General Control Philosophy

Honeywell's control philosophy is to provide a complete control system designed to operate a unit safely and efficiently over the unit's entire operating range. Honeywell can provide controls for the entire plant from the coal pile, to the burner safety system, to the turbine controls, to the flue gas clean-up system. The exact control configuration is dependent upon the unit design, operating philosophy, and process measurements available to the Experion PKS™ Process Knowledge System.

Honeywell has designed and developed a set of control implementation standards that are used as the starting basis for all projects. Use of these standards ensures continuity in design, shorter project cycles, lower implementation costs, more complete integration and utilization of control system functionality, and lower life-cycle costs. These standards include control strategies as well as graphic displays for operations.

Honeywell control standards are based upon the real world experience gained from past utility projects built on Honeywell control systems. The basic subgroups included in the standards are:

- Boiler-Turbine Coordination
- Air Control
- Fuel Control
- Mill Control
- Furnace Draft Control
- Feedwater Control
- Superheat Control
- Reheat Control

It is from these standard subgroups that Honeywell will implement a control system that meets a specific plant's design and operating requirements.

These proven strategies take full advantage of the Experion PKS system capabilities to provide the user with maximum benefit. Features inherent in all control subgroups include:

- Bumpless transfer between all modes of operation.
- Automatic transmitter selection when redundant transmitters are used.
- Intelligent alarming.
- Device operational balancing biases are memorized.
- Limit checking of operator inputs to prevent inappropriate commands.
- Predefined control action upon loss of a process measurement to ensure plant safety while maximizing the ability to maintain automatic control.
- A family of interlocks, overrides, rundown, and runback are provided to ensure safe operation of the plant.

Security of a control system goes beyond just providing hardware redundancy. Security must be an inherent feature in the control system.
Transmitters are usually the weakest link in a control system’s security. Several transmitter security approaches are standard within the Honeywell control system to ensure continued safe operation of the process. These approaches are a function of the degree of criticality of the signal, as well as the level of redundancy provided. In general, Honeywell recommends (and in some loops NFPA requires) that all critical process measurements use triple redundancy to guard against erroneous control action upon any single transmitter failure.

The operator interface is just as important to the safe operation of the unit as is the control hardware and strategy. The operator interface must be easy to use and intelligent. Ease of use means an operator can quickly ascertain desired information and implement an action. Intelligent means the system recognizes when grossly inappropriate control is being initiated and prevents those commands from being sent to the control system. Simultaneously, the operator is informed of the reason that the system ignored the command. The Experion PKS Station meets all these requirements.

**Boiler-Turbine Coordination**

Coordination between the Boiler Controls and the Turbine Controls is critical for maximizing stability and unit response. The Master Control section, often referred to as the Front End, consists of the Unit Master, Turbine Master, and Boiler Master subgroups. These three subgroups coordinate the actions of the boiler and turbine. The Unit Master can operate in one of four modes: BASE, Boiler Following, Turbine Following, or Coordinated. It is anticipated that Coordinated control will be the normal mode of operation since it offers the best response/stability relationship.

In BASE mode of operation both the Boiler Master and Turbine Master stations are in manual, therefore the operator has responsibility for the unit’s operation and coordination.

The Boiler Following mode automatically aligns the boiler to the actions of the turbine. This is accomplished with feedback action and giving the boiler responsibility for controlling throttle pressure. The Boiler Following mode is recognized for its speed of response to megawatt demand because the turbine’s response is independent of the boiler. Because the turbine’s response is without regard to the boiler’s ability, the overall system stability can be less than desirable.

In the Turbine Following mode the turbine is automatically aligned with the actions of the boiler. This is accomplished with feed forward action and by giving the turbine responsibility for controlling throttle pressure. This is considered a very stable mode of operation, since the turbine can respond much faster than the boiler. However, load changes are rather slow since they can only occur as fast as energy levels within the boiler can change. The Turbine Following mode is automatically activated on boiler runbacks/rundowns, due to its inherent stability.

The COORDINATED mode is considered the normal mode of operation since it provides the best response to load changes without sacrificing stability. In this mode, both the Boiler Master and the Turbine Master respond together, as opposed to one following the other, and the load demand is set by the Unit Master control. Features such as minimum, maximum, and rate of change limiting and frequency coordination are available in this mode. This mode provides rapid response to load changes without sacrificing stability. This mode also allows the unit load demand to be set by an Automatic Dispatch System (ADS).

**Air Control**

The air control subgroup regulates the Forced Draft fans to provide the proper amount of air for safe, efficient combustion of the fuel. The unit firing rate demand sets the requirement for airflow and acts as both a feed forward for the fans and as a setpoint for the required airflow. The airflow demand is low limited by actual fuel flow entering the boiler, and a minimum airflow requirement, to ensure that the demand for airflow will always be adequate for safe combustion of the actual fuel flow.
The Air Controls provide the ability to maintain a uniform response for either one or two fan operation. In addition, bias action applied to the fans will not result in a process upset. The FD fans are not released to automatic unless at least one ID fan has been placed in automatic.

Flue gas oxygen is measured and compared to a setpoint based on a load index, to trim the airflow demand. The O2 trim is applied to the airflow demand, as opposed to measured airflow. This ensures that the O2 trim cannot reduce airflow below the minimum value. This also means that the effect of the O2 trim on airflow is prior to using the total airflow signal for cross limiting of the fuel flow.

Interlocks are provided on both the inlet and discharge dampers so that if one fan is idle and the other fan is in service with its discharge dampers open, the idled fan's dampers will be interlocked closed.

**Fuel Control**

The Fuel Master develops the base control signal for the regulation of the unit's coal mills. The demand for energy input to the boiler is set by the Boiler Master logic. The demand for BTU input is cross limited by total airflow. Total coal flow is calculated by summing the coal flow for each mill. The type of coal flow measurement varies from plant to plant, and may be derived from feeder speed, mill differential, feeder demand, etc. A mill model is included to more accurately convert the coal flow measurement into a representation of the energy release in the furnace.

The coal flow is converted to a BTU value and is calibrated on line using the boiler as a calorimeter. This is done for safety rather than functional reasons, since it permits effective fuel-air cross limiting. BTU calibration is automatically defeated at low loads to prevent erroneous control action.

**Mill Control**

The Mill Control is a set of logic that regulates each pulverizer on the unit and sets the amount of coal fed to the mill, the amount of primary air flowing through the mill, and the temperature of the coal/air mixture leaving the mill. The mill control strategy is dependent upon the type of mill being used on a particular unit.

The density-compensated primary airflow into the mill is controlled to provide the transportation of coal to the furnace.

The temperature of the coal/air mixture leaving the mill is controlled to assure proper drying of the coal. In order to not limit the amount of primary airflow to the mill, limits are applied to the temperature correction to prevent the control system from trying to force the hot or cold air dampers beyond fully opened or closed.
Interlocks to the Burner Management System (BMS) are included, as required.

Feeder demand is set by the Fuel Master based on the unit’s load requirement and the number of mills in service. If Mill Differential Pressure or Mill Amps exceed high limits, the feeder demand is slowly reduced until the condition clears. The feeder demand is interlocked to 0% on any of the following conditions:

- Mill not running
- Exhauster not running (when applicable)
- Feeder not running
- Master Fuel Trip

The Feeder Station is not released to automatic unless safe operation of the mill is possible, and the Hot and Cold air stations are in automatic.

**Furnace Draft Control**

The Furnace Draft control regulates the Induced Draft (ID) fans to provide the proper exhausting force for gas flow through the boiler. The ID fans are balanced with the FD fans to keep the furnace pressure at the desired value. This control strategy regulates the ID fans by a feed forward program that is then corrected by any deviation of the furnace pressure from setpoint.

The furnace pressure is measured using the NFPA required three independent transmitters, with the middle signal selected for control. This assures that failure of any one transmitter will not result in loss of automatic control. In keeping with NFPA requirements to minimize any negative pressure excursions, a kicker circuit starts the ID fan inlet dampers running closed should a Master Fuel Trip occur. There is also a furnace pressure override that adds a bias to the ID fan damper control signal to minimize any furnace pressure excursion. This override is downstream of the fan stations, thus it is active even when the fans are in manual.

Interlocks are provided on the inlet and discharge dampers such that any time one fan is idle and the other fan is in service with its discharge dampers opened, the idled fan’s dampers will be interlocked closed.

**Feed Water Control**

Feed water control implementation will vary from plant to plant due to the type of final control devices - valves and/or pumps. Two modes of automatic control are provided:

- Single element for start up
- Three element for normal operation

Under single element control, the control devices are regulated strictly to maintain drum level.

Under three-element control, the control devices are regulated to maintain the desired feed water flow. Steam flow corrected by drum level control acts as the set point for feed water flow.

NFPA code requires that more than one level transmitter measure drum level. Honeywell recommends at least three. Density compensation of the level signal is critical for safe operation of the unit, especially when operating at other than design pressure, such as during startup or under variable pressure mode. Since multiple drum level measurements must be available to the operator for reference and/or recording, each transmitter must have its own density compensation.

Transfer between single element and three-element control is automatic and bumpless, and is initiated based on unit load.

**Superheat Control**

The physical process design will dictate details of the control requirements for the main steam temperature, typically referred to as the superheat temperature. For this discussion, two stage attemperation with a twin pass arrangement and a common final steam temperature measurement is assumed.
Boiler Control for Fossil-Fired Utility Boilers

Attemperator spray valves are regulated to maintain the proper attemperator discharge temperature, thus providing a relatively fast control loop. A dynamic program derives setpoints for each attemperator discharge temperature, providing stable regulation even though there is a significant time lag between spray and final steam temperature.

Interlocks are provided to close the spray and block valves on a Master Fuel Trip, turbine trip, or when operating at low loads. To ensure safe operation, the appropriate loops are transferred to manual upon detection of a process measurement failure.

Reheat Control

The reheat temperature control strategy is also dependent on the physical boiler design. The Honeywell standard approach assumes that water attemperation is used. A two-element design is used with deviation from desired temperature trimming a feed forward program to set the spray requirement. A detected process measurement failure will initiate manual control of the spray valve.

Redundancy – Reliability

The Honeywell boiler control strategy, like the Experion PKS system platform on which it resides, is designed for the utmost in reliability. Reliability, which is sometimes measured as availability, is provided by the following factors:

- **Integrity** - Integrity is achieved by self-checking, failure detection, fault containment, and inherent safety designed into the system.
- **Redundancy** - The configuration of multiple elements that can produce correct output when one or more of the elements is not functioning correctly. The Experion PKS system architecture provides for redundancy at several levels. The most critical system elements are fully redundant with automatic switch over.
- **Maintainability** - The Experion PKS Solution system is designed to be maintainable, resulting in minimal time to diagnose and correct troubles. Many maintenance activities can take place while the system remains on-line in control of the process.

Digital Transmitter Integration

Honeywell pioneered the use of digital communications to directly integrate multi-variable field measurement sensors with the distributed control system. The C200 Process Controller integrates with Honeywell's Smart Transmitter family. This integration provides:

- Enhanced measurement accuracy.
- The ability for operators from the Global User Station and/or Universal Station to access full and working range values and transmitter status.
- The ability to configure a transmitter from the Global User Station and/or Universal Station without the need for a handheld communicator.
- Full transmitter diagnostics monitored at the Experion PKS Station.

Optional Features

Advanced Control

Early control designs for fossil fueled power plants were not focused on response, dynamic heat rate, or other process issues because they were designed for base load operation. As the operating conditions of new units changed and larger units were built, the need arose to operate in a dynamic environment. Old pneumatic and analog electronic systems based on PID control have few provisions for accounting for process variations or process hysteresis.

The processing power available in modern control systems offers a platform suitable for more advanced control algorithms as well as more advanced control strategies. Concurrent Front End (CFE) and Advanced Combustion Control (ACC) are such offerings.
Concurrent Front End

Boiler-Turbine coordination can be accomplished with Concurrent Front End (CFE) as an alternative to using conventional front end, PID control. CFE was a joint development effort of Honeywell, The Electric Power Research Institute (EPRI), and Pennsylvania Electric Company (PENELEC).

The CFE replaces the older conventional Unit Master controller, or the "Front End" of the control system, with a technology specifically designed to control critical loops and to take advantage of the capability of modern control systems.

Advanced Combustion Control

Advanced Combustion Control (ACC) can be used to provide state-of-the-art advanced control of the combustion process. It delivers optimal thermal efficiency through tight dynamic coordination of the fuel flow with control of the individual air channels. Emission limits are observed, the boiler combustion process is stabilized, and heat loss in flue gas is minimized.

Final Drives / Interfaces

The condition of actuators and drives is as critical to efficient, reliable, and stable system operation as is the control system and control strategy. Honeywell can supply these actuators or assist in the evaluation of actuators and drives to ensure that the installed system will perform as expected.

Services

Honeywell offers project related services as well as plant-wide services. Honeywell services can ensure that your project will be completed on time with expected results realized.

Experienced Honeywell project personnel ensure the successful design, engineering, installation, and commissioning of your automation system. Honeywell's broad support capabilities address all phases of the project from initial justification to system implementation, system startup and commissioning.

Training

Honeywell provides regional and worldwide centers that offer the most effective, advanced automation training available. Standard courses cover products, systems, software, applications, and fundamentals.

Custom training courses can be developed to address unique needs. Standard or custom courses can be conducted at Honeywell training centers or at your plant site.

Training increases the knowledge and efficiency of your personnel and helps to maximize the return on your automation investment.

Getting Started

Boiler Control is offered on Honeywell's revolutionary new Experion PKS™ Process Knowledge System platform. Our Project Services personnel are ready to assist you in getting your boiler control project started.

For more information, contact your local Honeywell representative, or call 1-800-288-7491 in the U.S.A.