

# Plant Operation Engineering Services

## Repair, Replacement, and Automation Services

### Background

Plant Operation Engineering Services increase instrumentation and control (I&C) functional design, I&C Systems design, and I&C Systems integration for plant operation. These services directly support vintage I&C Systems (Foxboro, 7100, 7300, WDPF, Eagle, and Eagle 21).

### Engineering Services

(related to I&C functional design activities)

#### Feedwater System Tune-Up

The high number of automatic reactor trips in the nuclear power industry has been a major concern of utilities and vendors. An evaluation of reactor trip data has shown that the Feedwater System was the major contributor to automatic reactor trips. In response to the nuclear industry's high interest in reducing the number of reactor trips related to the Feedwater System, Westinghouse has assembled a systematic approach to achieving this goal. The scope is essentially a tune-up of the Feedwater Control System, adjustment of related system hardware per specifications, and operator training and awareness for steam generator level behavior (that is, level shrink/swell response during plant transients or maneuvers). These actions do not require licensing revisions or hardware modifications.

#### I&C System Scaling Manual

The I&C System Scaling Manual provides the utilities with the scaling information needed to properly input setpoints to a control and protection system that uses analog process equipment. Scaling is provided as part of many I&C upgrades as well.

#### Rod Control System Optimization

Several plants have experienced periodic hot leg temperature fluctuations attributed to a Reactor Coolant System (RCS) hot leg flow streaming phenomenon. This in turn impacts the measured RCS average temperature (used as an input to the Rod Control System on Westinghouse-designed plants), causing spurious control rod stepping during steady-state operation when the Rod Control System is in automatic mode. To avoid rod stepping, several plants are operating in the manual rod control mode. Nuclear Instrumentation System (NIS) fluctuations also have been noted in some plants.

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Since the NIS power is also used as an input to the Rod Control System, fluctuations and variations in this signal can also cause spurious rod stepping depending on the magnitudes of the NIS fluctuations.

Based on Westinghouse experiences with these issues at several plants, Westinghouse has developed recommendations for revising the Rod Control System setpoints and time constants to minimize automatic rod stepping.

### **Reactor Trip and ESFAS Time Response Determination**

Westinghouse will identify the differences between the assumptions made in the safety analyses and in the actual installed plant configuration and will develop recommended time response acceptance criteria to be used for the protection system time-response testing.

### **Margin Recovery Program**

This service helps customers address I&C System alarms that are caused by a reduction in operating margin (fuel designs, uprating, RTDBE, etc.). The service has been offered as stand-alone as well as part of a bigger package (uprating). It can be classified as an integrated control and protection system functional design revision since it includes control system modeling, dynamic control system analysis, protection-related Final Safety Analysis Report (FSAR) accident analysis, and setpoint changes in both the protection and control systems. Several short-term and long-term solutions are supported based on customer needs. Some solutions need safety analysis and Technical Specification revisions.

### **COMS Analyses**

These analyses support the Cold Overpressure Mitigation System (COMS, also called Low Temperature Overpressure Protection System, or LTOPS), a system required to protect against violation of the reactor vessel Appendix pressure/temperature limits during plant startup or shutdown. Westinghouse is responsible for the functional design of this system, the analysis of the plant response during the design basis overpressure events, and in development of the recommended I&C setpoints to be installed in the system. This work comes in based on the

Original Equipment Manufacturer (OEM) design basis. Westinghouse has performed both first-time analysis and recurring analysis for several plants.

### **Steam Generator Level Tap Relocation**

This product essentially increases the span on the narrow-range steam generator level measurement system (prime signals used in the plant protection and control systems), thereby providing significant benefits to operators in the control of steam generator level and greater margin to the high and low steam generator level protection-related trip setpoints. This is marketed in a number of different ways, including the steam generator replacement marketing initiatives.

### **Steam Generator Level Transmitter Calibration and Selection of Reference Conditions**

Westinghouse calculates the best reference condition at which the level transmitters can be calibrated such that the steam generator level uncertainty (that is, differences between actual and indicated level) can be minimized. Westinghouse provides the transmitter specification in terms of delta-p at 0% and 100% level indication (performed as add-on to steam generator replacement, uprating, and tube plugging).

### **Design Transient Evaluation**

When plant operating conditions are changed (for example, uprating, steam generator replacements, tube-plugging, and revised full-power  $T_{avg}$  setpoint), the design transients are revised so that the component engineers can determine the components' stress and fatigue. Westinghouse generates and provides the design transients to be used by the component fatigue stress analysis. Westinghouse also reviews the operating history of the plant and assigns proper classification of the transient so the plant can use this database to support plant lifetime extension.

### **Simulator Certification Transients**

Westinghouse develops the best-estimate transients to certify the simulator. Following a steam generator replacement, the utility needs to re-certify the simulator. This certification requires that the simulator be benchmarked against the results from independent data. Westinghouse develops these transients, based on the current simulator output and experience with actual plant response, and revises them to reflect the changes to the plant.

### **Control System Optimization Studies**

These studies require evaluating and tuning the control systems, an effort that falls again in the control system function design area. Westinghouse has performed studies for optimizing steam dump control and pressurizer pressure and level control.

### **Plant Transient Simulation**

When an unexpected event occurs at a plant, it is expected that a root cause analysis will be performed to determine the cause of the event. One item that can be of assistance in this task is a simulation of the transient to determine the cause of the malfunction. Westinghouse can simulate the best-estimate transient and confirm the cause of the trip for NRC event reporting.

### **Waterhammer Analysis**

Much attention has been given to waterhammer prevention, mitigation, and accommodation. Since a complete prevention of waterhammer events is not possible, utilities are trying to minimize the impact of water hammer event by mitigation (train operators) and accommodation (improve system design). Both require state-of-the-art analysis. Westinghouse has a computer code to analyze a classic waterhammer event. This code is capable of solving the phenomenon associated with blow-down from a pressurized system, propagation of 1-dimensional acoustic waves, homogeneous column separation and collapse, fluid structural interaction, and dynamic motion of valve. The primary benefit of performing water hammer analysis and subsequently the structural analyses is to provide sufficient information to determine what modifications in the piping system and supports may be required to ensure that unacceptable damage does not result. Additionally, the analysis will provide a means by which piping systems can be qualified per the ASME B&PV Code and system criteria.

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