   - New 100 MW Circulating Fluidized Bed, CFB boiler and steam turbine/generator.
   - Existing natural gas Boiler No. 8 and steam turbine/generator No. 8 will be upgraded.
   - The Combustion Turbine/generator will be retained in peaking capacity firing natural gas.

Option 2:

- New 70 MW CFB boiler at 1800 psi/1000 F and steam turbine/generator.
- A new 70 MW CFB boiler at 900 psi/900 F will repower steam turbine/generators No. 5, 7 and 8.
- The Combustion Turbine/generator will be retained in peaking capacity firing natural gas.

  The sequencing of this option will be developed further. However, in September of 2007, burning low chlorine content coal (<0.09 lb/MMBtu ≈ 0.1 wt.%) will enable boilers No. 6 & 7 to operate satisfying the Boiler MACT regulations.

Option 3:

- New 70 MW CFB boiler at 1800 psi/1000 F and steam turbine/generator.
- Refurbished stoker fired boilers No. 6 & 7 and auxiliaries for an extended 20 years of life. Gas boiler No. 8 could be refurbished to burn gas or replaced with a new 35 MW boiler.
- The Combustion Turbine/generator will be retained in peaking capacity firing natural gas.

5. Stanley Consultants, SCI, will provide further description of each alternative with a preliminary site layout sketch, conceptual flow diagram and calculated heat rate to verify the alternates to be evaluated in the estimating phase of this study.

6. A summary of the topics driving the costs of these on-site generating options are:
    - Coal selection (operating cost savings and long term stability as a fuel source)
    - Installed cost ($/kW).
    - Control area operating flexibility.
    - Purchased power alternative costs.
    - Avoiding the need for transmission upgrade to provide additional purchased power to the City of Columbia.
    - Including opportunity fuels (1%).

7. The CFB type boiler is recommended for the alternatives described. It can accept a wide range of coal as well as easily accept opportunity fuels in the 1% range of fuel input desired. CWL anticipates a minimum load of 75 – 80 MW five years from now with an average load of about 120 MW. CFB boilers can operate at 40% turndown, at a reduced efficiency. The CFB boiler may not require a spray absorber to meet emission requirements compared to pulverized coal boiler which would require a scrubber.

8. Constraints on projects that would be developed at this site include:
    - Additional natural gas generating capability is not desired.
    - A 30 day active coal storage pile will be provided onsite. The ability to receive and unload coal will be provided all year. This will include coal car thawing and either bottom dump or a rotary car dumper.
    - Option 3 will require stocking two coal supplies to satisfy the CFB and stoker needs.
    - Coal storage will be enclosed to control fugitive dust and simplify coal pile runoff control.
    - Opportunity fuels will be included at about 1% of the fuel input. Further discussions will be held with the Public Works Department regarding available sources.
    - Ash is currently used for road cover and other uses in the area at no cost to CWL.
    - Regarding the new site arrangement, the cost for removing abandoned equipment will only be included if the space is needed for the most cost effective arrangement. An allowance will be included for improving the administration offices, shops and facilities.
    - CWL is currently evaluating new gas service arrangements. The estimate will presume that the existing natural gas service to Boiler No. 8 and CT No. 6 is adequate.

9. CWL will provide a copy of their recent coal specification used to solicit coal bids. This specification will be used to define a range of suitable coals for establishing the CFB and environmental plan design basis. Any impact due to significant deviations from that coal will be identified in the report.

10. Jim Windsor has provided information on Monthly Minimum and Maximum Loads, and Hourly Load data.

11. The following other considerations were discussed:
    - Possible coordination with the University of Missouri regarding their need for steam at the campus. CWL will investigate the amount of steam required and advise if provisions should be included with these options.
    - The existing oil tanks can be removed to provide additional space onsite.
    - The existing water reservoirs can also be removed. A water tower may be required to meet plant water reserve capacity and improve pressure in the local fire water system. The water well will remain in service. The capacity of the well is expected to be adequate. This system currently provides cooling tower makeup.
    - The city water service at the south end of the plant serves the plant firewater system.
    - Filling the ash pond and converting to a dry ash system is feasible. Converting units 6 & 7 ash handling systems will be sequenced accordingly.

12. The applicability of air quality regulations impacting potential alternatives was reviewed. Environmental topics of discussion included:
    - Boilers No. 6 and 7 will be required to meet the Boiler MACT regulations by September 2007. After reviewing the plant information it appears that by burning a low chlorine content coal (less than 0.1 wt % chlorine) these boilers will avoid further control for HCl. It is anticipated that the existing baghouse will control total selected metals and Hg emissions to rates that are compliant with the Boiler MACT limit. Upgrading the older stoker fired boilers represents a risk as future upgrades for NO_x, SO_2, and/or Hg control may be necessary to comply with other future environmental regulations. The existing baghouse limits the full load operation of units 6 & 7 currently.
    - Alternatives which include replacing the stoker fired boilers with CFBs will result in an improvement in SO_2 emissions from the plant.
    - Improvements to Boilers No. 6 & 7 will trigger NSPS if refurbishment costs exceed 20% of the capital replacement cost at today's costs.
    - Fugitive dust may need to be addressed from a larger coal pile and coal handling system.
    - Cooling tower drift will be addressed when locating additional cooling tower needs. The east cooling tower has not been used recently, however, it has caused concern due to fogging and potential icing of the Business Loop 70 East.
    - CWL was not aware of a City standard for noise limits. Noise control will be included in each alternative.

13. CWL has control area requirements within their system which include operating and spinning reserve requirements which must be synchronized.

14. Michael Schmitz stated that the existing 69 kV transmission system is adequate to handle up to 69 MW of power. This should be adequate to handle the new generation, particularly because the feeders at the plant require up to 30 MW of power. The 69kV switchyard modifications will be limited to changes to accommodate the new units.

15. The electrical switchgear for units No. 6 and 7 may need to be replaced along with electrical infrastructure if they are rehabilitated. Unit 8 is newer, but its switchgear may need to be upgraded as well to extend it for an additional 20 years of life.

16. The system Control Room was discussed. Unless there is a need to relocate this Control Room and the 13.8 kV switchgear adjacent to it from its present location in the turbine hall it will not be relocated.

17. The existing plant is staffed as follows: four shifts, with five operators per shift; four relief operators; 10 full time maintenance personnel; three water chemistry; and four coal handling people. With administrative personnel the total plant staff is about 50.

18. Control system philosophy regarding a distributed control system for new units and the extent of integration of refurbished control systems were discussed. SCI will recommend the extent of remote control recommended with each alternative considered.

End of notes.

City of Columbia
Department of Water and Light
Power Plant Rehabilitation Upgrade and/or Expansion Project

December 21, 2004

Concept Team Meeting

The following discussion relating to the stakeholders, needs, requirements and constraints that would be impacted by a potential project to add power generating capability at the Columbia Power Plant formed the basis for establishing the Alternatives to be evaluated for this study:

Stakeholders:

Internal Stakeholders:

1. Operators
2. Maintenance Staff
3. Railroad
4. Citizens
    - City Council
    - Rate Payers
    - Voters (bonding)
5. Public Works Department
    - Solid waste
6. Water Department
    - Fire water system
7. City Financers (Bonders)

External Stakeholders:

8. Special Interest Groups
    - Green Power – "renewable fuels"
    - Environmental advocates – "no new coal"
9. Regulators
    - MDNR / EPA
    - NERC / MAIN / MISO
10. Utilities (Ameren, Fulton, AECI, others)
11. IPP Developers
12. University of Missouri
13. Industrial Customers (3M, Square D, Oscar Meyers, Quaker.Oats, Gates, others)
14. Neighbors.
    - Runoff through adjacent property
15. MDOT
    - I70 Highway exit near facility (no loss of property expected)

16. Traffic near plant
    - Coal car unloading (currently: 6-8 passes, once per week)
      (Train horn sounded with each move.)
    - Ash Hauling trucks
    - I70 business loop

Requirements:

1. Green Power: goal, which can't impact rte by more than +3%.
    a. 2% 2008
    b. 5% 2012
    c. 20% 2020

   What is the definition of "renewable" fuels?

2. Utilize existing site boundaries.
3. University of Missouri need steam. (Possible teaming project to avoid environmental impact of two new plants relatively close together, 2miles.)
4. Adjacent community/utilities are interested in joint development.
5. NERC – Control area requirements (Operating reserve/spinning reserve. Must be synchronized.)
6. Financial requirements -
    - Bonding Company – What bond amount is achievable? (Seek best available rates & coverage ratio.)
    - Voters – What rate increase might be acceptable? How will it be presented.
    - Purchase Power
    - Unit 8, Gas Boiler, capacity

7. Environmental
    - Existing Boilers have to meet Boiler MACT rules
    - New equipment - New Source Review, (PSP)
    - Asbestos disposition
      (sooner or later)
    - Neighborhood impacts:
        - Noise – (start-up, steam vented, car shaker)
        - Fugitive dust
        - Cooling Tower Drift

8. Constructability
    - Continue operating during construction preferable.
    - Can purchase power during transition.
    - Limited by existing property boundary.
    - Review site plan through assessor web site.

9. Fuel Mix
    - Base Load vs. Control area
    - Availability / price of gas/pipeline
    - Seek more solid fuel balance
    - Opportunity fuels (1% desired)
    - Definition of "renewable" fuel

10. Packaging of Study
    - Economic issues – Purchased vs. building
    - Local impact on jobs, resources
    - Environmental Impacts
    - Opportunity fuels
    - How alternatives impact rates
    - Technology
      (Negative experience at University with early CFB)

Considerations:

- Steam to University of Missouri
  (Reboiler)
- Remove Ash Pond
  (Build Water Tower)
- Coal Handling
  1. Two coal supplies for options with CFB & refurbished stoker boilers
  2. Winter unloading
  3. Onsite storage capacity
  4. Ash disposal
- Transmission
  1. System leaving plant is adequate for new generation capacity

Attachment to the Concept Team Meeting notes, Tuesday, December 21, 2004.

Distribution:

Attendees, File

City of Columbia , Missouri
Department of Water and Light

Power Plant Rehabilitation Upgrade and/or Expansion Project
Concept Team Meeting

Agenda
Tuesday, December 21st, 2004
8:30 am – 2:00 pm

Russ Price	8:30 am	**Introductions**
G. Wilkinson	8:45 am	**Goals & Objectives**
G. Wilkinson	9:00 am	**Report on Project Status** • Schedule
Jim Hodina	9:15 am	**State Needs & Expectations** • List and prioritize stakeholders, needs and constraints.
	9:45 am	**Break**
CWL	10:00 am	**Discuss the Plant Operating Philosophy**
	10:20 am	**Discuss significant Project Features**
Marc Elliott		• Steam Generators
Marc Elliott		• Coal selection, handling and storage
Marc Elliott		• Ash handling and pond
Bruce King		• Electrical systems
Wayne Hanno		• Control systems
Jim Hodina		• Environmental considerations
G. Wilkinson	11:30 am	**Identify Potential Plant Alternatives**
	Noon	**Lunch Break**
G. Wilkinson	1:00 pm	**Focus on Alternatives to be evaluated in study** • Discuss size of new generating capability, fuel, extent of renovation, logistics and location of alternatives. • Review selected Alternatives with respect to expectations.

Adjourn

Appendix F

Environmental Information

Potential Emissions from Proposed Boiler

Table F-1 shows the projected emissions for the three different new boilers considered in this study. The emission rates shown are based on the Foster Wheeler proposal and are representative of other vendor proposals considered in this study.

Table F-1 Potential Emissions of CFB Boilers at 100% Capacity

		100 MW[a] 1800 psi Alt. No. 1	70 MW 900 psi Alt. No. 2 or No. 3 Phase 1	70 MW 900 psi Alt. No. 2 Phase 2
Parameters	**Unit**			
Nominal Output	MW	100	70	70
Nominal Steam Pressure	Psi	1800	1800	900
Coal	Btu/lb (LHV)	11,900.9	11,900.9	11,900.9
Coal	Btu/lb (HHV)	12,450	12,450	12,450
Heat Input (HHV)	MMBtu/hr	983.55	717.12	873.12
Utilization	%	100%	100%	100%
MW	~0.05208 lb/ft^3	28.76	28.76	28.76
Molar Volume	ft^3/lb-mole	385.10	385.10	385.10
Foster Wheeler Proposal				
Fuel Flow	lb/hr	79,000	57,600	70,130
Flue Gas	lb/hr	991,400	722,600	880,000
Stack Temp	F	300	300	300
NO_x, Uncontrolled	lb/MMBtu	0.20	0.20	0.20
NO_x, SNCR	lb/MMBtu	0.10	0.10	0.10
SO_x, CFB Limestone	lb/MMBtu	0.23	0.23	0.23
SO_x, CFB + SDA	lb/MMBtu	0.04	0.04	0.04
PM_{10} BACT	lb/MMBtu	0.015	0.015	0.015
CO	lb/MMBtu	0.15	0.15	0.15
VOC	lb/MMBtu	0.01	0.01	0.01
Ash	lb/hr	22,400	22,401	22,402
Fly Ash @ 80%	lb/hr	17,920	17,921	17,922
Calculated Emissions				
NOx Uncontrolled	lb/hr	196.71	143.42	174.62
NOx, SNCR	lb/hr	98.36	71.71	87.31
SOx, CFB Limestone	lb/hr	226.22	164.94	200.82
SOx, CFB + SDA	lb/hr	39.34	28.68	34.92
PM_{10}	lb/hr	14.75	10.76	13.10
CO	lb/hr	147.53	107.57	130.97
VOC	lb/hr	4.92	3.59	4.37
NOx, Uncontrolled	ton/yr	861.59	628.20	764.85
NOx, SNCR	ton/yr	430.79	314.10	382.43
SOx, CFB Limestone	ton/yr	990.83	722.43	879.58
SOx, CFB + SDA	ton/yr	172.32	125.64	152.97
PM_{10}	ton/yr	64.62	47.11	57.36
CO	ton/yr	646.19	471.15	573.64
VOC	ton/yr	21.54	15.70	19.12

[a] Calculations were made on the basis of a nominal 100 MW net plant output.

Potential Emissions for Project Alternatives

The projected emissions of the three project alternatives are based on future projected annual average emission rates for each source. For existing sources, this is based on the emission factors used in the facility's recently submitted Title V Operating Permit Renewal Applications. For the new boilers, this is based on the data supplied by the vendors for the boilers and control equipment. The projected emissions of each individual project are shown in Table A-2 through Table A-4.

Table F-2 Alternative No. 1: No Operating Restrictions

	NO_X	SO_2	SO_2	PM_{10}	CO	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Increases						
100 MW CFB	SNCR	Limestone	Lime + SDA	Baghouse		
	430.79	990.83	172.32	64.62	646.19	21.54
Decreases						
Boiler 6	-138.25	-372.12	-372.12	-0.32	-48.10	-0.48
Boiler 7	-172.66	-434.85	-434.85	-0.39	-59.54	-0.60
Total Increases	430.79	990.83	172.32	64.62	646.19	21.54
Total Decreases	-310.91	-806.97	-806.97	-0.71	-107.64	-1.08
Net Change	**119.88**	**183.86**	**-634.65**	**63.91**	**538.55**	**20.46**
PSD Applicability	Yes	Yes	No	Yes	Yes	No

Table F-3 Alternative No. 2: No Operating Restrictions

	NO_x	SO_2	SO_2	PM_{10}	CO	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
PHASE I						
Increases						
70 MW, 1800 PSI	SNCR	Limestone	Lime + SDA	Baghouse		
	314.10	722.43	125.64	47.11	471.15	15.70
PSD Applicability	Yes	Yes	Yes	Yes	Yes	No
PHASE II						
Increases						
70 MW, 900 PSI	SNCR	Limestone	Lime + SDA	Baghouse		
	382.43	879.58	152.97	57.36	573.64	4.37
Decreases						
Boiler No. 6	-138.25	-372.12	-372.12	-0.32	-48.10	-0.48
Boiler No. 7	-172.66	-434.85	-434.85	-0.39	-59.54	-0.60
Boiler No. 8	-0.29	0.00	0.00	-0.01	-0.09	-0.01
Total Increases	382.43	879.58	152.97	57.36	573.64	4.37
Total Decreases	-311.20	-806.97	-806.97	-0.72	-107.73	-1.09
Net Change	**71.23**	**72.61**	**-654.00**	**56.65**	**465.91**	**18.04**
PSD Applicability	Yes	Yes	No	Yes	Yes	No

Table F-4 Alternative No. 3: No Operating Restrictions

	NO_x	SO_2	SO_2	PM_{10}	CO	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Increases						
70 MW, 1800 psi CFB	SNCR	Limestone	Lime + SDA	Baghouse		
	314.10	722.43	125.64	47.11	471.15	15.70
Decreases						
NONE						
Total Increases	314.10	722.43	125.64	47.11	471.15	15.70
Total Decreases	0.00	0.00	0.00	0.00	0.00	0.00
Net Change	**314.10**	**722.43**	**125.64**	**47.11**	**471.15**	**15.70**
PSD Applicability	Yes	Yes	Yes	Yes	Yes	No