# Green Energy Engineering, Inc.

*"Pay less for Energy and save the Earth"*

4737 Dolphin Cay Lane South Unit B108 • St. Petersburg, FL 33711-4671
Phone (727) 742-7276 • www.geeintl.com


## SAMA Symbols – Firing Rate Control


SAMA Symbols reveal the ease of communicating and documenting the economics and safety of boiler firing rate controls. This is the fourth of a nine part series on SAMA Symbols.


Fuel prices are rising and the public is focused on smoke stack emissions. Upgrading to a fully automatic boiler firing rate control scheme will save money over the current mechanical linkage (jack shaft) system and allow for better and cleaner emissions. The mechanical linkage is fixed and cannot adjust for summer and winter combustion air temperatures, nor can it be easily modified to accommodate an oxygen trim system.

Boiler firing rate control maintains the steam header pressure while adjusting the fuel and combustion air in a safe and economical range. The mechanical linkage can do this safely with excess air. Too much combustion air allows heat and money to needlessly go up the stack. However, too little air and unburned fuel is wasted or worse, there is a boiler explosion.

In this article we'll look at how a mechanical linkage oil fired system can be converted to a full metered, parallel, cross limited boiler firing rate control scheme that is clearly represented on paper by SAMA symbols. SAMA stands for Scientific Apparatus Makers Association, the organization that came up with the symbolic language to represent the various pieces of control loop hardware and how they interact together to create a process control scheme.

The oil control valve with mechanical linkage will be changed out to a pneumatic control valve with positioner and a current-to-pneumatic (I/P) transducer. A fuel flow meter will be installed and the combustion air will be measured by a flow device. The combustion air damper will be retrofitted with a damper drive positioner and a current-to-pneumatic (I/P) transducer. Changes to the combustion safeguards system will also be required, but that is beyond the scope of this discussion.

A boiler firing rate control scheme is a full metered system if it measures (or meters) both combustion air flow and oil flow. A parallel control scheme is one in which independent two-mode (or proportional / integral) controllers regulate the oil and combustion air flow separately. A cross limited scheme means that the actual oil flow set point and combustion air flow set point are tied together in a safe and conservative ratio. And finally, these controllers are driven by a boiler pressure master. If all these assumptions are correct, then the boiler firing rate control scheme would look as follows in SAMA symbols in figure 1.

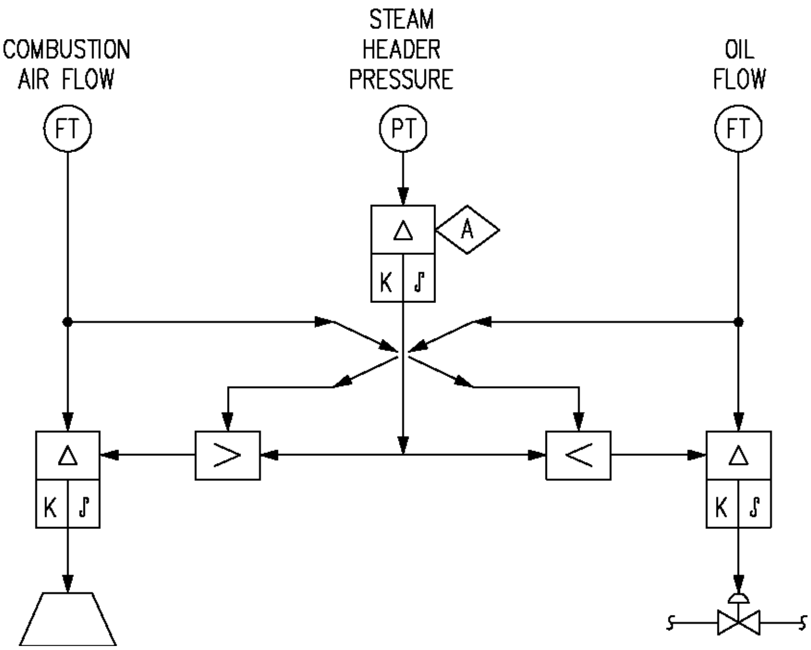


Figure 1

From this drawing, we see that the combustion air flow is measured, controlled, and modulated. The same can be said about the oil flow. This diagram then shows full metered, parallel combustion control. The steam header pressure controller outputs a signal to these two controller set points by way of high and low select relays. Notice that these relays also receive signals from the actual combustion air flow and oil flow. This is representative of cross limiting.

This is how the cross limiting high and low select relays operate. Assume that the boiler is at 50% firing rate and that the steam header pressure controller output increases to 55%. This signal goes to both the high and low select relays which are currently also receiving 50% fuel and air flow signals. The output of low select relay on the fuel side stays at 50% because the measured air flow is only 50% despite the 55% demand signal. The output of the high select relay on the combustion air side increases to 55% as requested by the steam header pressure controller because that is the higher value signal between the 50% fuel flow and 55% demand signal. As the measured combustion air flow signal increases from 50% to 51%, the low select relay on the fuel side starts passing that increasing signal through (51% then 52%, etc) until it also has a set point of 55%. This shows the cross limiting result of air leading fuel on load increases. This is a safe condition because the control system has ensured that there is more than adequate air for combustion.

On a load decrease, the fuel would lead the combustion air. For instance, on a load decrease from 75% to 70%, the low select relay would pass through the lower 70% signal and the fuel flow would start to decrease. Only upon measured fuel flow decrease would the high select relay start to pass through the lower signal. Once again the control system has ensured that there is more than adequate air for combustion by proving that the fuel flow has decreased before decreasing the air flow.

The combustion air can also be temperature and pressure compensated to allow for a more accurate mass flow indication to correct for winter and summer conditions. An oxygen trim control scheme can also be added to directly optimize the proper and economical amount of combustion air. And that will be the topic of the next article on SAMA symbols, the fifth article of a nine part series.

This article on SAMA symbols was written to convey the power, elegance, and ease of designing complex control schemes. This article is not a full, complete, or correct design of any control system. The reader shall retain the services of a licensed professional engineer with extensive process control experience. The professional engineer must first analyze the specific process in question. As my college professor used to say, “You can’t design a control system ***until*** you understand the process.”



Eric Coffin, Registered P.E. - Florida, is president of Green Energy Engineering, Inc., a company focused on solutions that can reduce the amount and cost of purchased energy. He has a Bachelor’s degree in Mechanical Engineering with an emphasis on Thermal Processes, Process Control, and Fluid Flow. Coffin is a certified energy manager worldwide and is an approved Professional Engineer Continuing Education provider in many states. For more information, visit www.geeintl.com