

## QUARTERLY REPORT July 1 – September 30, 1999

### Project Background

The use of biomass and wood waste solids and sludges as fuel is often hampered by their low heating values and the presence of bound nitrogen that result in inefficient combustion and high NO<sub>x</sub> emissions. Cofiring supplemental fuel through auxiliary burners helps with improving the combustion effectiveness and NO<sub>x</sub> reduction, but the benefits are limited to the fractional heat input of the auxiliary fuel.

IGT has developed a process called METHANE de-NO<sub>x</sub><sup>®</sup>, which has shown substantially greater economic, energy and environmental benefits than traditional cofiring methods in demonstrations with both MSW- and coal-fired stoker boilers. In this process, illustrated in Figure 1, auxiliary fuel such as natural gas or oil is injected directly into the lower region of the primary flame zone just above the grate. This increases and stabilizes the average combustion temperature, which improves combustion of high-moisture fuels, provides more uniform temperature profiles and reduced peak temperature, and reduces the availability of oxygen to reduce NO<sub>x</sub> formation. This is in contrast to conventional reburning, where natural gas is injected above the primary combustion zone after the majority of NO<sub>x</sub> has already been formed.

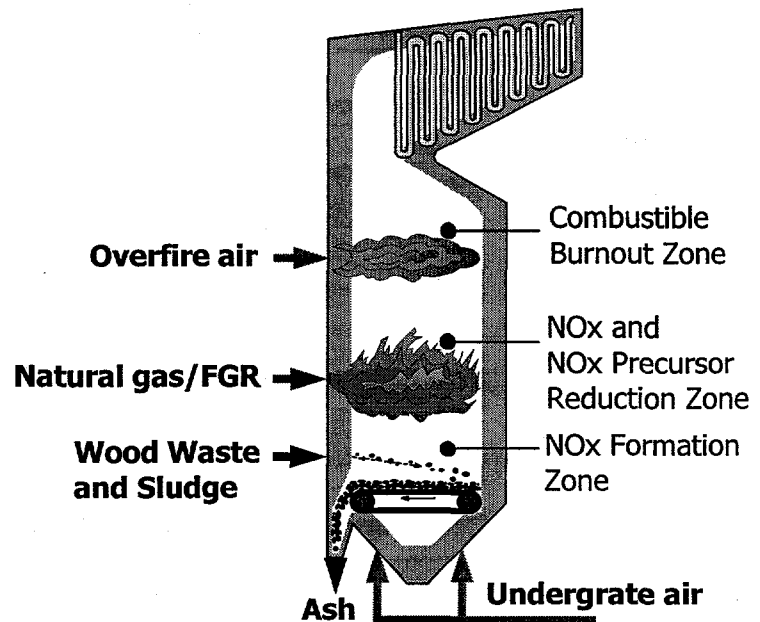


Figure 1. METHANE de-NO<sub>x</sub><sup>®</sup> reburn process for stoker boilers

Demonstration tests carried out with MSW- and coal-fired stoker boilers have shown over 60 % reduction in NO<sub>x</sub>, CO and VOC emissions, and a 2 % increase in boiler thermal efficiency using only 8 to 13 % natural gas. Since August 1998, METHANE de-NO<sub>x</sub><sup>®</sup> has been in continuous operation on all eight coal-fired boilers in Cogentrix's 240 MWe cogeneration plant in Richmond, Virginia.

### Project Objectives

The project team includes the Institute of Gas Technology (IGT), Detroit Stoker Company, Sargent and Lundy LLC, Boise Cascade Corporation and US EPA. The primary objective of the project is to promote greater and more efficient use of waste wood and sludge for energy generation in the forest products industry while keeping NO<sub>x</sub> and CO emissions in compliance. Phase 1 of the project will demonstrate the technology on the 300 MMBtu/h waste wood- and sludge-fired Boiler No. 2 at Boise Cascade's plant in International Falls, MN. The specific performance targets for the demonstration are:

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- Increased sludge firing from the current 1.2-1.5 tph to 5 tph
- Increased thermal efficiency for 40-100% load of 1 to 2 %
- NOx emissions reduced by over 50%
- Natural Gas input reduced by 25% compared to the current cofiring mode

In Phase 2 of the project, long-term performance testing of the process will be conducted on Boiler No. 2 to confirm performance, operability and reliability of the system over the full range of boiler operations. A second objective of Phase 2 is development of engineering design protocols for the METHANE de-NOX<sup>®</sup> reburn system suitable for a variety of boiler and grate types currently used for energy generation in the forest products industry. This will involve the following project tasks:

- Development of a furnace computer model as a design tool
- Pilot-scale testing with wood waste and sludge for model validation
- Baseline performance and emissions field testing on 3 additional wood waste stoker boilers
- Additional field testing on Boise Cascade Unit No. 2 simulating operating conditions found on other boiler types
- Development of a METHANE de-NOX<sup>®</sup> technology database for wood waste-fired boilers
- Development of design protocols
- Development of a commercialization and technology transfer plan

**Project Status and Plans**

A detailed schedule for the project is shown in Figure 2. The current status of each project task is discussed below.

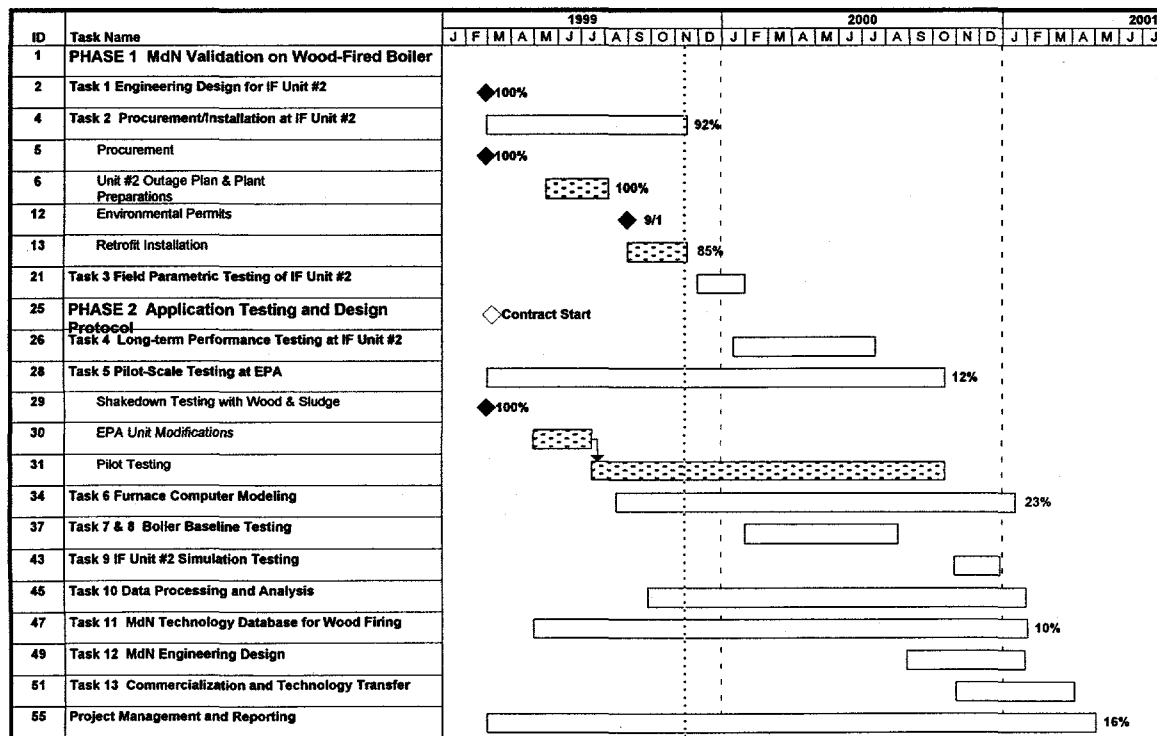


Figure 2. Project Schedule

### *Task 1 Conceptual & Engineering Design for International Falls Boiler No. 2*

All work in this task is complete. As previously reported, baseline testing was conducted on Boiler No. 2 and the results used to generate a conceptual METHANE de-NOX<sup>®</sup> design. Detroit Stoker Company has completed the detailed engineering design based on this information and all design documents were approved for construction.

### *Task 2 Reburn Equipment Procurement and Installation*

As previously reported, installation was significantly delayed from the original project schedule by delay in acquisition of the necessary Title V permit. This permit was received by Boise in late August, and retrofit installation begun in early September. Installation of the METHANE de-NOX equipment and has been the primary project activity for the reporting period, and is currently over 90 % complete. All major equipment and controls have now been installed. Electrical installation and insulation of the FGR fan and ductwork will be completed next week. A project review meeting will be held at Boise, International Falls, on November 18th attended by Boise, IGT and Detroit Stoker personnel to review final installation status and test planning. A 1-day boiler outage is planned for the week of November 22<sup>nd</sup> for final adjustments and instrument zero checks.

### *Task 3 Field Parametric Testing of the Retrofitted Boiler No. 2*

A preliminary parametric test plan was developed by IGT and reviewed by Boise operating personnel. The primary control approach for the METHANE de-NOX system was also defined based on the relationship of natural gas and flue gas recycle (FGR) flow distribution to boiler steam flow. This forms the basis for a detailed test matrix currently being developed by IGT for final review and approval by Boise at the end of November. The basic test sequence will be as follows:

- 1) Repeat test points #2 and #11 of the baseline testing at the normal average sludge feeding rate and steam production rate to confirm that the basic boiler operating parameters have not changed significantly from the original baseline testing conducted almost 2 years ago.
- 2) Conduct a total of 4 tests at the test #2 conditions (including normal sludge feeding rate) with FGR only to determine the effect of FGR distribution to the overfire air vs. undergrate air headers and between the front and rear overfire air headers.
- 3) Adjust FGR flow distribution based on results of the above testing, increase sludge flow to 3.5 ton/h (about 3 times normal) and then test with natural gas flow at 5 % and 10% of total thermal input to the front and rear distribution headers.
- 4) Select FGR and natural gas distribution based on the above testing, then conduct at least 2 tests at 4-5 ton/h sludge to optimize FGR and natural gas distribution for minimum natural gas usage.

IGT's specialized sampling and analysis equipment was inspected and repaired as necessary prior to shipping to the plant site. An additional water-cooled furnace sample probe has been ordered for delivery to the site as a spare. IGT personnel will arrive at the site on December 1<sup>st</sup> for installation and checkout of the sampling and analysis systems. Parametric testing will begin during the week of December 6<sup>th</sup> and is expected to continue for 6 – 10 days.

### *Task 4 Long Term Performance Testing*

No activity has taken place to date. Long term testing will start immediately following conclusion of the parametric testing in early 2000.

*Task 5 Pilot-Scale Testing*

As previously reported, shakedown testing was conducted using wood waste and sludge provided by Boise Cascade in EPA's 2 MMBtu/h multifuel combustor/stoker. It was determined that the existing feeding system on Pilot unit could not provide reliable and uniform feed rate with these fuels. EPA has modified the feeder to improve reliability and therefore data quality. The physical modeling effort will begin once feeder performance is tested and confirmed by EPA and IGT.

*Task 6 Furnace Computer Modeling*

IGT has acquired FLUENT (Computational Fluid Dynamics modeling and design code) software for the CFD modeling and design effort. The necessary computer hardware and peripherals have also been acquired. A full-time scientist with an extensive modeling background has been added to the project staff, and is supervising the subcontracting of the basic furnace model development effort. Since the last reporting period, Request for Proposals (RFPs) have been developed and sent to Reaction Engineering International (REI) and Fluent Incorporated for model development and implementation in FLUENT code, respectively. A draft Three-Party Non-Disclosure Agreement has been developed and circulated for review as the basis for the cooperative modeling effort by REI, FLUENT and IGT.

*Tasks 7, 8 and 9 Additional Field Baseline and Simulation Testing*

No activity has taken place to date. Negotiations for additional baseline test sites will be initiated following conclusion of the parametric testing in Boise Cascades Boiler No. 2 in early 2000.

*Task 10 Data Processing*

Activities will be conducted on an as-needed basis during and after completion of the parametric testing in December.

*Task 11 Development of METHANE de-NOX® Technology Database*

As previously reported, an extensive database of stoker boilers compiled by the Gas Research Institute was utilized to identify over 140 stoker boilers over 100MMBtu/h currently in use in the pulp and paper industry. A questionnaire was developed to acquire boiler design and performance information from boiler owner/operators. The questionnaire was submitted to Boise Cascade for review and comment prior to distribution. Distribution of the questionnaire will be coordinated with industry contacts to maximize response.

*Tasks 12 and 13 Engineering Design Protocols and Commercialization/Technology Transfer*

No activity has taken place to date.

*Task 14 Project Management and Reporting*

The IGT project manager, Joseph Rabovitser and Senior Combustion Engineer, Bruce Bryan participated in the Agenda 2020 Energy Performance Task Group annual review meeting in Washington DC on July 27<sup>th</sup>. Monthly progress review meetings, attended by the key Boise, IGT and DSC personnel, have been held at the Boise Cascade, International Falls plant site throughout the quarter to monitor and assist the METHANE de-NOX retrofit installation activities. This has been supplemented by weekly conference calls to insure timely response to all questions and concerns among the project team. As a result, the installation and process safety inspection (PSI) checks are proceeding on schedule.

**Project Schedule Summary**

With completion of the METHANE de-NOX installation and parametric testing in December-January, it is expected that the overall project can still be completed as originally scheduled in the 1<sup>st</sup> quarter of 2001.