DOE/CE/15604--T3

COAL AIR TURBINE "CAT" PROGRAM

INVENTION 604

BY

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THIRD QUARTER PROJECT REPORT (April-June 1995)

JULY 31, 1995

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1.0 Project Objective

The primary objective of this "CAT" project is to complete a conceptual design of this unique new combination of existing technology with cost estimates to show that the "CAT" system offers the economic incentive with low technical risk for a plant to be built which will demonstrate its viability.

The technologies involved in the components of a "CAT" plant are proven, and the integration of the components into a complete plant is the only new developmental activity involved.

Industry and the Federal General Services Administration (GSA), require the demonstration of a "commercial plant" before the viability of a new concept is accepted. To satisfy this requirement the construction of a plant of commercially viable size in excess of 15 MW if cogeneration and above 30 MW if all power, is proposed. This plant will produce economical power and heat for the owner. The plant will operate for a full commercial life and continue as an operating demonstration of the viability of the technology, gathering long term life and maintenance data, all adding to the credibility of the concept.

2.0 Project Overview

The "CAT" System is an innovative new use of existing technology in a unique configuration which will be more cost effective than competitive systems.

In layman's language a Coal Air Turbine "CAT" generates electric power or cogenerates electric power and heat for process use from the burning of coal. Cogeneration, the sequential generation of electricity and heat, is more efficient and economical than their separate production.

Commercial "CAT" power plants with outputs up to 100 MW will be the outcome of this program. The "CAT" plants are expected to be 10% more cost effective than current state of the art plants with the same output.

The major components of "CAT" plants are an air turbine, a heater of compressed air, a coal combustion system, means to recover waste heat and a steam turbine when appropriate. An air turbine is the same as a gas turbine except that it runs on hot air.

The "CAT" plant burns raw coal in a fluid bed at atmospheric pressure. The air turbine operates on clean compressed air heated inside tubes immersed in the fluid bed, thus it is called an "Air Turbine" and the cycle is called a Coal Air Turbine, or "CAT", cycle. Heat is recovered from the exhaust of the air turbine and the coal combustor, to produce steam for process use and / or for driving a steam turbine to generate more power. In a version producing only electric power, the steam is expanded in a steam turbine, condensed and recirculated, instead of the steam being exported for an external use.

Gas turbines now built operate at hotter temperatures than air heaters can produce and if operated at the lower temperatures which air heaters can deliver would be less efficient and more costly. Thus, gas turbines built in the past, which operate with a turbine inlet temperature matching the temperature capability of fluid bed air heaters, are more suitable for "CAT".

Until new gas turbines are again made available for temperatures suitable for air heaters, surplus used gas turbines will be purchased, reconditioned and modified to use hot air from the air heater instead of from combustors.

The operation of fluid bed air heaters has been proven by DOE and others in many tests extending over twenty years. Many metal alloys in many configurations of fluid bed air heaters have been operated for thousands of hours. Suitable alloys and arrangements have been identified. Manufacturers now offer air heaters for the proposed operating conditions with normal commercial warranties. A Circulating Fluid Bed (CFB) combustor will be used to burn the coal. The CFB emits the least sulfur, oxides of nitrogen and particulate material of all the coal combustion systems and meets the most rigorous emission regulations.

In "CAT" cycles, heat can be recovered from the clean, breathable hot air exhausted by the air turbine for production of steam for coal drying, paper drying, building heat or more power generation.

The following features will result in the production of low cost power by a "CAT" plant:

1. Inexpensive, plentiful coal fuel.
2. Simple efficient coal combustion at atmospheric pressure. (Not

- pressurized fluid bed or gasification.)
3. Simple emission control by limestone and baghouses.
 4. A steam turbine for power generation is unnecessary for cogeneration (but may be used if advantageous).
 5. The low cost, low temperature used gas turbines are readily available.

Where coal is competitive, a "CAT" plant will be more economical at capacities above 10 MW for cogeneration and for power generation at capacities above 30MW.

3.0 Project Progress Summary

Progress continues to be made on all of the technical tasks in the project. However, it has not yet been possible to obtain definite commitments for the conceptual design and cost estimates for the Gas Turbine modifications nor the Fluid Bed Combustion System. Active discussions are in progress with several contractors to fill this requirement. It may be necessary to extent the project end date past September, 1995.

Task 1 was to select an Architect Engineer for the primary engineering work. This contract was signed with Gilbert/Commonwealth for the work defined in the RFP. Gilbert has also agreed to perform any additional required work identified during the course of the project. This would be at appropriate additional cost.

Task 2 is the Conceptual Design and Cost Estimating work which is being done by Gilbert/Commonwealth. Foster-Pegg Associates(FPA) has produced most of the additional clarifying documents as needed by Gilbert. Gilbert has prepared the major elements for the conceptual design for each of the three "CAT" plants and for doing the cost estimation. However, Gilbert has now halted work until details of the Gas Turbine Modifications and the Fluid Bed Combustion system design are available and the cost details are firm for these major components. Cost comparisons between reference cases and the three "CAT" cases are essentially complete awaiting the availability of Gas Turbine and Fluid Bed Combuster details.

Task 3 is the Conceptual Design of the Gas Turbine Modifications. FPA has prepared a description of the modifications required and the design approach to be use. This description has split the work into eight separate pieces in order to attract interest from more contractors having only certain of the skills needed. Discussions are continuing with several contractors to obtain the best estimates of all elements of this work. Mr. Foster-Pegg's Houston trip report is attached. In Houston, discussions were held with four contractors in regard to cost estimates for both the Design of these modifications and for the actual modification work. This trip report is included as an attachment to this report.

Task 26 is the Combustion System Design which includes the Circulating Fluid Bed and the Air Heater. Discussions with Combustion Engineering and with Tampella Power have been terminated since neither is able to participate at this time. Struthers will still do the Air Heater cost estimation. Foster-Pegg Associates is continuing to contact potential contractors. During the Houston trip, discussions were held with a representative of Babcock and Wilcox concerning a proposal from B&W for the Combustion System.

Task 4 is the Used Gas Turbine Survey. This Survey is about complete. There has been a good market in the General Electric and Westinghouse turbines of the size required for this project. During the Houston trip, meetings with Power Systems Investment Group revealed that there were 20 Used GE Frame 5's available in the Houston area.

Task 5 is the Competitive Analysis to be done as part of the Task 2 work by Gilbert. FPA has prepared a report for use in this analysis which shows a comparison of the efficiencies of "CAT" cycle plants and all steam cogeneration plants. Gilbert Commonwealth is prepared to complete this analysis as soon as the details are available on the Gas Turbine and the

Combustion System.

4.0 Project Task Reports

4.1 Task 1 - Selection of AE

4.1.1 Task Description

This task required: 1) Potential Contractor identification, 2) Contractor discussions to determine interest and capability, 3) Preparation of an RFP with detailed work scope description 4) Soliciting bids from qualified contractors, 5) Selection of the project AE.

4.1.2 Task Status and Activity in the Current Quarter

This AE contract has been signed for the work defined. The contractor has agreed to perform additional tasks should unforeseen but required work be identified as the project progresses. Any new work would be at additional cost.

4.2 Task 2 - Conceptual Design "CAT"

4.2.1 Task Description

The purpose of this task is to prepare a conceptual design and a cost estimate of a "CAT" plant on a hypothetical site, and to compare the capital cost and cost of power and steam from the "CAT" plant with power produced by alternate power plants on the same site.

Three "CAT" plant configurations will be investigated as follows:

Cycle A - Condensing "CAT"

- "Wet" condenser tower (or river) cooling
- Steam injection for peaking
- Coal fuel.

Cycle B - Cogeneration "CAT"

- Back-pressure steam turbine.
- Steam export and steam injection.
- Coal fuel.

Cycle C - Cogeneration "CAT"

- No steam turbine.
- Steam export and steam injection.
- Waste coal fuel.

Deliverables will include:

- Site layout drawings
- Equipment layout drawings
- Estimates of Total Plant Costs
- Estimates of the cost of power
- Final report

The final report will be the main report developed in the project and will include information developed/produced in other tasks and by Foster-Pegg Associates.

4.2.2 Task Status and Activity in the Current Quarter

Gilbert Commonwealth has completed the work as planned for this quarter but without firm details on the Gas Turbine and on the Fluid Bed Combustion system. Conceptual designs for each of the three "CAT" configurations need only to have the Gas Turbine and Combustion system detail plugged in. Capital costs also for each configuration need only these details to finalize. The comparison of capital costs and cost of power and steam for the three systems are complete except for details of these two systems.

4.2.3 Activity Planned in the Next Quarter

Gilbert will not expend additional funds this quarter until details of the Gas Turbine and Combustion Systems are available to finalize their planned report.

4.3 Task 3 - Conceptual Design of Gas Turbine Modifications

4.3.1 Task Description

This task requires: 1)Identifying qualified contractors, 2)Discussing the requirement with prospective contractors, 3)Preparing a RFP to solicit bids, 4)Requesting bids, 5)Selecting a contractor

4.3.2 Task Status and Activity in the Current Quarter

FPA has prepared discussion and description including conceptual layouts of the modifications required. This report has specifically split the work required by the type of specialty known to be available from qualified contractors. As many as eight unique skills are required. Contractors with which discussions are in progress are: Revak Turbomachinery Services; Hickman Industries; Boyce Engineering International; Gas Path Technology; Sermatechs(Heat barrier coatings).

FPA has documented control and starting systems concepts, as well as the dynamics of the "CAT" control system components including the overspeed protection of the air turbine.

4.3.3 Activity Planned in the Next Quarter

Discussions will continue to identify contractors for each unique requirement. Conceptual designs and cost estimates will be solicited for each modification required.

4.4 Task 26 - Combustion System Conceptual Design

4.4.1 This task was added during the first quarter in order to obtain more detailed design information and more accurate cost estimates on this very vital part of the "CAT" plant. This would include conceptual designs, performance and cost estimates of the Circulating Fluid Bed and Air Heater components for the 3 cycles being investigated. Information requested for each cycle includes:

Specifications.

Drawings for layout purposes.

Costs for inclusion in the overall cost estimates.

Performance.

Descriptive Material for inclusion in a report.

This request includes all primary components and auxiliary elements needed for the combustion system.

4.4.2 Task Status and Activity in the Current Quarter

Tampella Power Corporation will not be able to perform this task. Struthers Wells Corporation still is retained (for \$3000) to provide the Air Heater part of the task. As shown in the Houston trip report, Babcock & Wilcox may be willing to provide a proposal for the Combustor.

4.4.3 Activity Planned in the next Quarter

FPA will be discussing this task with prospective Contractors to negotiate details of their participation. Pyropower of San Diego will be one of the contractors with whom discussions are planned.

4.5 Task 4 - Used Gas Turbine Survey

4.5.1 Task Description

The purpose of this task is to survey the availability and cost of used gas turbines. The scope of information desired is as follows:

- . Type and number of gas turbines offered for resale by year.
- . Type and number of gas turbines resold by year.
- . Sources of used gas turbines, by country, by industry.
- . Resale price range of gas turbines by type.
- . Cost of refurbishing resold gas turbines by type.
- . Cost of moving and installing pre-owned gas turbines by type.
- . List of vendors offering pre-owned gas turbines.
- . Purchasers of preowned gas turbines.
- . Impediments to the use of preowned gas turbines
Insurance, Financial, Utility commissions, etc.

4.5.2 Task Status and Activity in Current Quarter

It continues to be encouraging to find that there is an active market in the used turbines of the type suitable for "CAT" plants. There should be no problem in obtaining as many turbines as will be needed for "CAT" plants. PSIG has identified 20 GE Frame 5s available in the Houston area alone.

4.5.3 Activity Planned in the next Quarter

Information obtained will be consolidated for inclusion into the final project report.

4.6 Task 5 - CAT Competitive Analysis

4.6.1 Task Description

This task is to provide comparative results to be expected with a "CAT" plant relative to competitive alternative type plants.

4.6.2 Task Status and Activity in the Current Quarter

FPA has prepared a report showing a "Comparison of the Efficiencies of "CAT" and all Steam Cogeneration Plants. The final competitive analysis must show all costs over the expected life of a plant. This includes all design, installation, operational, and other plant ownership expenses. Gilbert Commonwealth has prepared this analysis and needs only to plug in the Turbine and Combustor details to be made available.

4.11 Task 10 - Quarterly/Final Reports to DOE

4.11.1 Task Description

This task is to provide quarterly progress reports and a final report to DOE. As per the current schedules these reports will be as follows:

- . 1st Quarter Report for Oct-Dec 1994 due 1/31/95 (Delivered)
- . 2nd Quarter Report for Jan-Mar 1995 due 4/30/95
- . 3rd Quarter Report for Apr-Jun 1995 due 7/31/95
- . 4th Quarter Report for Jul-Sep 1995 due 10/31/95
- . Final Report due per current schedule on 12/29/95

Per the current project schedule, this project will be completed in September, 1995 so that the Final Report will be due 90 days following the end of the project. Since Gas Turbine and Fluid Bed Combustion System design and estimation details are still being investigated, it is possible that the project may need to be extended past September, 1995.

5.0 Financial Status

The plan submitted November 11, 1994 has continued to be modified to reflect the slower use of funds due to Gilbert/Commonwealth schedule change dictated by the delay in firming up Contractors for several key elements of the project. It is still estimated that the project can be completed by September, 1995 as planned. However, should additional time be needed the plan will be modified accordingly. This section shows the Sources and Uses of Funds Summary and the DOE Advance Payment Request Experience. This advanced payment process has been very satisfactory. Also provided in this section are the detailed spreadsheets which show the experience for the first quarter Oct-Dec 1994, the second quarter Jan-Mar 1995, and the third quarter Apr-Jun 1995.

FPSAUOF

SOURCES AND USES OF FUNDS SUMMARY THRU ^{JUNE} APRIL 30, 1995

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Date	DOE	Fund Source PSIG	Total	Project Expenses Foster-Pegg Johnson Gilbert	Expense Total	Funds Received Less Expense
12/05/94		6114.00	6114.00			
12/19/94		6250.00	6250.00			
01/03/95		7991.00	7991.00			
01/16/95		12556.00	12556.00			
02/06/95		16028.00	16028.00			
04/03/95		13203.00	13203.00			
04/18/95		8131.00	8131.00			
06/24/95		12096.00	12096.00			
12/19/94				5000.00		
1/06/95					2531.50	
2/09/95				13040.50	308.00	
3/06/95				5095.70	1007.30	
4/12/95						13400.00
4/20/95					746.00	
5/24/95					626.00	
6/07/95						13400.00
6/26/95					335.85	
TOTAL	82369.00	.00	82369.00	25136.20	6154.65	26800.00
						56090.85
						26278.15

* R.H.Foster-Pegg has earned but not withdrawn an additional \$12921.15 as shown in the Payee Report provided.

DOE ADVANCE PAYMENT REQUEST EXPERIENCE

Request Number	For Period	Date Sent	Date Received	Amount	Days Request in Process
1	10/6-11/6/94	10/11/94	12/5/94	6114.00	55
2	11/7-12/7/94	10/27/94	12/19/94	6250.00	53
3	12/8-1/6/95	11/14/94	1/3/95	7991.00	50
4	1/7-2/5/95	12/7/94	1/16/95	12556.00	40
5	2/6-3/6/95	12/29/94	2/6/95	16028.00	39
6	3/7-4/6/95	2/20/95	4/3/95	13203.00	41
7	4/7-5/5/95	3/7/95	4/18/95	8131.00	42
8	6/1-6/30/95	5/24/95	6/24/95	12096.00	31

Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,

4)Other such as telephone,copying,postage,office expense

PAYEE	TASK	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION	PAYMENT DATE	AMOUNT
Total:						\$0.00	0.0				\$0.00
Gilbert/C	2	04	12	95		\$13400.00		3	Conceptual Design "CAT"	4/12/95	\$13400.00
		05	20	95		\$13400.00		3	Conceptual Design "CAT"	5/20/95	\$13400.00
Total:						\$26800.00	0.0				\$26800.00
R.W.Foster-Pegg	1	10	31	94		\$474.00	15.8	1	A&E Selection		
			31	94		\$25.00		2	Travel		
			31	94		\$98.50		4	A&E Selection Support		
	10	01	31	95		\$60.00	2.0	1	Rpts to DOE		
		04	30	95		\$15.00		2	DOE Reports		
	2	01	31	95		\$2643.00	88.1	1	Conceptual Design "CAT"		
			31	95		\$50.00		2	Conceptual Design "CAT"		
			31	95		\$269.00		4	Conceptual Design "CAT"		
		02	28	95		\$3021.00	100.7	1	Conceptual Design "CAT"		
			28	95		\$256.25		2	Conceptual Design "CAT"		
			28	95		\$223.00		4	Conceptual Design "CAT"		
		03	31	95		\$3465.00	115.5	1	Conceptual Design "CAT"		
			31	95		\$75.00		2	Conceptual Design "CAT"		
			31	95		\$210.00		4	Conceptual Design "CAT"		
		04	30	95		\$2430.00	81.0	1	Conceptual Design "CAT"		
			30	95		\$269.00		2	Conceptual Design "CAT"		
			30	95		\$75.00			Conceptual Design "CAT"		
		05	31	95		\$2010.00	67.0	1	Conceptual Design "CAT"		
			31	95		\$75.00		2	Conceptual Design "CAT"		
			31	95		\$261.15		4	Conceptual Design "CAT"		
		06	30	95		\$769.00	25.6	1	Conceptual Design "CAT"		
		10	31	94		\$2492.00	83.1	1	Conceptual Design "CAT"		
			31	94		\$127.00		2	Travel		
			31	94		\$27.00		4	Task 2 Support		
		11	30	94		\$2984.00	99.5	1	Conceptual Design "CAT"		
			30	94		\$150.00		4	Task 2 Support		
		12	30	94		\$2014.00	67.1	1	Conceptual Design "CAT"		
			30	94		\$263.00		2	Travel		
			30	94		\$269.00		4	Task 2 Other support		
	26	01	31	95		\$342.00	11.4	1	Combustion System consulting		
			31	95		\$50.00		4	Combustion System Consulting		
		02	28	95		\$330.00	11.0	1	Combustion System		
			28	95		\$41.45		4	Combustion System		
		03	31	95		\$330.00	11.0	1	Combustion System		
			31	95		\$50.00		4	Combustion System		
		04	30	95		\$399.00	13.3	1	Combustion System		
			30	95		\$50.00		4	Combustion System		
		05	31	95		\$399.00	13.3	1	Combustion System		
		12	30	94		\$332.00	11.1	1	Combustion System Consulting		
			30	94		\$40.00		4	Task 26 other support		
	3	01	31	95		\$600.00	20.0	1	Conceptual Des.GT Mods		
		02	28	95		\$898.00	29.9	1	Conceptual Design GT Mods		
		03	31	95		\$555.00	18.5	1	Conceptual Des.GT Mods		
		05	31	95		\$819.00	27.3	1	Gas Turbine Design		
		06	30	95		\$554.00		2	Conceptual Des.GT Mods		
		10	31	94		\$1575.00	52.5	1	Conceptual Design GT Mods		
			31	94		\$325.00		4	Task 2 Support		
		11	30	94		\$1452.00	48.4	1	Conceptual Design GT Mods		

5.2 *07/19/95(n)* PAYEE REPORT FOR FP604
Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,
4)Other such as telephone,copying,postage,office expense

PAYEE	TASK	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION	PAYMENT DATE	AMOUNT
R.W.Foster-Pegg	3	11	30	94		\$124.00	4		Task 4 Other Support		
	4	01	31	95		\$300.00	2.0	1	Used Gas Turbine Survey		
			31	95		\$60.00		2	Used Gas Turbine Survey		
			31	95		\$35.00		4	Used Gas Turbine Survey		
		02	28	95		\$297.00	9.9	1	Used Gas Turbine Survey		
			28	95		\$29.00		4	Used Gas Turbine Survey		
		04	30	95		\$111.00	3.7	1	Used Gas Turbine Survey		
		11	30	94		\$477.00	15.9	1	Used Gas Turbine Survey		
			30	94		\$50.00		4	Task 4 Other Support		
		12	30	94		\$298.00	9.9	1	Used Gas Turbine Survey		
			30	94		\$35.00		4	Task 4 other support		
P		02	09	95						02/09/95	\$13040.50
		03	06	95						03/06/95	\$5095.70
		12	19	94						12/19/94	\$5000.00
Total:						\$36057.35	1054.5				\$23136.20
W.H.Johnson	1	10	31	94		\$120.00	4.0	1	A&E Selection		
			31	94		\$12.50		4	A&E Selection Support		
	10	01	31	95		\$300.00	10.0	1	Reports to DOE		
			31	95		\$25.00		2	Reports to DOE		
			31	95		\$67.00		4	Reports to DOE		
		04	30	95		\$360.00	12.0	1	DOE Reports		
			30	95		\$10.00		2	DOE Reports		
			30	95		\$67.00		4	DOE Reports		
		06	30	95		\$75.00	2.5	1	DOE Reports		
	2	01	31	95		\$396.00	13.2	1	Conceptual Design "CAT"		
		02	28	95		\$624.00	20.8	1	Conceptual Design "CAT"		
			28	95		\$4.75		2	Conceptual Design "CAT"		
			28	95		\$46.00		4	Conceptual Design "CAT"		
		03	31	95		\$180.00	6.0	1	Conceptual Design "CAT"		
			31	95		\$59.00		4	Conceptual Design "CAT"		
		05	31	95		\$180.00	6.0	1	Conceptual Design "CAT"		
			31	95		\$5.85		4	Conceptual Design "CAT"		
		10	31	94		\$514.00	17.1	1	Conceptual Design "CAT"		
		11	30	94		\$616.00	20.5	1	Conceptual Design "CAT"		
		12	30	94		\$416.00	13.9	1	Conceptual Design "CAT"		
	26	01	31	95		\$60.00	2.0	1	Combustion System Consulting		
		02	28	95		\$69.00	2.3	1	Combustion System		
			28	95		\$8.55		4	Combustion System		
		03	31	95		\$69.00	2.3	1	Combustion System		
		12	30	94		\$68.00	2.3	1	Combustion System Support		
	3	02	28	95		\$186.00	6.2	1	Conceptual Design GT Mods		
		03	31	95		\$45.00	1.5	1	Conceptual Des.GT Mods		
		10	31	94		\$325.00	10.8	1	Conceptual Design GT Mods		
		11	30	94		\$300.00	10.0	1	Conceptual Design GT Mods		
	4	01	31	95		\$60.00	2.0	1	Used Gas Turbine Survey		
		02	28	95		\$63.00	2.1	1	Used Gas Turbine Survey		
			28	95		\$6.00		4	Used Gas Turbine Survey		
		03	31	95		\$360.00	12.0	1	Used Gas Turbine Survey		
			31	95		\$33.00		4	Used Gas Turbine Survey		
		04	30	95		\$189.00	6.3	1	Used Gas Turbine Survey		
		05	31	95		\$150.00	5.0	1	Used Gas Turbine Survey		
		11	30	94		\$98.00	3.3	1	Used Gas Turbine Survey		
		12	30	94		\$62.00	2.1	1	Used Gas Turbine Survey		
P		01	07	95						01/07/95	\$2531.50

Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,
4)Other such as telephone,copying,postage,office expense

PAYEE	TASK	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION	PAYMENT DATE	AMOUNT
W.H.Johnson	P	02	10	95						02/10/95	\$908.00
		03	07	95						03/07/95	\$1007.30
		04	20	95						4/20/95	\$746.00
		05	23	95						5/23/95	\$626.00
		06	26	95						6/26/95	\$335.85

Total:						\$6229.65	196.2				\$6154.65

MO	DA	YR	PAYEE	TASK	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
Total:						\$0.00	0.0		
01	31	95	R.W.Foster-Pegg	10		\$60.00	2.0	1	Rpts to DOE
	31	95		2		\$2643.00	88.1	1	Conceptual Design "CAT"
	31	95				\$50.00		2	Conceptual Design "CAT"
	31	95				\$269.00		4	Conceptual Design "CAT"
	31	95		26		\$342.00	11.4	1	Combustion System consulting
	31	95				\$50.00		4	Combustion System Consulting
	31	95		3		\$600.00	20.0	1	Conceptual Des.GT Mods
	31	95		4		\$300.00	2.0	1	Used Gas Turbine Survey
	31	95				\$60.00		2	Used Gas Turbine Survey
	31	95				\$35.00		4	Used Gas Turbine Survey
	31	95	W.H.Johnson	10		\$300.00	10.0	1	Reports to DOE
	31	95				\$25.00		2	Reports to DOE
	31	95				\$67.00		4	Reports to DOE
	31	95		2		\$396.00	13.2	1	Conceptual Design "CAT"
	31	95		26		\$60.00	2.0	1	Combustion System Consulting
	31	95		4		\$60.00	2.0	1	Used Gas Turbine Survey
Total:						\$5317.00	150.7		
02	28	95	R.W.Foster-Pegg	2		\$3021.00	100.7	1	Conceptual Design "CAT"
	28	95				\$256.25		2	Conceptual Design "CAT"
	28	95				\$223.00		4	Conceptual Design "CAT"
	28	95		26		\$330.00	11.0	1	Combustion System
	28	95				\$41.45		4	Combustion System
	28	95		3		\$898.00	29.9	1	Conceptual Design GT Mods
	28	95		4		\$297.00	9.9	1	Used Gas Turbine Survey
	28	95				\$29.00		4	Used Gas Turbine Survey
	28	95	W.H.Johnson	2		\$624.00	20.8	1	Conceptual Design "CAT"
	28	95				\$4.75		2	Conceptual Design "CAT"
	28	95				\$46.00		4	Conceptual Design "CAT"
	28	95		26		\$69.00	2.3	1	Combustion System
	28	95				\$8.55		4	Combustion System
	28	95		3		\$186.00	6.2	1	Conceptual Design GT Mods
	28	95		4		\$63.00	2.1	1	Used Gas Turbine Survey
	28	95				\$6.00		4	Used Gas Turbine Survey
Total:						\$6103.00	182.9		
03	31	95	R.W.Foster-Pegg	2		\$3465.00	115.5	1	Conceptual Design "CAT"
	31	95				\$75.00		2	Conceptual Design "CAT"
	31	95				\$210.00		4	Conceptual Design "CAT"
	31	95		26		\$330.00	11.0	1	Combustion System
	31	95				\$50.00		4	Combustion System
	31	95		3		\$555.00	18.5	1	Conceptual Des.GT Mods
	31	95	W.H.Johnson	2		\$180.00	6.0	1	Conceptual Design "CAT"
	31	95				\$59.00		4	Conceptual Design "CAT"
	31	95		26		\$69.00	2.3	1	Combustion System
	31	95		3		\$45.00	1.5	1	Conceptual Des.GT Mods
	31	95		4		\$360.00	12.0	1	Used Gas Turbine Survey
	31	95				\$33.00		4	Used Gas Turbine Survey
Total:						\$5431.00	166.8		

5.3 *07/19/95(n)* MONTH REPORT FOR FP604
Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,
4)Other such as telephone,copying,postage,office expense

MO	DA	YR	PAYEE	TASK	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
04	12	95	Gilbert/C	2		\$13400.00		3	Conceptual Design "CAT"
	30	95	R.W.Foster-Pegg	10		\$15.00		2	DOE Reports
	30	95		2		\$2430.00	81.0	1	Conceptual Design "CAT"
	30	95				\$269.00		2	Conceptual Design "CAT"
	30	95				\$75.00			Conceptual Design "CAT"
	30	95		26		\$399.00	13.3	1	Combustion System
	30	95				\$50.00		4	Combustion System
	30	95		4		\$111.00	3.7	1	Used Gas Turbine Survey
	30	95	W.H.Johnson	10		\$360.00	12.0	1	DOE Reports
	30	95				\$10.00		2	DOE Reports
	30	95				\$67.00		4	DOE Reports
	30	95		4		\$189.00	6.3	1	Used Gas Turbine Survey
Total:						\$17375.00	116.3		
05	20	95	Gilbert/C	2		\$13400.00		3	Conceptual Design "CAT"
	31	95	R.W.Foster-Pegg	2		\$2010.00	67.0	1	Conceptual Design "CAT"
	31	95				\$75.00		2	Conceptual Design "CAT"
	31	95				\$261.15		4	Conceptual Design "CAT"
	31	95		26		\$399.00	13.3	1	Combustion System
	31	95		3		\$819.00	27.3	1	Gas Turbine Design
	31	95	W.H.Johnson	2		\$180.00	6.0	1	Conceptual Design "CAT"
	31	95				\$5.85		4	Conceptual Design "CAT"
	31	95		4		\$150.00	5.0	1	Used Gas Turbine Survey
Total:						\$17300.00	118.6		
06	30	95	R.W.Foster-Pegg	2		\$769.00	25.6	1	Conceptual Design "CAT"
	30	95		3		\$554.00		2	Conceptual Des.GT Mods
	30	95	W.H.Johnson	10		\$75.00	2.5	1	DOE Reports
Total:						\$1398.00	28.1		
10	31	94	R.W.Foster-Pegg	1		\$474.00	15.8	1	A&E Selection
	31	94				\$25.00		2	Travel
	31	94				\$98.50		4	A&E Selection Support
	31	94		2		\$2492.00	83.1	1	Conceptual Design "CAT"
	31	94				\$127.00		2	Travel
	31	94				\$27.00		4	Task 2 Support
	31	94		3		\$1575.00	52.5	1	Conceptual Design GT Mods
	31	94				\$325.00		4	Task 2 Support
	31	94	W.H.Johnson	1		\$120.00	4.0	1	A&E Selection
	31	94				\$12.50		4	A&E Selection Support
	31	94		2		\$514.00	17.1	1	Conceptual Design "CAT"
	31	94		3		\$325.00	10.8	1	Conceptual Design GT Mods
Total:						\$6115.00	183.3		
11	30	94	R.W.Foster-Pegg	2		\$2984.00	99.5	1	Conceptual Design "CAT"
	30	94				\$150.00		4	Task 2 Support
	30	94		3		\$1452.00	48.4	1	Conceptual Design GT Mods
	30	94				\$124.00		4	Task 4 Other Support
	30	94		4		\$477.00	15.9	1	Used Gas Turbine Survey
	30	94				\$50.00		4	Task 4 Other Support
	30	94	W.H.Johnson	2		\$616.00	20.5	1	Conceptual Design "CAT"
	30	94		3		\$300.00	10.0	1	Conceptual Design GT Mods

5.3 *07/19/95(n)* MONTH REPORT FOR FP604
 Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,
 4)Other such as telephone,copying,postage,office expense

MO	DA	YR	PAYEE	TASK	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
11	30	94	W.H.Johnson	4		\$98.00	3.3	1	Used Gas Turbine Survey
Total:						\$6251.00	197.6		
12	30	94	R.W.Foster-Pegg	2		\$2014.00	67.1	1	Conceptual Design "CAT"
	30	94				\$263.00		2	Travel
	30	94				\$269.00		4	Task 2 Other support
	30	94		26		\$332.00	11.1	1	Combustion System Consulting
	30	94				\$40.00		4	Task 26 other support
	30	94		4		\$298.00	9.9	1	Used Gas Turbine Survey
	30	94				\$35.00		4	Task 4 other support
	30	94	W.H.Johnson	2		\$416.00	13.9	1	Conceptual Design "CAT"
	30	94		26		\$68.00	2.3	1	Combustion System Support
	30	94		4		\$62.00	2.1	1	Used Gas Turbine Survey
Total:						\$3797.00	106.4		
=====									
Total:						\$69087.00	1250.7		

Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,

4)Other such as telephone,copying,postage,office expense

TASK	PAYEE	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION

Total:						\$0.00	0.0		

1	R.W.Foster-Pegg	10	31	94		\$474.00	15.8	1	A&E Selection
			31	94		\$25.00		2	Travel
			31	94		\$98.50		4	A&E Selection Support
	W.H.Johnson	10	31	94		\$120.00	4.0	1	A&E Selection
			31	94		\$12.50		4	A&E Selection Support

Total:						\$730.00	19.8		

10	R.W.Foster-Pegg	01	31	95		\$60.00	2.0	1	Rpts to DOE
			04	30	95	\$15.00		2	DOE Reports
	W.H.Johnson	01	31	95		\$300.00	10.0	1	Reports to DOE
			31	95		\$25.00		2	Reports to DOE
			31	95		\$67.00		4	Reports to DOE
			04	30	95	\$360.00	12.0	1	DOE Reports
			30	95		\$10.00		2	DOE Reports
			30	95		\$67.00		4	DOE Reports
			06	30	95	\$75.00	2.5	1	DOE Reports

Total:						\$979.00	26.5		

2	Gilbert/C	04	12	95		\$13400.00		3	Conceptual Design "CAT"
			05	20	95	\$13400.00		3	Conceptual Design "CAT"
	R.W.Foster-Pegg	01	31	95		\$2643.00	88.1	1	Conceptual Design "CAT"
			31	95		\$50.00		2	Conceptual Design "CAT"
			31	95		\$269.00		4	Conceptual Design "CAT"
			02	28	95	\$3021.00	100.7	1	Conceptual Design "CAT"
			28	95		\$256.25		2	Conceptual Design "CAT"
			28	95		\$223.00		4	Conceptual Design "CAT"
			03	31	95	\$3465.00	115.5	1	Conceptual Design "CAT"
			31	95		\$75.00		2	Conceptual Design "CAT"
			31	95		\$210.00		4	Conceptual Design "CAT"
			04	30	95	\$2430.00	81.0	1	Conceptual Design "CAT"
			30	95		\$269.00		2	Conceptual Design "CAT"
			30	95		\$75.00			Conceptual Design "CAT"
			05	31	95	\$2010.00	67.0	1	Conceptual Design "CAT"
			31	95		\$75.00		2	Conceptual Design "CAT"
			31	95		\$261.15		4	Conceptual Design "CAT"
			06	30	95	\$769.00	25.6	1	Conceptual Design "CAT"
			10	31	94	\$2492.00	83.1	1	Conceptual Design "CAT"
			31	94		\$127.00		2	Travel
			31	94		\$27.00		4	Task 2 Support
			11	30	94	\$2984.00	99.5	1	Conceptual Design "CAT"
			30	94		\$150.00		4	Task 2 Support
			12	30	94	\$2014.00	67.1	1	Conceptual Design "CAT"
			30	94		\$263.00		2	Travel
			30	94		\$269.00		4	Task 2 Other support
	W.H.Johnson	01	31	95		\$396.00	13.2	1	Conceptual Design "CAT"
			02	28	95	\$624.00	20.8	1	Conceptual Design "CAT"
			28	95		\$4.75		2	Conceptual Design "CAT"
			28	95		\$46.00		4	Conceptual Design "CAT"
			03	31	95	\$180.00	6.0	1	Conceptual Design "CAT"
			31	95		\$59.00		4	Conceptual Design "CAT"
			05	31	95	\$180.00	6.0	1	Conceptual Design "CAT"

TASK	PAYEE	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
2	W.H.Johnson	05	31	95		\$5.85	4		Conceptual Design "CAT"
		10	31	94		\$514.00	17.1	1	Conceptual Design "CAT"
		11	30	94		\$616.00	20.5	1	Conceptual Design "CAT"
		12	30	94		\$416.00	13.9	1	Conceptual Design "CAT"
Total:						\$54269.00	825.1		
26	R.W.Foster-Pegg	01	31	95		\$342.00	11.4	1	Combustion System consulting
			31	95		\$50.00	4		Combustion System Consulting
		02	28	95		\$330.00	11.0	1	Combustion System
			28	95		\$41.45	4		Combustion System
		03	31	95		\$330.00	11.0	1	Combustion System
			31	95		\$50.00	4		Combustion System
		04	30	95		\$399.00	13.3	1	Combustion System
			30	95		\$50.00	4		Combustion System
		05	31	95		\$399.00	13.3	1	Combustion System
		12	30	94		\$332.00	11.1	1	Combustion System Consulting
			30	94		\$40.00	4		Task 26 other support
	W.H.Johnson	01	31	95		\$60.00	2.0	1	Combustion System Consulting
		02	28	95		\$69.00	2.3	1	Combustion System
			28	95		\$8.55	4		Combustion System
		03	31	95		\$69.00	2.3	1	Combustion System
		12	30	94		\$68.00	2.3	1	Combustion System Support
Total:						\$2638.00	80.0		
3	R.W.Foster-Pegg	01	31	95		\$600.00	20.0	1	Conceptual Des.GT Mods
		02	28	95		\$898.00	29.9	1	Conceptual Design GT Mods
		03	31	95		\$555.00	18.5	1	Conceptual Des.GT Mods
		05	31	95		\$819.00	27.3	1	Gas Turbine Design
		06	30	95		\$554.00	2		Conceptual Des.GT Mods
		10	31	94		\$1575.00	52.5	1	Conceptual Design GT Mods
			31	94		\$325.00	4		Task 2 Support
		11	30	94		\$1452.00	48.4	1	Conceptual Design GT Mods
			30	94		\$124.00	4		Task 4 Other Support
	W.H.Johnson	02	28	95		\$186.00	6.2	1	Conceptual Design GT Mods
		03	31	95		\$45.00	1.5	1	Conceptual Des.GT Mods
		10	31	94		\$325.00	10.8	1	Conceptual Design GT Mods
		11	30	94		\$300.00	10.0	1	Conceptual Design GT Mods
Total:						\$7758.00	225.1		
4	R.W.Foster-Pegg	01	31	95		\$300.00	2.0	1	Used Gas Turbine Survey
			31	95		\$60.00	2		Used Gas Turbine Survey
			31	95		\$35.00	4		Used Gas Turbine Survey
		02	28	95		\$297.00	9.9	1	Used Gas Turbine Survey
			28	95		\$29.00	4		Used Gas Turbine Survey
		04	30	95		\$111.00	3.7	1	Used Gas Turbine Survey
		11	30	94		\$477.00	15.9	1	Used Gas Turbine Survey
			30	94		\$50.00	4		Task 4 Other Support
		12	30	94		\$298.00	9.9	1	Used Gas Turbine Survey
			30	94		\$35.00	4		Task 4 other support
	W.H.Johnson	01	31	95		\$60.00	2.0	1	Used Gas Turbine Survey
		02	28	95		\$63.00	2.1	1	Used Gas Turbine Survey
			28	95		\$6.00	4		Used Gas Turbine Survey
		03	31	95		\$360.00	12.0	1	Used Gas Turbine Survey

5.4 *07/19/95(n)* TASK REPORT FOR FP604
Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,
4)Other such as telephone,copying,postage,office expense

TASK	PAYEE	MO DA YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
4	W.H.Johnson	03 31 95		\$33.00	4		Used Gas Turbine Survey
		04 30 95		\$189.00	6.3 1		Used Gas Turbine Survey
		05 31 95		\$150.00	5.0 1		Used Gas Turbine Survey
		11 30 94		\$98.00	3.3 1		Used Gas Turbine Survey
		12 30 94		\$62.00	2.1 1		Used Gas Turbine Survey
Total:				\$2713.00	74.2		
=====							
Total:				\$69087.00	1250.7		

6.0 Current Project Plan

11

The following shows the updated PERT Chart for the project and the revised Financial Plan for the total project.

FOSTER-PEGG "CAT" PROJECT FINANCIAL PLAN - INVENTION 604

ACTIVITY	PLAN TOTAL	OCT ACTUAL	NOV ACTUAL	DEC ACTUAL	JAN ACTUAL	FEB ACTUAL	MAR ACTUAL	APR ACTUAL	MAY ACTUAL	JUN ACTUAL	JUL	AUG	SEP	TOTAL PLAN ESTIMATE
TASK 1														
SEL-A/E/s														
Pers	594	594												594
Travel	25	25												25
Contrs.	0	0												0
Other	111	111												111
TL	730	730	0	0	0	0	0	0	0	0	0	0	0	730
TASK 2														
DES. "CAT"														
Pers	25955	3006	3600	2430	3038	3645	3645	2430	2192	769	400	400	400	25955
Travel	1685	127		263	50	261	75	75	75		300	300	159	1685
Contrs.	53600							13400	13400		9000	9000	8800	53600
Other	1790	27	150	269	269	269	269	269	268					1790
TL	83030	3160	3750	2962	3357	4175	3989	16174	15935	769	9700	9700	9359	83030
TASK 3														
DES. GT														
Pers	7955	1900	1752		600	1084	600		819		400	400	400	7955
Travel	818									554	264			818
Contrs.	10000										3000	5000	2000	10000
Other	449	325	124											449
TL	19222	2225	1876	0	600	1084	600	0	819	554	3664	5400	2400	19222
TASK 4														
GT SURVEY														
Pers	2835		575	360	360	360	360	300	150			250	120	2835
Travel	60				60									60
Contrs.	10000				3000	2000	2000	1500	1500					10000
Other	188		50	35	35	35	33							188
TL	13083	0	625	395	3455	2395	2393	1800	1650	0	0	250	120	13083
TASK 26														
COMBUSTION														
SYS. CONSULTING														
Pers	3601			400	402	399	400	400	400		400	400	400	3601
Travel	0													0
Contrs.	17780			40	50	50	50	50	50		5926	5926	5928	17780
Other	285			440	452	449	450	450	450	0	45			285
TL	21666	0	0	440	452	449	450	450	400	0	6371	6326	6328	21666
TASK 5&6														
CAT DES/T														
Pers	4790										790	2000	2000	4790
Travel	143											143		143
Contrs.</														

7.0 List of new Documents included with this report

1.0 Visit and Meetings in Houston and environs June 4-8 1995 by R.W.Foster-Pegg P.E.

2.0 Proposed Site Plan and Equipment Layout by Gilbert/Commonwealths

Visit and Meetings in Houston and environs June 4-8 1995
By R.W.Foster-Pegg P.E.

In conjunction with the annual conference of the International Gas Turbine Institute of ASME discussions were held with companies in the Houston area which might assist the "CAT" program.

The factory of Revak Turbomachinery services was visited to review their capabilities to overhaul and modify a used Frame 5 gas turbine into an air turbine. Meetings were held with Mr Revak sr and jr and the plant was toured. Mr Lynn Revak Sr was employed by General Electric and also by Hickham before starting on his own. Lynn Revak is familiar with the Frame 5 and repair procedures. The facilities and equipment are entirely suitable for the work and the owner is anxious to participate. Revak will provide an estimate of the cost to perform the overhaul and modifications.

Met with Warren Holmes of Hickham Industries. Hickham would be interested in the conversion and overhaul of a used Frame 5 gas turbine for "CAT". Hickham would be more difficult to work with than Revak but are an alternative. Warren Holmes estimated the cost of an overhauled (not modified) used Frame 5 as \$3.5 million.

Met with Merhwen Boyce of Boyce Engineering International to discuss Boyce doing the detail engineering design of the engine conversion and control system. This is a possibility, however their presentation was not impressive.

Meetings were held with Power Systems Investors Group concerning the availability of used Frame 5 engines. Approximately 20 suitable engines are available for purchase at this time in the Houston area.

A meeting was held with Gas Path Technology concerning the overhaul of the used Frame 5. Gas Path would do part of the job but not all of it.

Sermatech were contacted for application of heat barrier coatings to gas turbine transitions as part of the conversion of gas turbines to air turbines. As a result a quotation has been received for the work on Frame 5 used engines.

A meeting was held with Mr Andrew Grant E.P.C. Project Manager of Babcock Wilcox concerning a proposal from B&W for the coal combustion system.

Expenses Chargeable to "CAT" for the visit to Houston
June 4-8 1995

As other business was conducted during the visit 50% of the cost is assigned to the "CAT" project and 50% to other accounts.

Portion of expenses chargeable to "CAT" are as follows : -

Cabs to and from Philadelphia airport	\$ 20.00
Air Fare Philadelphia to Houston RT	281.00
Hotel (includes some meals) and tax	185.25
meals	27.49
Cabs to and from Houston AP and hotel	35.00
Gratuities registration and phones	<u>5.50</u>
	\$ <u>554.24</u>

R.W.Foster-Pegg P.E.

Date

houston.doc

LAYOUT DRAWINGS OF "CAT" POWER ISLAND
AND COMPLETE PLANT

Preliminary layouts have been prepared by the architect engineer Gilbert-Commonwealth and are attached to this report. The drawings are preliminary because information on the circulating fluid bed combustion system is not available at this time.

The plans are for the "CAT" plant producing only electric power with the air turbine, a condensing steam turbine and cooling towers. Other "CAT" plants being studied cogenerate electric power and also export heat for process. The other plants have either a back pressure steam turbine or no steam turbine and no cooling towers.

An elevation drawing of the power island will be made when the circulating fluid bed has been defined. The drawing is produced by CAD so the layout can be adjusted with minimal effort as new information is developed.

The circulating fluid bed is not identified on the drawing. It will be located between the coal silos (18F) and the baghouse filter (7). The high temperature pipes conveying the heated compressed air from the circulating fluid bed air heater to the turbine (2B) are costly. The layout has been predicated on minimizing the length of run of these pipes for least cost.

"CAT"17.doc

July 26 1995

PROPOSED SITE PLAN

0 20 40 60

GRAPHIC SCALE IN FEET

6 5 4 3 2 1

EE

PROPOSED FACILITY LEGEND

1. ATMOSPHERIC FLUIDIZED BED BOILER
- 1A. LATER
2. MODIFIED GC FRAME 5 GAS TURBINE
- 2A. AIR DUCT
- 2B. TURBINE COMPARTMENT
- 2C. GENERATOR COMPARTMENT
- 2D. EXHAUST DUCT
- 2E. GENERATOR AUXILIARY COMPARTMENT
3. HEAT RECOVERY STEAM GENERATOR (HRSG)
- 3A. STACK
4. STEAM TURBINE
5. GENERATOR
6. CONDENSER
7. BAGHOUSE
8. I.D. FAN
9. STACK
10. CEM BUILDING
11. LUBE OIL SKID
12. GLAND STEAM CONDENSER
13. CONDENSATE PUMPS
14. FEEDWATER PUMPS
15. FLASH TANK
16. HIGH PIPE BRIDGE
17. LOW PIPE BRIDGE
18. COAL HANDLING EQUIPMENT
- 18A. COAL TRUCK UNLOADING AREA
- 18B. COAL UNLOADING HOPPERS
- 18C. COAL STORAGE SILOS
- 18D. COAL CRUSHER BUILDING
- 18E. COAL CONVEYOR
- 18F. IN-PLANT COAL SILOS
19. LIMESTONE HANDLING EQUIPMENT
- 19A. LIMESTONE TRUCK UNLOADING AREA
- 19B. LIMESTONE UNLOADING HOPPERS
- 19C. LIMESTONE CONVEYOR
- 19D. IN-PLANT LIMESTONE SILOS
20. ASH HANDLING EQUIPMENT
- 20A. ASH STORAGE SILOS
21. STEP-UP TRANSFORMER
22. SUBSTATION
23. EMERGENCY DIESEL GENERATOR
- 24.
- 25.
- 26.
- 27.
28. COOLING TOWER
29. WATER TREATMENT BUILDING

A

B

C

D

E

F

G

H

J

K

DATE	BY	REVISION

STATUS	REVISION
☐ APPROVED	REVISIONS ARE APPROVED BY THE PROJECT MANAGER AND THE DESIGN ENGINEER.
☐ PRELIMINARY	REVISIONS ARE PRELIMINARY AND SUBJECT TO CHANGE.
☐ CORRECTED	REVISIONS ARE CORRECTED AND SUBJECT TO CHANGE.

	GILROY/CONRADALTA, INC.	
	DESIGN AND ENGINEERING	
	10000 100th AVE. N.E.	
	REDMOND, WA 98073	
DATE	BY	REVISION

PROPOSED FACILITY LEGEND

1. ATMOSPHERIC FLUIDIZED BED BOILER
 - 1A. LATER
2. MODIFIED GE FRAME 5 GAS TURBINE
 - 2A. AIR INLET
 - 2B. TURBINE COMPARTMENT
 - 2C. GENERATOR COMPARTMENT
 - 2D. EXHAUST DUCT
 - 2E. GENERATOR AUXILIARY COMPARTMENT
3. HEAT RECOVERY STEAM GENERATOR (HRSG)
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 - 19C. LIMESTONE CONVEYOR
 - 19D. IN-PLANT LIMESTONE SILOS
20. ASH HANDLING EQUIPMENT
 - 20A. ASH STORAGE SILOS
21. STEP-UP-TRANSFORMER

PROPOSED SITE PLAN