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Operational Training: The Role of Simulators in Plant Operations

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## Abstract

It's 4 a.m. and the crane operator is a little overzealous, which is starting to show inside the boiler. The bad news is that by the way he's feeding the chute, it's only a matter of time until the control room operator loses control of the combustion process, the temperature drops and they'll face the consequences. The good news, this is a drill. It's only a drill. And the situation they're facing is only a simulation.

As part of its core training program for plant operating personnel, Wheelabrator Technologies relies on a special computer simulator, licensed from Von Roll Inova, that's as close to real life as flight simulators are to flying. Just as there's no airplane to damage as the pilot trains, there's no boiler. The simulator runs a sophisticated computer program that is identical to the control rooms of the waste-to-energy facilities Wheelabrator operates. It provides users with real-life operating challenges—the good, the bad, and the ugly.

Operating scenarios are simulated to exacting standards to provide plant personnel—the plant managers, control room operators, and crane operators—with the ability to respond appropriately to any situation. The simulator allows users to adjust any aspect of operation, from over- or under-fire air to moisture in the virtual trash being fed into the boilers. The process encourages teamwork and allows users to experience situations that could damage property, injure employees or harm the environment. The benefits of the ability to replicate upset and emergency, situations are clear: employees are ready for anything and the instruction helps prevent what would otherwise be downtime or expensive mistakes.

The simulator process only works, however, because it's part of Wheelabrator's overall training process. The simulator enhances "textbook" instruction in theory and hands-on qualification checks that all operators receive on a regular basis. It allows them to apply the knowledge they gain from the instruction in the controlled atmosphere of the simulator.

Roger Boisse, Senior Manager, Operations Projects with Wheelabrator Technologies, will explain the core operations training program and demonstrate the combustion simulator developed by Von Roll Inova, showing how it can be effective in providing operators with hands-on, and risk-free, experience.

## Overview

Over the past 4 years, Wheelabrator Technologies Inc (WTI) has been improving its in-house training program to challenge and improve the technical knowledge base of its employees. The core-training program uses a blended approach that combines both the theoretical and hands-on applications of power plant knowledge.

For the hands-on piece, WTI has developed job performance measures that are used as qualification standards based on an individual's job position. Each facility has developed a customized set of qualification checks used to examine employees' abilities--teaching new employees and refreshing seasoned employees in the, safe, efficient operations of their plant.

The theoretical curriculum of the program uses General Physics Corporation's web-based training topics. Operators can access the base theory from over 1,500 topics. Each employee has a training plan developed that they follow in conjunction with the hands-on training.

One of the highlights of the Wheelabrator training program is a Combustion Simulator developed by Von Roll Inova of Zurich, Switzerland. Wheelabrator licensed the simulator from Von Roll and uses it to train employees on proper combustion practices in the waste to energy boiler. The simulation program was originally used by Von Roll's R&D division and through discussions with WTI developed it into a simulation-training tool.

The simulator combines Von Roll's furnace design technology with Wheelabrator's combustion control system and B&W boiler configuration to produce a computerized working model of a Wheelabrator 750-ton per day mass burn waste to energy boiler. Trained operators, E&I technicians, and mechanics all benefit from the simulator to better understand the operations of their units, making better judgments to continuously improve performance.

There are many advantages to the simulator that will be presented in the following sections.

1. Simulator characteristics
2. Operator training sessions
3. System modeling – comparison to current operation

## Simulator Characteristics

The Von Roll Combustion Simulator interface is comprised of multiple screens for the operator. It is best if the simulator is run on two or three screens using a dual video card, allowing the user to see many screens readily without having to change back and forth between them. The two most common screens the operator uses are the process simulator and the process control system screens. The simulator software runs from a main server program that controls both the process and control system programs once they are linked together.

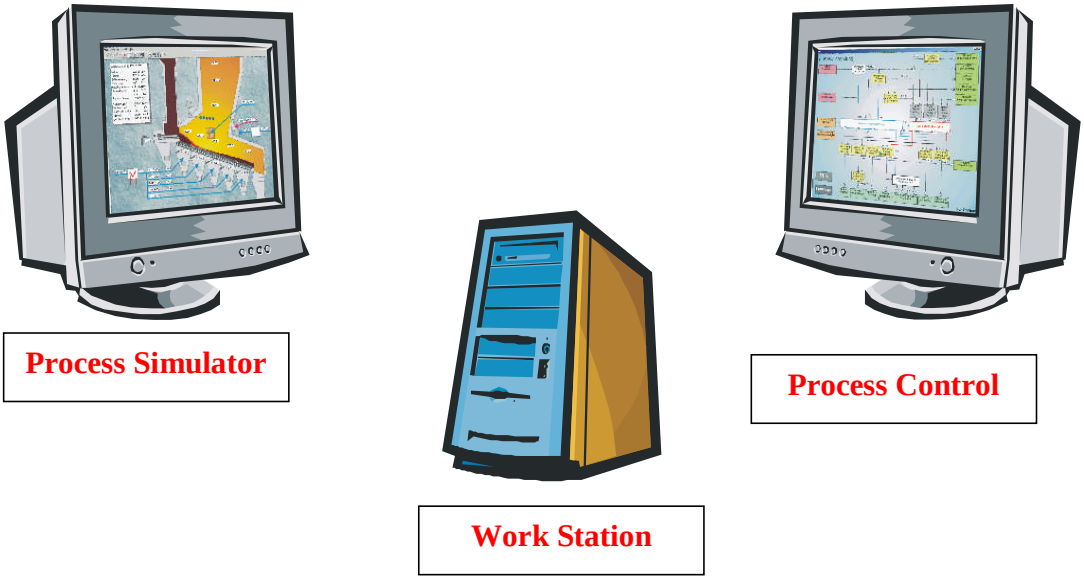



Figure 1: Model of process and control simulator

The process simulator is a computerized model (Fig. 1) that replicates a waste to energy boiler's operating characteristics. The process simulator displays a side sectional view of the boiler with real time pressures, temperatures, and other operating characteristics that pertain to the simulator operations. The side sectional (Fig. 2) provides a display of the refuse "bed" so that the operator can see the thickness of the fuel bed and flame indication during the simulations and can adjust accordingly. Fuel HHV, feedchute arches, and tramp air intrusion all can be adjusted to provide different scenarios that challenge the student.

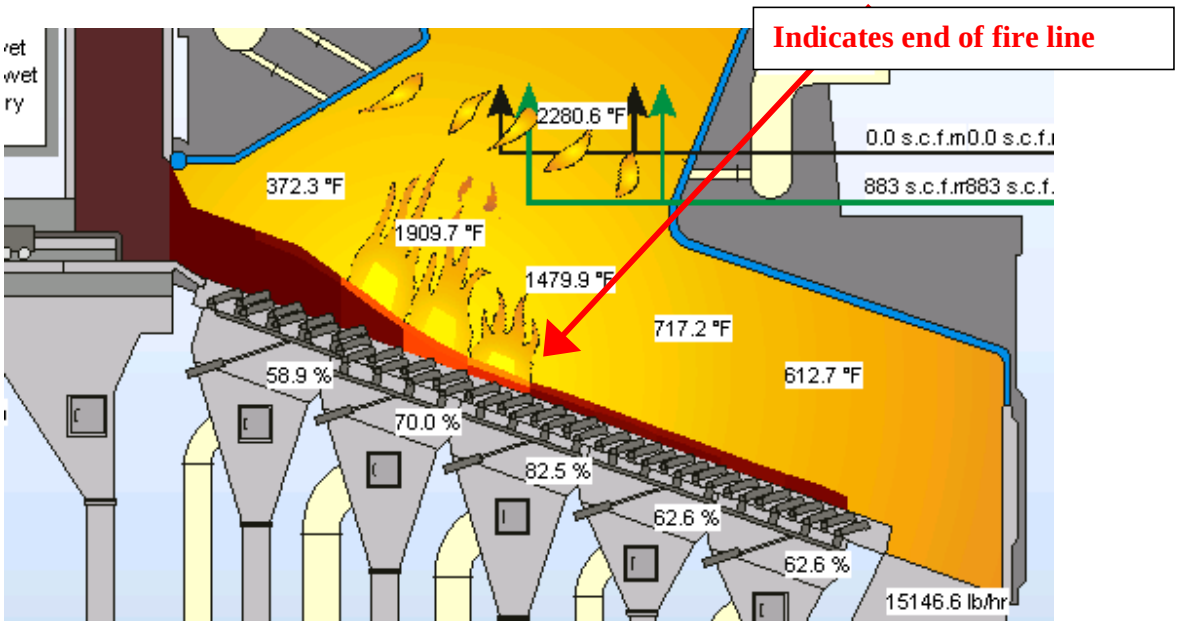



Figure 2: Furnace profile showing fire line

The bed is multi-colored to visually represent temperatures so the operator can identify the differences in temperature of the fuel bed. The visual scale ranges from brown (cooler temperatures) to yellow (hot temperatures). The actual "fire line" is located just following the flame pattern. The process simulator also contains an information box (Fig. 3) with critical system operating information to help the operator evaluate conditions in the unit. The box displays the current "system time" and contains information on steam production & temperature, FEGT, and flue gas values. These parameters are critical to the operation of the unit over the life of the campaign. The simulation time of the program can be adjusted so that the instructor and student can analyze events faster then real time. Students learn by testing different scenarios and upset conditions that require operator intervention. Focus is placed on understanding the affects of the upsets throughout the unit and their affect on boiler performance.

It is well documented throughout the waste to energy industry that high temperature chloride corrosion is present in waste to energy boilers. It has also been stated by the National Association Of Corrosion Engineers (NACE) [1], that it is usually more economical to simply control corrosion to a reasonable limit than to try to eliminate corrosion completely. The simulator provides the laboratory for this type of analysis and instruction so the operator of the unit can see how his/her changes affect the overall performance and they can test different scenarios to find the appropriate operational solutions.

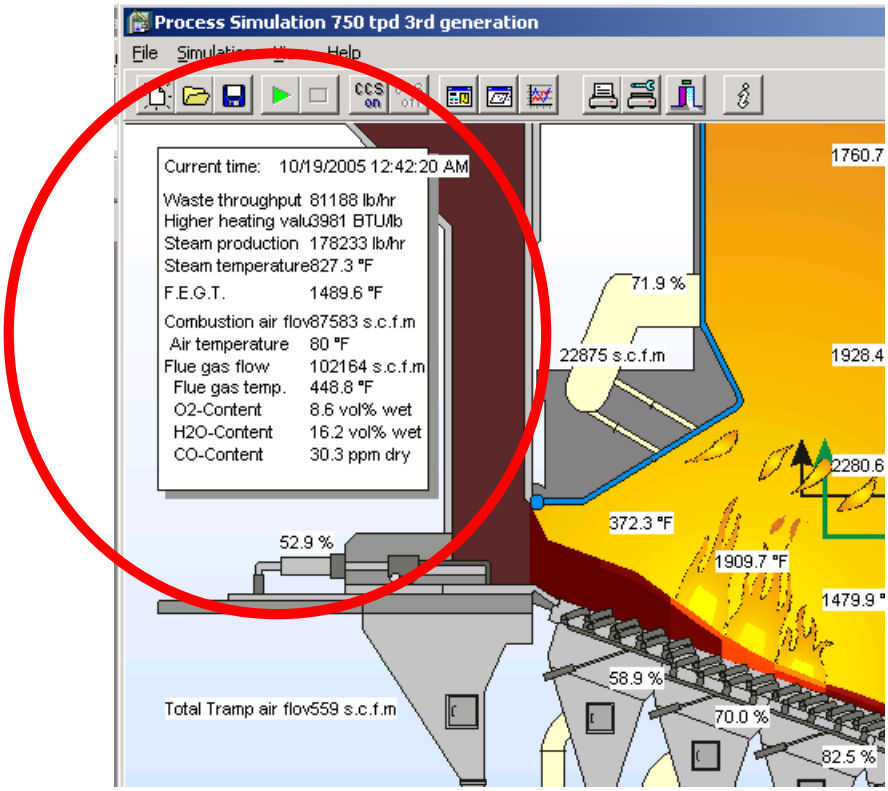



Figure 3: Simulation Operating Data

## Combustion Control System

The combustion control system program (Figs. 4&5) controls the boiler master, grate, ram and air bias stations and zone ratio stations. The student has control to manipulate any of the operating parameters that currently exist on the operational units at the facility. This has been very beneficial in training new operators as they learn how to burn refuse. It familiarizes them with the control logic so that mistakes or miscues can occur on the simulator and not on the operational unit.

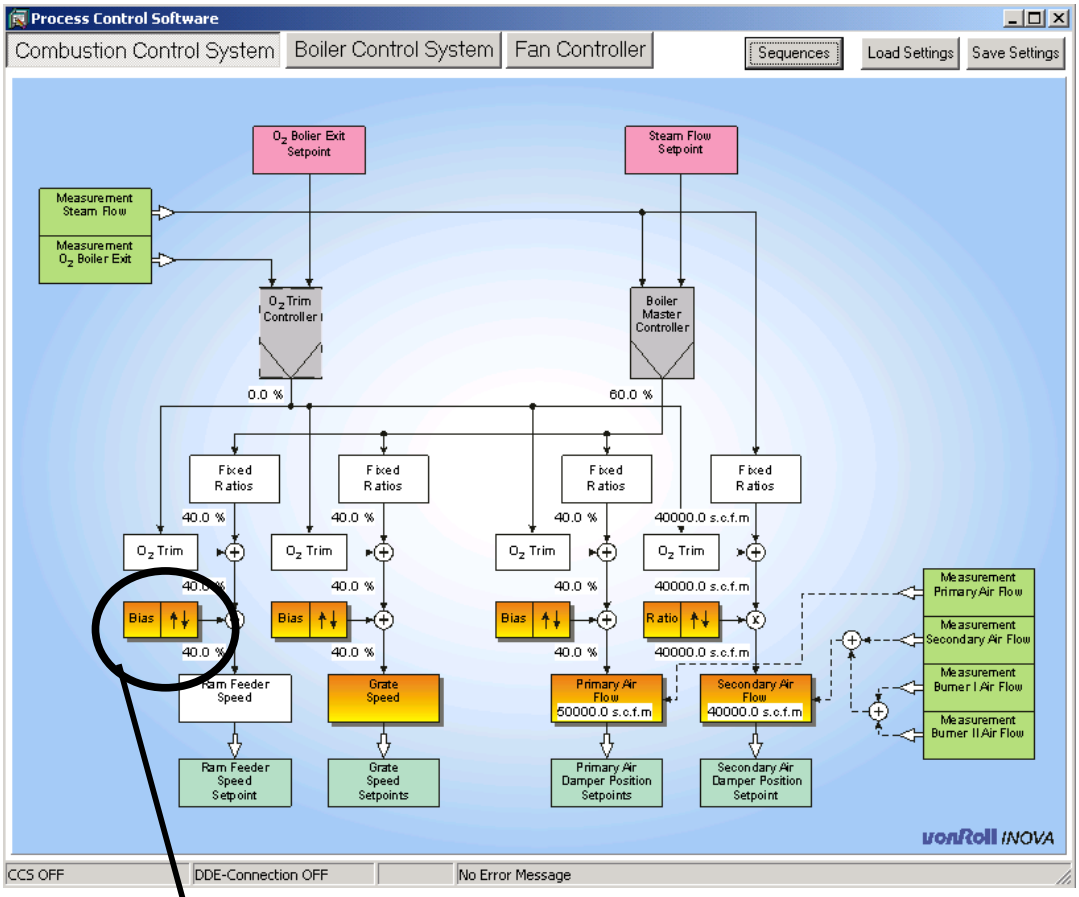
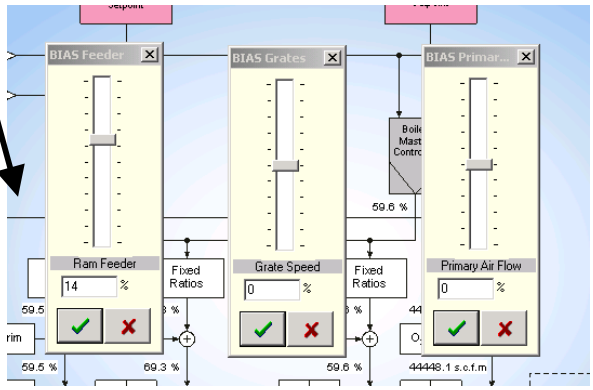



Fig. 4 & 5 Combustion Control Screen and bias controls



**Boiler Side Sectional and Control System**

The Boiler view (Fig. 6) displays a cross sectional view of the WTE boiler so that the operator can monitor temperatures, pressures and other operating characteristics throughout the unit's different heat exchange surfaces and air pollution control (APC) equipment.

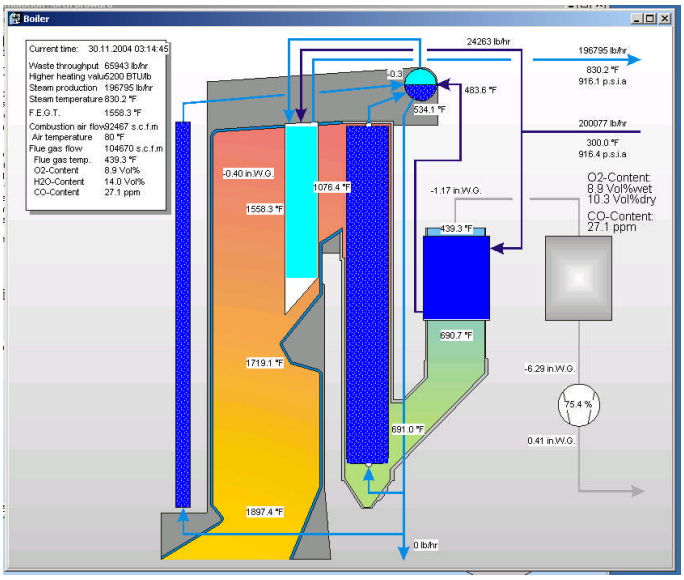



Figure 6: Boiler Side view

An additional function of the boiler screen allows the operator to view a cross sectional area of a tube from any of the different heating surfaces. The display (Fig. 7) shows the temperature changes from the flue gas, through the dust layer, tube and into the water.

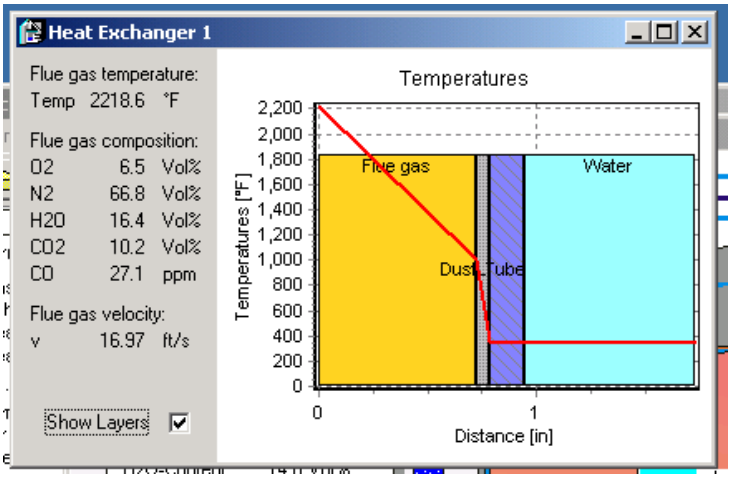



Figure 7: Flue gas detail at boiler tube

Another tool that the operator has at his/her disposal is the Load Range Diagram (Fig.8) that provides data to the operator on where in the overall design of the unit he/she is operating.

Operators apply directly the theory they learn from the tube profiles and load range diagram to the operating units to see how changes in operation translate into boiler performance of their operational units over a period of time.

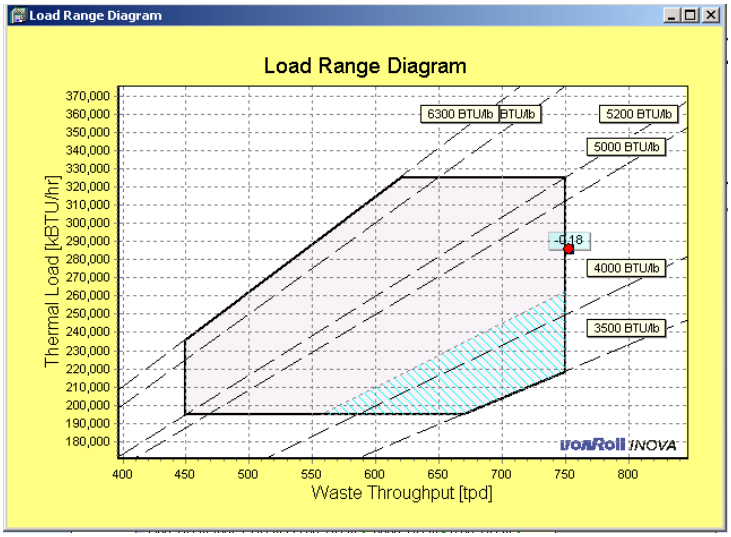



Figure 8: Load Range Diagram

## Trending

Trend graphs (Fig. 9) display data using any of the parameters in the simulator. This functionality is critical to the learning process as the student and instructor together analyze performance of a scenario and how the changes made to the simulator during the scenario affect the overall operation of the unit. Operators evaluate these trends to identify more efficient operations and to analyze where the correct or incorrect decision may have started.

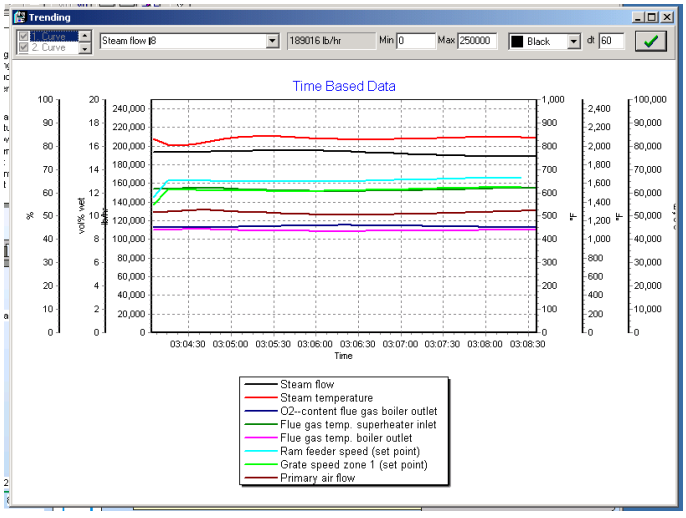



Figure 9: Trend Graphs

**Changes to Process Simulation and Combustion Control Settings**

The instructor using the server software simulation settings can make temporary changes to the process simulation. This permits the instructor to be able to "modify in real time" the scenarios that the student is working on. The scenarios can be modified at any time during the simulation or can be designed specifically for a certain response. Students are challenged with casualties, upsets, changes in fuel conditions and can then evaluate their changes based on their actions. Some common parameters that are changed are:

- Heating Value (HV)
- Deviation Heating Value
- Crane Capacity
- Vapor from Expeller
- Tramp Air (Refuse Feed Hopper, Ash Expeller, Generator Hopper
- Max. Temperature Preheater
- Operating Hours – Fouling of the unit (All surfaces, Superheater, Generator, Economizer)

**Operator Training sessions and system modeling**

**Annual training**

Wheelabrator has developed a training course in conjunction with Von Roll Inova where multiple simulators are set up in a classroom environment. Operators, E&I technicians, mechanics and plant management all take part in the classes. Von Roll Inova provides two experts in waste to energy as lead instructors for the sessions. The sessions are designed to have entire shift compliments attend together so that shift teams work together to understand how each change affects the other individuals of the team. Each group has the opportunity to walk in the others shoes. The process builds communication across the shift by each of them experiencing and analyzing scenarios together. The simulator has the capability of recording multiple trends of student groups and these recordings are used to compare and review with the entire class, so that the greater group can understand why certain actions were taken. This evaluation has been very effective in large group training classes.

**Plant modeling**

One other function of the simulator that Wheelabrator has been developing at its facilities is to set up the simulator to match the current operating situation and combustion settings already in operation. Operators can then use the simulator to create what if scenarios and evaluate the results of their actions prior to making changes on the operating units.

**Conclusion**

The functions of the simulator are useful to the operator in helping to understand the theory of operation. They have proven to be a real life laboratory of applied combustion management and operations.

Today's Wheelabrator employees are thinking the thinkable.

References:

[1] NACE International, August 2003, Basic Corrosion Course, Chapter 1