Advanced Gasification-Based Fuel Conversion and Electric Energy Production System

Quarterly Technical Progress Report – Phase I

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COOPERATIVE AGREEMENT:
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SUBMITTING ORGANIZATION:
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ABSTRACT

The objective of this project is the development and commercial demonstration of an advanced biomass gasification-based power generation system at Boise Cascade Corporation's pulp and paper mill in DeRidder, Louisiana. The advanced power generation system is intended to meet the immediate needs of the forest products industry for highly efficient and environmentally friendly electricity and steam generation systems utilizing existing wood waste as the primary fuel resource. The novel system is based on three advanced technology components: GTI's RENUGAS® and 3-stage solid fuels combustion technologies coupled with one of the power generation approaches used in DOE's HIPPS program.

The project will be conducted by the Gas Technology Institute (GTI) and Boise Paper Solutions (Boise), the paper making division of Boise Cascade. The project team includes Babcock Borsig Power (BBP), Solar Turbines Inc., Carbona Corporation, the University of North Dakota Energy and Environmental Research Center (EERC), and Nexant LLC, a Bechtel technology and consulting company.

Phase 1 of the project is a technical and economic evaluation of the system at the DeRidder site. A Continuation Application will be submitted at the conclusion of Phase 1 for authorization to proceed to testing and design in Phase 2. Phase 2 includes pilot-scale verification of selected system components and preparation of a detailed engineering design and cost estimate for retrofit of the advanced power system at the DeRidder mill. Phase 3 will complete procurement and construction of the system at the DeRidder site along with all required permitting activities. Phase 4 of the project will included plant commissioning, startup and demonstration operations.

During the quarter, design basis information for the Gasification Island was finalized and the process flow sheet, section battery limits, utility requirements, heat and material balances and preliminary equipment layout drawings were completed. Based on this information, final design and performance calculations were begun for the gasifier syngas cooler/air heater, PB No. 2 modifications and Power Island turbines. Requests for quotations were sent out to two vendors of industrial bark/hog fuel dryers. Discussions were initiated with the Institute of Paper Science and Technology (IPST) for a laboratory study on VOC emissions from wood waste drying. Materials selection for the air heater test coupons was completed along with the mechanical and instrumentation design for installation of the coupons in PB No. 2. Vendors for the required materials were identified and the materials ordered. It was decided that turbine study should be expanded to identify the best candidate engines for development and demonstration in subsequent phases of the project. Inquiries were made to five additional turbine manufacturers for this purpose.

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INTRODUCTION

Boise Paper Solutions and the Gas Technology Institute (GTI) are cooperating to develop, demonstrate and place in continuous operation an advanced biomass gasification-based power generation system suitable for near-term commercial deployment in the Forest Products Industry. The system will be used in conjunction with, rather than in place of, existing wood waste fired boilers and flue gas cleanup systems. The novel system will include three advanced technological components based on GTI's RENUGAS® and three-stage stoker combustion technologies, and a gas turbine-based power generation concept developed in DOE's High Performance Power System (HIPPS) program. The system has, as its objective, to avoid the major hurdles of high-pressure gasification, i.e., high-pressure fuel feeding and ash removal, and hot gas cleaning that are typical for conventional IGCC power generation. It aims to also minimize capital intensity and technology risks. The system is intended to meet the immediate needs of the forest products industry for highly efficient and environmentally friendly electricity and steam generation systems utilizing existing wood waste as fuel resources.

EXECUTIVE SUMMARY

Project Objective: The overall objective of this project is to demonstrate the commercial applicability of an advanced biomass gasification-based power generation system at Boise Paper Solutions' pulp and paper mill located at DeRidder, Louisiana.

Background: The project team, led by GTI, will develop, design, install, demonstrate and place in continuous commercial operation and advanced biomass gasification-based power generation system including gasification, syngas reburning and indirect high temperature air heating technology and utilizing existing wood waste resources as fuel. The system will be integrated with existing powerhouse equipment, including the wood waste-fired stoker boiler and flue gas cleaning system, in a stepwise manner to insure the reliability of steam and power generation. Staged implementation will reduce technology risk, improve operator acceptance and allow energy, environmental and economic benefits to begin to be realized by the mill early in the project.

The project will be conducted in four phases over a period of 6 years. The phases are structured to provide a logical path to verify the technical and economic feasibility of the proposed biomass gasification-based power generation approach in Phase 1, with a Continuation Decision point prior to proceeding with pilot testing and detailed design. A detailed engineering design and cost estimate will be developed in Phase 2 with another Continuation Decision point prior to proceeding to Phase 3. Construction and demonstration of the system will be completed in Phases 3 and 4.

Boise's DeRidder mill has agreed to be the host site for the project, completing a major milestone ahead of schedule and allowing the design to center on the specific requirements of the host site early in the project. The major subcontractors for the project have been identified and approved by both DeRidder and DOE.

The power system configuration has been refined from the original concept to better meet the specific energy requirements and constraints existing at the DeRidder mill. The reconfiguration addresses several limitations in the application of the original system concept to DeRidder's Power Boiler No.2, including space and heat limitations for the air heater heat exchange surfaces inside the boiler, the desire by DeRidder to maintain the maximum steam production possible

from the boiler, and the need to cool the syngas somewhat from the gasifier exit temperature before injecting the syngas through the boiler waterwall.

A list of commercially available candidate tube materials for the high-pressure, high-temperature air heaters has been selected. These tube materials will be tested through exposure to actual furnace conditions in PB No. 2. Two gas turbine configurations for the Power Island have been selected for further study. The Gasification Island, Power Island, Boiler Modification Indirect Air Heater and Power Systems Integration Studies are all underway.

Status (September 30, 2002): Design basis information for the Gasification Island was finalized and the process flow sheet, section battery limits, utility requirements, heat and material balances and preliminary equipment layout drawings were completed. The principal changes to the gasification section as a result of the system reconfiguration include:

- Pressurizing the gasifier slightly to about 15 psig in order to reduce the vessel diameter and resolve a layout problem
- Increasing the amount of syngas combusted at the syngas cooler/air heater exit in order to transfer more heat to the Turbine No. 1 working fluid (high pressure air) and eliminate the need for a tar cracker between the gasifier and syngas cooler

Based on the gasifier output calculations, final design and performance calculations were begun for the gasifier syngas cooler/air heater, Power Boiler No. 2 modifications and the Power Island turbines.

The modified plant configuration includes a bark/hog fuel dryer(s) of sufficient capacity to dry all fuel to both the gasifier and boiler. Accordingly, requests for quotations were sent out to two vendors of industrial bark/hog fuel dryers. Discussions were also initiated with the Institute of Paper Science and Technology (IPST) for a laboratory study on VOC emissions from wood waste drying.

Materials selection for the air heater test coupons was completed along with the mechanical and instrumentation design for installation of the coupons in PB No. 2. Vendors for the required materials were identified and the materials ordered.

It was decided that turbine study should be expanded beyond Solar's Titan 130 engine to identify the best candidate engines for development and demonstration in subsequent phases of the project. Inquiries were made to five additional turbine manufacturers for this purpose.

Power Systems Integration Study focused has been started and is focused on developing and overall equipment layout scheme, determining plant utility requirements and availability, and permitting requirements. A Cost Estimating format in accordance with Boise guidelines for capital projects was obtained and distributed to the design teams

Additional activities during the reporting period included:

- Attended project review meeting in DeRidder, LA on July 24 to present project status to DOE management and Boise senior corporate engineering and capital project evaluation management.
- Presented the DeRidder project status at the AF&PA Gasification Technology Development Research Update and Pathway Review meeting in San Diego on September 12.

Activities Next Quarter:

- Obtain DOE approval for the IPST bark dryer emissions study and initiate the work.
- Complete Host Site Agreement with Boise DeRidder
- Conduct site walkdown and equipment layout review on 10/17 at DeRidder
- Fabricate and install air heater tube testing system in PB No. 2
- Finalize workscope and initiate EERC support study for the air heater design
- Continue Gasification Island, Boiler Modification, Power Island and Integration Design Studies

Project Costs and Schedule: The project budget and milestone information is presented in Appendix A.

EXPERIMENTAL

Project Tasks

Phase 1 Predesign Evaluations

In Phase 1 the major technical design and economic factors determining project viability will be evaluated for up to three potential host sites to allow a final host site selection and authorization to proceed to demonstration by Boise Cascade and DOE. These objectives shall be accomplished through the following tasks:

Task 0.0. NEPA Review

GTI and Boise will provide information deemed necessary for DOE to prepare a NEPA review of the project. This information will describe and quantify all anticipated environmental impacts of the project. The NEPA review and approval process will be completed prior to initiation of detailed design studies, or any actions that could prejudice the decision of the NEPA analysis.

Task 1.1. Demonstration Site Evaluations

GTI and Boise will evaluate up to three candidate demonstration host sites at Boise Cascade mills leading to a final host site selection for the demonstration project. The preferred fuels and process configurations will be determined based on site-specific needs, economics and the impact on the cost of steam and electricity produced. Existing plant layouts will be evaluated with respect to design and layout requirements for the gasifier, fuel feeding systems, air heater and turbine system will be evaluated, as well as control integration and modification requirements for the stoker boilers. Permitting requirements will be determined including federal, state and local construction and operating permits required for the demonstration.

Task 1.2. Gasification Island Design Study

Based on the feedstocks identified in Task 1.1, process modeling will be performed using biomass gasification databases to develop gasifier heat and material balances, perform gasifier sizing calculations, predict product fuel gas compositions, and define process input and output flow ranges for candidate feedstocks identified and possible mixtures thereof. Additional design evaluations will include: (a) Fuel preparation, handling and low pressure feeding equipment evaluation; (b) Stoker bottom ash and fly ash evaluation as gasifier fluid bed media, (c) Stoker bottom ash and fly ash handling modifications for recovery and transport to the gasifier; (d)

Gasifier bottom ash removal/disposal equipment requirements; and (e) Layout requirements for the gasifier, fuel feeding systems, and syngas ducts.

Task 1.3. Indirect Air Heater System Design Study

The efficacy of utilizing this novel air superheater in the stoker boiler shall be evaluated. Air superheater materials of construction, installation techniques and heat transfer will be evaluated to determine the best superheater design suited for application under biomass-fired stoker conditions. Selection of candidate structural materials will be evaluated, to include test coupon studies in the superheater section of DeRidder's boiler No. 2. The results of these evaluations shall be used to design one or more air heater test sections for pilot performance evaluations in the Boise Cascade boiler in Phase 2.

Task 1.4. Stoker Boiler Modification Study

GTI, Boise and BBP will evaluate the selected boiler with respect to modifications required for the syngas reburn and air superheater retrofits. Evaluations shall include physical layout and condition of the boiler and supporting equipment, as well as operating load ranges, requirement to burn non-condensable gases or pulp mill sludge from the pulping process, availability of alternate steam generating capacity such as natural gas- or oil-fired boilers, combustion stability and need for combustion enhancement, grate type, condition and performance, boiler control hardware, software and data acquisition capabilities, and any other factors that would influence the suitability of the boiler for a successful demonstration.

Task 1.5. Power Island Design Study

Gas turbine design options will be evaluated based on the energy conditions and needs at the DeRidder site. Preliminary specifications will be developed for any modifications required to the turbine generator set, including the combustor, turbine, air compressor, and generator to operate reliably and efficiently with high pressure heated air as the working fluid. Turbine and generator control options will be evaluated with respect to expected load ranges, duty cycles, existing power conditions, and the potential for further integration with existing steam turbines at the site.

Task 1.6. Power Systems Integration Study

GTI, Boise and Nexant will use information from the various design evaluations above as the basis for a power systems integration study which will consider integration of the gasifier, reburners, stoker boiler, high temperature air heater, and gas turbine system controls from the standpoint of operational flexibility, reliability and safety. Operational and control system design requirements will be developed, including safety interlocks and other equipment or operational provisions for boiler, gasifier, and power island trips and combinations thereof. In addition to integration of the individual power system components with each other, the team will evaluate integration of the combined system into the balance of the existing powerhouse. A stepwise implementation strategy will be developed that will reduce technical risk, minimize outage requirements for equipment retrofits, allow early realization of incremental economic and operating benefits for the host site, and accelerate operator understanding and acceptance of the new technologies.

Task 1.7. Capital and Operating Cost Study

The capital costs at the total plant cost level shall be determined by the team and include equipment, materials, labor, indirect construction costs, engineering, and contingencies.

Operation and maintenance cost values will be determined. The capital and operating cost results will be combined with plant performance in the comprehensive evaluation of the plant's Cost of Electricity.

Task 1.8. Phase 1 Project Management

GTI will coordinate the work required to accomplish Phase 1. GTI will provide for all project deliverables, including quarterly Financial Status Reports, quarterly Technical Progress Reports, a list of ES&H approvals and a topical report on the complete findings of the Phase 1 Predesign Evaluation. Additionally, GTI will confirm through written endorsements that the demonstration host site and three other like Forest Products Industry companies consider the Boise/GTI demonstration project essential to their management decisions regarding retrofit or replacement of existing boilers and achieving emission levels imposed under EPA promulgated MACT regulations. A summary of these site visits will be included in the Phase 1 Predesign Evaluation report along with the resulting endorsement letters, which will then be presented to the AF&PA's Energy Performance Task Group. Endorsement of the project by the AF&PA Energy Performance Task Group will be necessary to proceed to Phase 2.

GTI and Boise will present the Phase 1 Predesign Evaluation report including all necessary Forest Product Industry endorsements to DOE at the conclusion of Phase 1. A cooperative determination for continuation into Phase 2 shall then be made jointly by DOE, GTI and Boise within 45 days of submission of the Phase 1 Evaluation review.

Phase 2 Demonstration Plant Design Development

Contingent on a decision to proceed based on the results of the Phase 1 Predesign Evaluations, pilot-scale verification of the air heater design, and a detailed engineering design and cost estimate for the retrofit will be completed in Phase 2. The project team will prepare the Phase 2 Design and Cost Estimate for presentation to DOE upon completion. A cooperative determination for continuation into Phase 3 shall be made jointly by DOE, GTI and Boise within 45 days of submission of the Evaluation Review.

Phase 3 Procurement and Construction

Equipment purchase, subcontract procurement, retrofit construction and permitting will be completed in Phase 3.

Phase 4 Demonstration Plant Operations

Demonstration plant startup, verification of mechanical completion, operability testing, performance tests in integrated power generation mode, and commercial demonstration operations shall be completed during Phase 4.

RESULTS AND DISCUSSION

Task 0.0. NEPA Review

There were no activities in this task during the quarter.

Task 1.1. Demonstration Site Evaluations

The objective of this task was completed with the agreement by the DeRidder mill to be the host site for the advanced gasification-based power system demonstration. Since this was accomplished without the additional site evaluations originally proposed, DOE has agreed that GTI will perform preliminary site evaluations to obtain project endorsements from three FPI

companies other than Boise. This will be performed under Task 1.8 within the budgeted costs for Phase 1.

Task 1.2. Gasification Island Design Study

The current power system configuration is shown in Figure 1. The Gasification Island Design Study scope includes development of the gasifier system design basis and conceptual design of the feed dryer, fuel feeding system, gasifier, ash removal system, tar cracker and syngas cooling to 650° F. Heat and material balances, PFDs and P&IDs were developed for the gasification section during the quarter, along with preliminary utility requirements and layout drawings. The first issue of the Process Flow Diagram for the Gasification Island is shown in Figure 2. The preliminary equipment layout is shown in Figure 3. These design elements will be finalized during the next quarter, along with development of equipment specifications and sizing and equipment, erection and operating cost estimates for incorporation into the overall power system

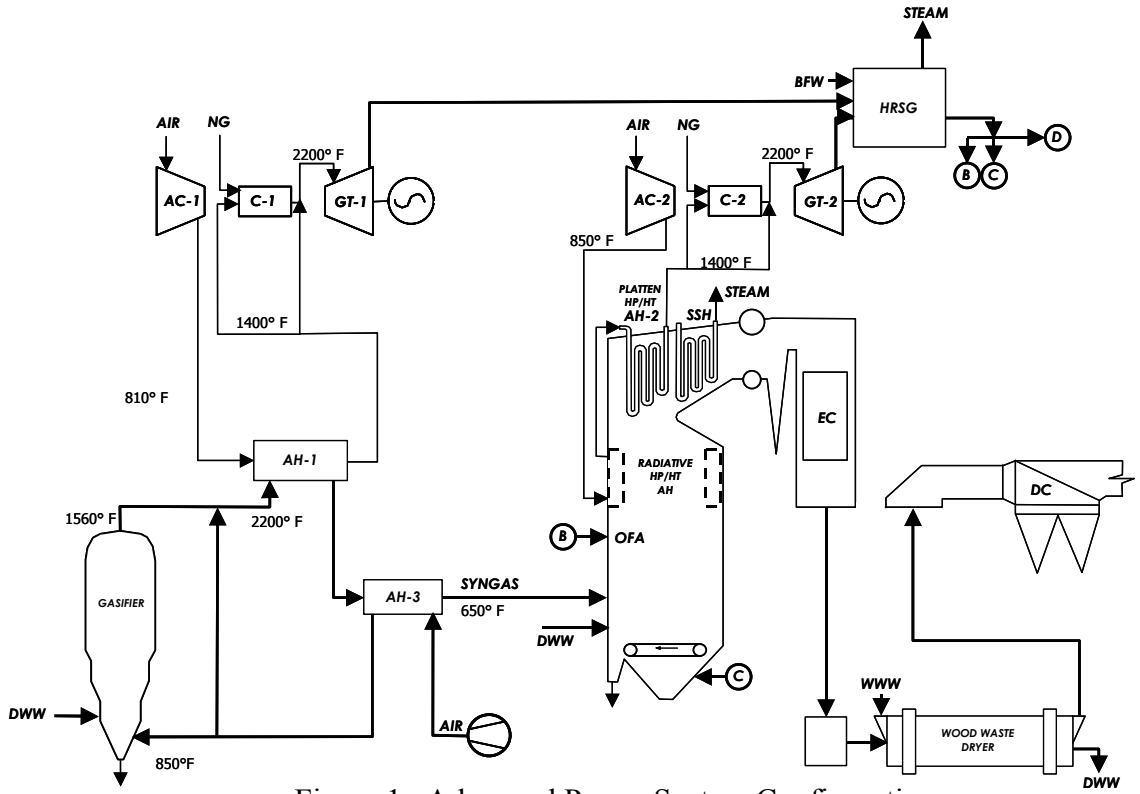


Figure 1. Advanced Power System Configuration

cost evaluation.

The Gasification Island design basis is now based on a separate air compressor and heat exchanger for gasification air and combustion air ahead of the syngas cooler/air heater. Heat exchanged with the syngas is used to heat high-pressure air from the turbine compressor to 1400°F. Prior to entering the turbine, the air temperature is boosted further to meet the turbine inlet temperature requirement of 2200°F using natural gas in the turbine's combustor. Two cases – combustion air at 850°F from the turbine compressor (air heater in parallel with the combustor) and combustion air at 1400°F from the air heater (air heater in series with the combustor as in Figure 1) are being evaluated in the Power Island Design Study.

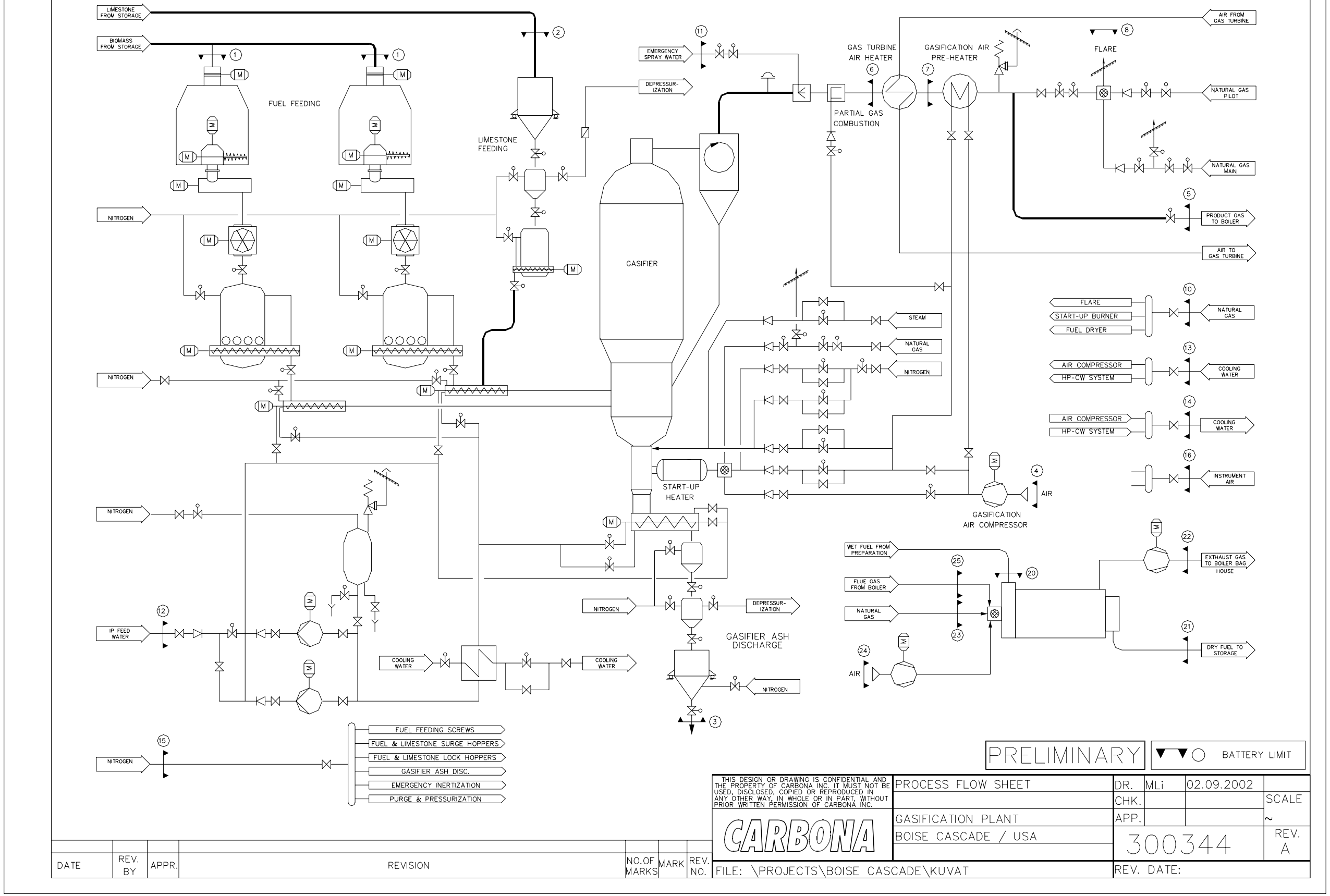


Figure 2. Process Flow Diagram for the Gasification Island

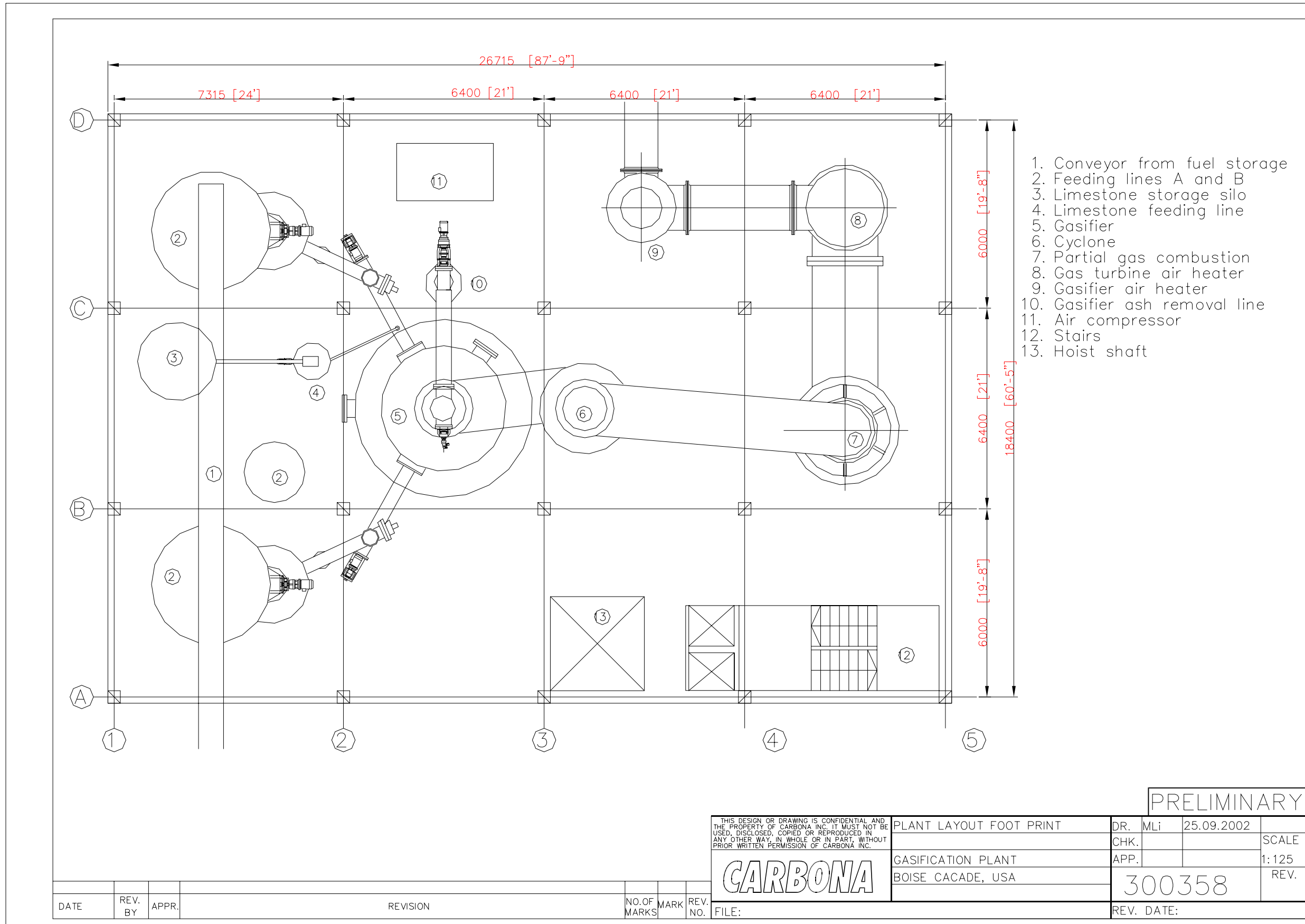


Figure 3. Preliminary Major Equipment Layout for the Gasification Island

Task 1.3. Indirect Air Heater System Design Study

The stoker boiler's HPHT air heater will be sized to supply air to only one of the two Solar Titan 130 gas turbines due to space and heat limitations in Power Boiler No. 2. Heat required to supply high temperature air for the second Titan 130 will be supplied by heat exchange with hot syngas prior to the stoker. The Titans will produce 14 MW of electric power each. The separate air heaters will have their tubes exposed to different gas environments – oxidizing in the stoker and reducing after the gasifier. Sample tubes will therefore be tested in two different zones in the boiler: near the grate where fuel rich conditions simulate the reducing atmosphere after the gasifier, and at the top of the furnace in front of the existing superheater banks.

Design of the tube testing experiment was completed, including material selection, tube design, temperature instrumentation, airflow requirements and air flow controls. Two locations for the test racks in the boiler were also finalized. Four different materials, including SA-213T91, SA-213TP347H, SB-213-800H, and SS-353 will be tested in both locations, at metal temperatures ranging from 1200°F to 1600°F and exposure times up to 6 weeks.

Task 1.4. Stoker Boiler Modification Study

The initial evaluation of PB No. 2 with respect to the HTHP air heater resulted in splitting the air heating duty between two heaters as discussed above. Efforts were then focused on evaluating the revised configuration, including the effects of drying the stoker's bark fuel to 20 % from about 50% and reducing the boiler's steam production by about 50,000 lb/h. (Note that a Heat Recovery Steam Generator (HRSG) has been added to the system to generate about 80,000 lb/h of steam, increasing the overall steam output from the system by about 30,000 lb/h). Both of these changes significantly increase the high temperature heat available for heating air in the boiler, providing air outlet temperatures up to 1400-1600°F.

Several configurations for the HPHT air heater have been evaluated to accommodate the required surface area in the boiler. Final air heater configuration and temperature calculations are currently underway using the syngas composition and conditions developed in Task 1.2. Currently, boiler design calculations indicate that up to 320,000 lb/h of air can be heated to about 1400°F in the stoker HPHT air heater at a total heat input to the stoker of 450 MMBtu/h. Higher air temperatures may be achieved by increasing the stoker heat input (bark plus syngas) to 485 MMBtu/h, raising the syngas and overfire air injection points, and increasing inside turbulence in the air heater tubes to increase the heat transfer coefficient.

Task 1.5. Power Island Design Study

Six potential configurations were defined for the HPHT air heater and turbine systems. Two configurations, shown in Figure 4 below, were selected for further study. In the parallel configuration, air routed directly from the turbine combustor is used as combustion air in the turbine combustor, requiring more natural gas to achieve the required turbine inlet temperature. This approach is the same as is currently used for the combustor, and is expected to require the smallest change from current combustor design. The parallel option uses more natural gas for power production than the series configuration, which uses more energy from biomass by using air from the HPHT air heater as the turbine combustor combustion air. The high combustion air temperature may require modification to the combustor to prevent flashback, particularly if air temperatures reach the 1600°-1800°F range.

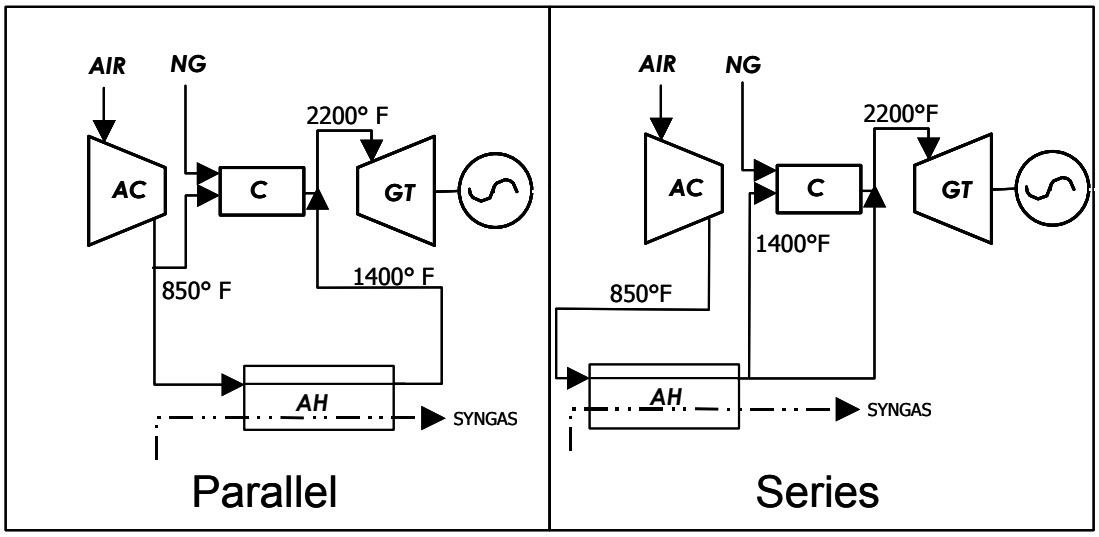


Figure 4. Power Island configurations selected for further evaluation.

Both of the above cycles will be evaluated for air temperatures of 1400°-2000°F over a range of compressor inlet temperatures, HTHP air heater pressure drops, and turbine inlet temperatures.

Potential limitations in the ability to readily modify Solar's Titan 130 to an externally recuperated design resulted in a determination that the turbine study should be expanded beyond the Titan 130 engine to include other candidate engines for development and demonstration including externally recuperated machines. Inquiries were made to five additional turbine manufacturers for this purpose, including GE, Rolls Royce, Pratt & Whitney, Siemens-Westinghouse and Alstom-ABB.

Task 1.6. Power Systems Integration Study

The DeRidder mill steam and power objectives were defined to include 28 MW of additional self-generated power while maintaining or increasing steam production at or above current levels. In addition to satisfying the various design constraints at the DeRidder site, adoption of the two-air heater system facilitates stepwise implementation of the advanced power system by allowing the gasifier, syngas cooler/air heater and one of the two 14MW turbines to be installed before major modifications are required to the stoker for the HIPPS air heater installation. The equipment, piping and controls for this first portion of the system can be installed while the boiler is maintained in normal operation, with only a 5-7 day outage required for final tie-ins. The benefits to the mill from this first step will be significant, including an additional 14 MW of self-generated power and NO_x reduction from the stoker boiler of 40-60% from syngas reburning. Shakedown and debugging of the gasification, air heating and turbine systems can be accomplished with minimum impact on boiler operation and availability.

Information was obtained on the mill's Balance of Plant requirements, including the electrical interface, availability of boiler feed water, cooling water, instrument air, fire protection, MCC center and process control system capacities. The initial evaluation indicated that there is very little useable margin in any of the major utilities, and the project will therefore have to provide its own utilities as required.

A preliminary layout of the overall power system equipment was completed based on areas identified by the mill as being available as is or with minor modifications. The available areas

were more than adequate to accommodate all required equipment, but in general are not in close enough proximity to PB No. 2 to allow the necessary HPHT air, syngas and boiler flue gas interconnections between the gasifier, boiler HPHT air heater, bark dryer and boiler flue gas ductwork. A site meeting has been scheduled for mid-October to resolve these issues and finalize equipment locations.

Task 1.7. Capital and Operating Cost Study

A Cost Estimating format in accordance with Boise guidelines for capital projects was obtained and distributed to the design teams. Information on the costs of bark, natural gas and purchased electricity will be provided by the mill, as well as seasonal variation in the mill's steam and electricity demand. This, together with capital and operating cost inputs from the various design studies, will be consolidated for the overall system economic evaluation.

Task 1.8. Phase 1 Project Management

A project review meeting was held at the site in DeRidder, LA on July 24 to present project status to DOE management and Boise senior corporate engineering and capital project evaluation management. A progress review meeting was held between GTI, Solar, Carbona and NEXANT at NEXANT's offices in San Francisco on August 13-14. A presentation was also given on the DeRidder project status at the AF&PA Gasification Technology Development Research Update and Pathway Review meeting in San Diego on September 12.

Discussions were initiated with the Institute of Paper Science and Technology (IPST) for a laboratory study on VOC emissions from wood waste drying. The study will focus on an experimental determination of VOC emissions from bark samples from the DeRidder mill exposed to expected dryer conditions.

Additional activities during the reporting period included:

- A proposal was received from EERC for support work related to the Air Heater Design Study and is currently under evaluation.
- A subcontract was placed with Nexant for the Power Systems' Integration Study and Capital and Operating Cost Study.

CONCLUSION

The overall power system configuration has been revised to accommodate space and heat limitations in the existing stoker boiler and site-specific steam and electricity requirements. Process calculations for the Gasification Island based on the new configuration have been performed and the results are being used in the Power Island, Boiler Modification, Indirect Air Heater System and Power Systems Integration Design Studies. The gasification, boiler, air heater and power systems integration designs are proceeding as envisioned in the revised plant configuration. It has been determined that additional turbine engines should be evaluated for the Power Island and inquiries have been made to five more turbine manufacturers.

Work Planned for Next Quarter:

- Finalize scope and costs for EERC support of the HPHT air heater design and execute subcontract
- Execute Field Test Agreement with Boise DeRidder
- Obtain DOE approval for the IPST bark dryer emissions study and initiate the work.
- Conduct site walkdown and equipment layout review on 10/17 at DeRidder
- Fabricate and install air heater tube testing system in PB No. 2
- Continue Gasification Island, Boiler Modification, Power Island and Integration Design Studies

Appendix A

Project Costs

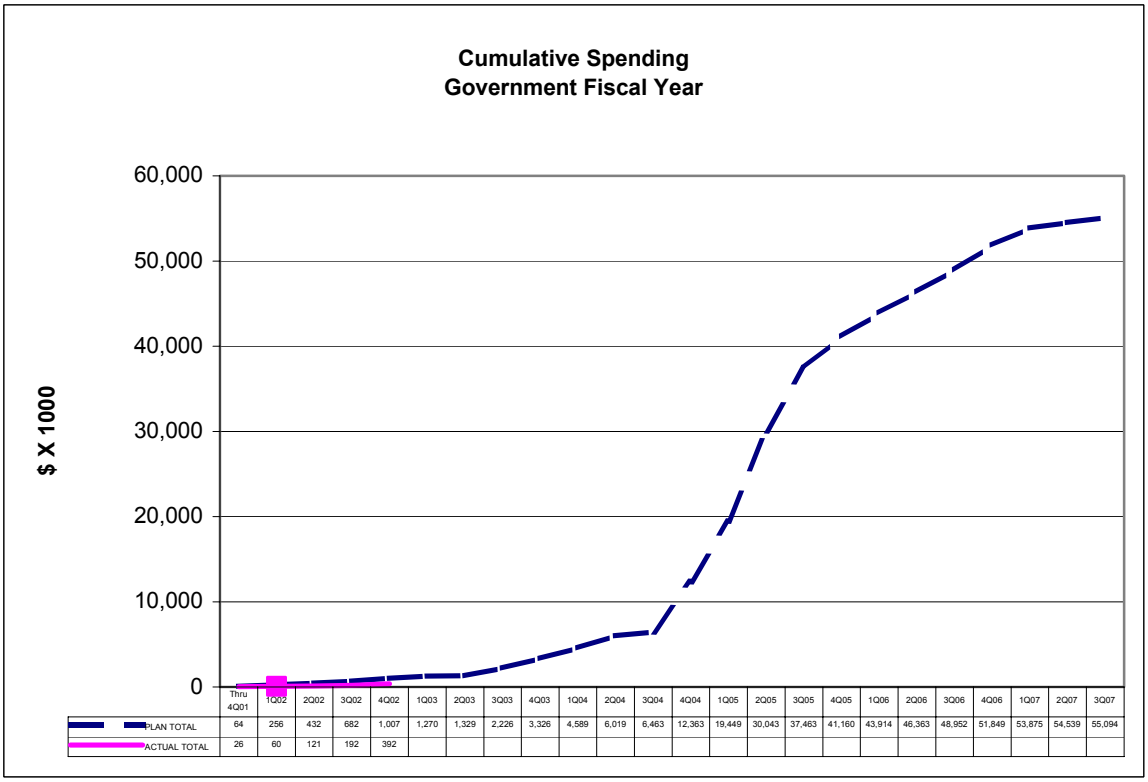
Project Budget Period		Period			Cumulative		
From	To	DOE*	Share*	Total	DOE	Share	Total
7/1/02	9/30/02	$ 132,105	$ 67,977	$ 200,082	243,991	147,848	391,839
Previous Total		$ 111,886	$ 79,871	$ 191,757	62.3%	37.7%	100.0%

Budget Data

GTI, Boise Cascade		Advanced Gasification-Based Fuel Conversion and Electric Energy Production System (1691)									
FC26-01NT41108		Rabovitser									
Project Budget Periods		Approved						DOE Obligated			
		Incremental			Cumulative			Mod	Increm	Cumul	Date
From	To	DOE	Share	Total	DOE	Share	Total	A000	1,028,010	1,028,010	8/8/2001
7/15/2001	3/31/2003	1,028,010	300,500	1,328,510	1,028,010	300,500	1,328,510				
4/1/2003	6/30/2007	25,965,065	27,800,000	53,765,065	26,993,075	28,100,500	55,093,575				
	Total	26,993,075	28,100,500	55,093,575	49.0%	51.0%	100.0%				

Note: Only the first budget period has been approved. The second budget period is estimated.

Cost Curve



Schedule and Milestones