

## Feedwater Heaters and Heater Drains Control System

### Background

The new Westinghouse feedwater heaters and heater drains control system (FWHCS/HDCS) upgrade provides reliable and stable level control in feedwater heaters and drains at all power levels, and provides stable main feedwater pump suction flow from the heater drain system.

The new system incorporates a fully redundant digital control system architecture utilizing advanced processing algorithms. The existing heater drain controls are pneumatic or analog controls that are problematic and challenging to plant operations. They have no diagnostics and have limited control room indication for the operators. The new system provides:

- More stable input conditions to the feedwater system that reduce control challenges
- Reduced impact on reactor coolant system temperatures, and therefore on reactivity
- More reliable heater drain water level control
- More reliable steam generator level control
- More stable overall nuclear steam supply system control performance

### Description

#### Operator Interface and Control Capabilities

Typically, plant operators have no control capabilities for the FWHCS/HDCS in the main control room (MCR), and are only presented with a level indication for a subset of the heaters and drain tanks.

The upgrade to the FWHCS/HDCS allows for the removal of existing analog level indications from the MCR and the installation of two soft operator displays that provide control and indication functionality. This approach helps to streamline diagnosis and response to issues with the FWHCS/HDCS via the following features:

- Ability to manually control any of the level control valves, condenser dump valves or minimum flow valves

- Individual heater drain tank levels and system alarm indications with supporting detailed information on the basis for the alarm

Existing alarm annunciators are maintained in the MCR, and are supplemented by a new alarm annunciator to alert the operators of degraded conditions with the FWHCS/HDCS. This increased alarming provides information to plant operators for diagnosing the source of degraded system condition (for example, failed sensor input, processor errors, failed I/O or failed valve positioner). Plant personnel can also retrieve multivariable information for smart field devices (e.g., transmitters and valve positioners) that utilize appropriate interface technology, which will likewise assist them in diagnosing health of FWHCS/HDCS transmitters and valve positioners.

For control, the system provides valve position demand signals to control valves for the heater drains/receiver tanks, as well as any associated moisture separator and reheater drain receiver tanks. It makes use of an enhanced single-element (level) control algorithm. It also provides valve position signals to condenser dump valves for each of the associated tanks for use during transients, which can cause a high level condition in a given tank.

### Functional Enhancements

The scope of the FWHCS/HDCS upgrade incorporates a control algorithm generally based upon the existing system, but with the following enhanced functionality and features:

- Automatic signal validation
- Variable control dynamics based upon variations in plant process conditions
- Coordinated sequencing of flow control, where appropriate, to address inadvertent pump trips
- Enhanced minimum flow control for pumps
- Redundant control outputs normal level/flow control components (high pressure heater drains, multiple per each redundant feedwater train)

The above enhancements can require addition of several input signals not previously utilized by the existing FWHCS/ HDCS:

- Process parameter(s) to indicate process conditions
- Component status feedback

### **General Instrumentation and Control (I&C) Platform Features**

- Controller anti-windup
- Bumpless transfer
- Complementary contact input checking
- Alarming of system and process faults
- Manual control backup to redundant processors from manual/automatic station interface
- Degraded backup modes for fault tolerance driven by signal validation
- Redundant architecture with automatic fail-over (controllers, input/output, power supply)
- Continuous online self-diagnostics and alarming

### **Benefits**

- Fault tolerance within control algorithm logic and I&C platform
- Automatic control over the complete range of normal power operation
- Operational flexibility through coordinated control of heater drain/receiver tank levels
- Ability to handle operational maneuvers with reduced water level deviation from reference; for example, flow disturbances due to transitioning pumps into/out of service or changes in feedwater system alignment
- Ability to address demands of process characteristics with reduced impact to control stability and performance due to:
  - Shrink/swell water level behavior
  - Process and control device non-linearities

### **Experience**

Feedback in the industry confirms that FWHCS/HDCS is a leading contributor to operational challenges and reactivity control disturbances. Westinghouse is offering this proven solution to address these issues, and industry forums confirm a growing recognition of the value of original equipment manufacturer experience in support of digital nuclear I&C upgrade projects. Numerous lessons-learned reflect the need for vendor cognizance of plant operational performance demands and design considerations unique to the nuclear industry. This highlights values of characteristic importance: risk aversion, reliability and confidence based upon demonstrated, evolutionary advancement. These values are firmly reflected in the standardized Westinghouse I&C upgrade product offerings, and the standardized design and test process employed for Westinghouse's digital I&C upgrades.



Feedwater Heater System Components