**Advanced Gasification-Based Fuel Conversion and Electric Energy
Production System**

Quarterly Technical Progress Report – Phase I

REPORTING PERIOD:

From: July 15, 2001

To: December 31, 2001

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January 2002

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DE-FC26-01NT41108

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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 the Boise Cascade 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 METHANE de-NOX[®] 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 Cascade (Boise). 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 HIPPS 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 include plant commissioning, startup and demonstration operations.

The Cooperative Agreement was executed for the project by DOE on August 8, 2001. GTI confirmed DeRidder as the demonstration host site with mill management on September 4 meeting a major project milestone. GTI conducted a conference call with DeRidder management on September 7 during which the proposed major subcontractors for the project were reviewed and accepted by Boise DeRidder and the project kickoff meeting tentatively scheduled for early October. Events of September 11 resulted in schedule disruptions and travel restrictions, which caused the kickoff meeting to be postponed. The meeting was held on December 12 at the DeRidder site with representatives from DOE, GTI, Boise and all major subcontractors attending.

During the performance period, appropriate Non-Disclosure Agreements were executed with all prospective Subcontractors. Agreement was reached on project scope and cost with the selected boiler and turbine contractors and subcontracts are now being developed. GTI also submitted a proposal to the Gas Research Institute during the quarter to secure cost share funds for the project and this proposal was approved. Work was initiated on the Budget Period 1 Project Evaluation Plan and Phase 1 Hazardous Substance Plan for DOE and a Host Site Agreement with the DeRidder mill.

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INTRODUCTION

Boise Cascade Corporation 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 METHANE de-NOX[®] 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 the Boise Cascade Corporation's mill 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.

Status (December 31, 2001): The Cooperative Agreement was executed with DOE for the project on August 8. A fully signed contract was executed on August 13. The contract was subsequently modified to change the DOE Project Officer pursuant to receipt of Sponsor's Amendment No. M001, dated October 1, 2001.

Discussions between GTI and Boise Cascade Corporation led to the selection of Boise's DeRidder, Louisiana mill as the host site for the demonstration. The gasification-based power generation system will be retrofitted to DeRidder's bark-fired and natural gas-cofired Boiler No. 2. DeRidder mill management confirmed this decision to GTI on September 4.

GTI conducted a conference call with mill management on September 7 during which the proposed major subcontractors for the project were reviewed and accepted by Boise DeRidder.

The project team will include Babcock Borsig Power (BBP) for boiler modifications and air heater design, Solar Turbines Inc. for the power island and air turbine development, Carbona Corporation for the biomass gasification technology, the University of North Dakota Energy and Environmental Research Center (EERC) for air heater materials studies, and Nexant LLC for plant integration and costing.

The project kickoff meeting was originally scheduled for early October, but the events of September 11 resulted in schedule disruptions and travel restrictions, which caused the kickoff meeting to be postponed. The kickoff meeting was held on December 12 at the DeRidder site with representatives from DOE, GTI, Boise and all major subcontractors attending. The meeting included a review of the project objectives by DOE and the overall project scope of work and project management and execution by GTI. Boise presented an overview of the mill's steam and electricity production and demand and the individual subcontractors made brief presentations on their experience and capabilities relative to their roles in the project. A detailed review of the Cooperative Agreement terms and conditions was completed by DOE, GTI and Boise. Tours of the paper mill and powerhouse were conducted for all meeting participants. Significant actions and decisions made during the meeting were:

- The DeRidder mill was accepted as the demonstration project host site, completing the project's site selection milestone
- Carbona Corporation will be added to the project subcontractors list
- The NEPA review task will be moved from Phase 2 into Phase 1
- In-furnace testing of air heater tube materials should be conducted in Phase 1 to facilitate selection of candidate tube materials for the Phase 1 cost evaluation
- The next major project milestones are execution of the major subcontracts and a Host Site Agreement

GTI executed appropriate Non-Disclosure Agreements with all prospective subcontractors during the performance period. GTI reached agreement on work scope and cost with BBP and Solar in December and subcontracts are now being prepared for DOE review. GTI also submitted a proposal to the Gas Research Institute during the performance period to secure cost share funds for the project and this proposal was approved. Work was initiated on the Project Evaluation Plan for DOE and a Host Site Agreement with the DeRidder mill.

Activities Next Quarter:

- Issue Budget Period 1 Project Evaluation Plan and Phase 1 Hazardous Substance Plan
- Finalize and execute subcontracts after review by DOE
- Update project schedule and spending curve based on kickoff meeting agreements
- Finalize and execute Host Site Agreement with Boise DeRidder after review by DOE
- Initiate boiler modification and air heater design studies by BBP
- Initiate Power Island Design study by Solar
- Initiate Gasification Island Design Study by Carbona
- Initiate preparations for Power Systems Integration Study by Nexant
- Define air heater tube materials testing plan for completion in Phase 1
- Attend project review meeting with DOE project team at OIT offices in Washington, DC

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 which 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. 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

It was agreed in the project kickoff meeting in December that DOE's NEPA review of the project would be moved from Project Phase 2 into Project Phase 1. Information for the review will be provided to DOE by GTI, the Boise DeRidder host site and GTI subcontractors as necessary. GTI will coordinate information gathering and submittal to DOE.

Task 1.1. Demonstration Site Evaluations

The primary focus of this task was to identify a paper mill host site for the advanced power system demonstration. The approach used was to evaluate the energy and environmental costs and needs of up to three candidate mills and then estimate the costs and benefits of applying the advanced power system configured in three different ways; maximum steam production, maximum power generation, and intermediate steam and power. GTI obtained detailed data on recycled waste fuels and supplemental fossil fuel characteristics and costs, steam generation and demand, electric power self-generation and demand, and environmental compliance issues from two Boise Cascade mills at Wallula, WA and DeRidder, LA. Energy cost comparisons were calculated from this data for three hog fuel-fired power boilers at the two sites ranging from 317 GJ/h (300 MMBtu/h) to 1160 GJ/h (1100 MMBtu/h) thermal input. A baseline operating case was calculated for each boiler and compared to the three advanced power system configurations discussed above. As a result of this analysis, the DeRidder mill expressed a strong interest in participation in the project. DeRidder's participation as host site for the demonstration was confirmed to GTI by mill management on September 4, 2001, completing this task.

Task 1.2. Gasification Island Design Study

No design activities were performed in this area during the reporting period. Discussions outlining workscope and costs for this task were initiated between GTI and Carbona Corporation in preparation for subcontract negotiations with Carbona for the gasifier section design evaluation.

Task 1.3. Indirect Air Heater System Design Study

No design activities were conducted in this area during this period. It was decided that the high pressure, high temperature air heater design evaluation would be included in BBP's work scope. As a boiler manufacturer, they are the best qualified to handle all aspects of the air heater design, including material selection, placement in the boiler, supports and heat transfer considerations. BBP will also assist GTI and EERC in defining a materials testing program and methodology for candidate tube and support materials to be conducted as part of the Phase I evaluation.

Task 1.4. Stoker Boiler Modification Study

No design activities were performed in this area during the reporting period. An agreement on the boiler modification evaluation work scope, including the air heater design study, was reached with BBP in a meeting between GTI and BBP at their offices in Worcester MA on November 29. BBP then submitted a cost proposal for this work and a draft subcontract to BBP is in preparation for review by DOE. Subcontract preparation is being expedited because boiler requirements will dictate much of the overall system design, and BBP will therefore play a central role in the design evaluation.

Task 1.5. Power Island Design Study

No design activities were conducted in this area during this period. An agreement on the power island design study work scope was reached with Solar and their cost proposal has been received by GTI. A draft subcontract to Solar is in preparation for review by DOE.

Task 1.6. Power Systems Integration Study

No design activities were performed in this area during the reporting period. Efforts will be initiated to define work scope and costs with Nexant for the integration study in preparation for subcontract development, review and approval by DOE. Discussions with Boise DeRidder during the December kickoff meeting indicated that the implementation strategy outlined in the proposal to DOE might be changed to install the gasifier earlier in the schedule (ahead of the HIPPS system) to accelerate benefits (reduced emissions and cofiring fuel costs) to the mill. This approach will be considered in the study.

Task 1.7. Capital and Operating Cost Study

No activities were conducted in this area during this period. Consolidation of cost inputs from the various design studies will be part of Nexant's subcontract scope to be developed.

Task 1.8. Phase 1 Project Management

The Cooperative Agreement was executed for the project by DOE on August 8 and signed by GTI on August 13. GTI confirmed DeRidder as the demonstration host site with mill management on September 4. GTI conducted a conference call with DeRidder management on September 7 during which the proposed major subcontractors for the project were reviewed and accepted by Boise DeRidder.

The project kickoff meeting was held on December 12 at the DeRidder site with representatives from DOE, GTI, Boise and all major subcontractors attending. Project objectives, work scopes and management approach were reviewed, and presentations made by all subcontractor on their respective roles and capabilities. Steam and electricity production and demand was reviewed by the mill. In a separate meeting, DOE, GTI and Boise reviewed the CA terms and conditions. It was agreed that the CA would be modified to move the NEPA study from Phase 2 to Phase 1 of the project and that Carbona Corporation would be added to the list of project subcontractors for the gasification island study. It was agreed that a revised project cost plan would be submitted to DOE in March when the subcontracts are finalized. It was further agreed that DOE would forward examples to GTI of the required project evaluation plan and report and an explanation of backup information required to accompany invoices. This material was received by GTI on December 17. The kickoff meeting concluded with a tour of the paper mill and powerhouse by all attendees.

In addition, during the performance period, appropriate Non-Disclosure Agreements were executed with all prospective Subcontractors. Agreement was reached on project scope and cost with the selected boiler and turbine contractors and subcontracts are now being developed. GTI submitted a proposal to the Gas Research Institute during the quarter to secure cost share funds for Phase 1 of the project and this proposal was approved. Work was initiated on the Budget Period 1 Project Evaluation Plan and Phase 1 Hazardous Substance Plan for DOE and a Host Site Agreement with DeRidder.

CONCLUSION

The reporting period saw all current Cooperative Agreement issues reviewed and resolved and the project plan modified to reflect current project conditions. The most significant accomplishment during period was the commitment by the Boise DeRidder mill to be considered as the host site for the demonstration. Obtaining a host site commitment was the major project objective for Phase 1 and DeRidder's early commitment will allow more project resources to be focused on the actual host site technical and economic feasibility evaluation and to developing engineering approaches for site-specific technical and economic barriers that may be encountered. However, the project team recognizes the value of insuring broad applicability of the technology within the FPI through pre-design evaluations of other paper mill sites. To retain this value to the project, GTI proposes to perform preliminary site evaluations to obtain project endorsements from three FPI companies in addition to Boise. This will be performed under Task 1.8, within the budgeted costs for Phase 1.

Work Planned for Next Quarter:

- Issue Budget Period 1 Project Evaluation Plan and Phase 1 Hazardous Substance Plan
- Finalize and execute subcontracts after review by DOE
- Update project schedule and spending curve based on kickoff meeting agreements
- Finalize and execute Host Site Agreement with Boise DeRidder after review by DOE
- Initiate boiler modification and air heater design studies by BBP
- Initiate Power Island Design study by Solar
- Initiate Gasification Island Design Study by Carbona
- Initiate preparation for Power Systems Integration Study by Nexant
- Define air heater tube materials testing plan for completion in Phase 1
- Attend project review meeting with DOE project team at OIT offices in Washington, DC

Appendix A

Project Costs

Project Budget Period		Period			Cumulative		
From	To	DOE*	Share*	Total	DOE	Share	Total
7/15/01	12/31/01	\$ 38,961	\$ 21,218	\$ 60,179	38,961	21,218	60,179
Previous Total		\$ -	\$ -	\$ -	64.7%	35.3%	100.0%

*Does not include approximately \$18,000 of subcontractor costs incurred for kickoff meeting attendance but not yet invoiced to GTI.

Budget Data

GTI, Boise Cascade FC26-01NT41108		Advanced Gasification-Based Fuel Conversion and Electric Energy Production System (1691) 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