Introduction
The primary function of a utility boiler is to convert water into steam to be used by a steam turbine/generator in producing electricity. The boiler consists of a furnace, where air and fuel are combined and burned to produce combustion gases, and a feedwater tube system, the contents of which are heated by these gases. The tubes are connected to the steam drum, where the generated water vapor is drawn. In larger utility boilers, if superheated steam (low vapor saturation) is to be generated, the steam through the drum is passed through superheater tubes, which are also exposed to combustion gases. Boiler drum pressures can reach 2800 psi with temperatures over 680°F. Small to intermediate size boilers can reach drum pressures between 800 and 900 psi at temperatures of only 520°F if superheated steam is desired. Small to intermediate size boilers are only being considered for this application note.

Application
Feedwater Flow Control - In electrical power plants, demineralized feedwater is pumped to the boiler tube header. The feedwater flow is regulated by either controlling the pump speed by using a process control valve. The normal effect of pure water corrosion-erosion (or cavitation) that causes premature seat failure within the valve is amplified because velocities of 10+ fps can be reached.

Figure 1: Typical Boiler Drum/Feedwater System
The added cost of frequent valve replacement makes utilizing a feedwater pump the preferred method of flow control. Controlling pressure by varying the pump speed saves on overall pump power usage.

**Pump Speed Control** - Controlling pump speed is accomplished by variable-speed electric drives or by close-coupling a steam turbine to the pump. By definition, cogeneration power plants produce both electricity and excess steam where turbine exhaust is used as a heat source. A steam turbine driven feedwater pump is most often applied because of the abundance of available steam.

**Boiler Optimization** - With a boiler’s firing rate held constant, feedwater pressure and flow affect boiler pressure. As electricity demands change, so do associated boiler loads. When more electricity needs to be generated, the boiler produces more steam, therefore feedwater flow must be increased to the boiler. Significant savings are realized if boiler drum pressure and feedwater discharge pressure are held to a constant differential. This can be accomplished by accurately measuring this pressure differential and controlling the pump speed and feedwater flowrate accordingly.

In this example, boiler drum pressures can vary between 800 and 900 psi depending upon the load, (See Figure 2). The feedwater pump discharge pressures can vary between 875 and 1000 psi depending upon boiler demand. Differential pressure between the two points can be up to 200 psi, or even higher in system upset conditions. This differential pressure must be accurately measured, without regard to the 800 psi and above changing boiler drum static pressure.

**Yokogawa Solution**

DPharp’s EJA110E and EJX110A "V" range capsule can measure differential pressures up to 2000 psi with the same ±0.055% and ±0.040%, respectively, of span reference accuracy of lower range capsules. In this common application example, ranging the EJA110E V range transmitter 0 to 300 psi allows for the measurement of both boiler pressure and feedwater pump discharge pressure. During pump start-up severe pressure spikes of 500+ psi can occur which can cause shifts in zero.

Many competitors claim re-zeroing their transmitter at static line pressure minimizes these zero shifts but this task may not be practical under fluctuating pressure conditions. The DPharp transmitter can be bench calibrated and installed into a high static pressure line without re-zeroing. DPharp is unaffected by these pressure surges due to its superior overpressure protection. The transmitter performance specs are guaranteed over two years.

The power plant’s control system can use the high pressure differential measurement to automatically set the feedwater rate depending on the boiler load demand. At lower demand periods, less steam is used to power the steam turbine driven pump and less feedwater is consumed. Significant savings are realized through steam conservation and by lowered maintenance costs with the use of the DPharp transmitter.

(Also see Application Note on Boiler Drum Level Measurement PAG-505)