Control Performance Enhancements of Control Valves In Nuclear Power Plants

Hoguen Ryu [a*], Bongsub Han [a], Juhyoung Seon [a]
[a]*SOOSAN INDUSTRIES, Bamgogae-ro, Gangnam-gu, Seoul*
[*]Corresponding author: rhg0613@soosan.co.kr

1. Introduction

Letdown H / E outlet pressure low alarm occurrence has been frequently occur by fluctuation phenomenon of the flow rate and back pressure of Chemical and Volume Control System (CVCS) in nuclear power plants with increasing operating time. Due to this problem it was caused a problem that the chemical and volume control system letdown flow rate control is unstable. This study was performed to analysis the operability of control valve to solve the problems caused by letdown flow rate control instability of chemical volume control system in nuclear power plant.

Based on the results of diagnostic tests of control valves performed recently and overseas studies about control valves, it presented the problem analysis results and the action plans for troubleshooting of the control valve.

2. Review the Research about Control Valves

2.1 Overview of the CVCS Letdown System

Letdown flow control of CVCS consists of a pressurizer level control and the back pressure control of letdown H/E. Pressurizer water level control is to maintain constant the volume of reactor coolant through the control the outflow of the flow control valve so that the pressurizer level is to be programmed water level by the signals from the pressurizer water level control system. Back pressure control of letdown H/E is to maintain the pressure in Letdown H / E to the saturation pressure or more in order to prevent boiling within Letdown H / E and to prevent flashing the coolant in the flow control valve after the cooling water loss.

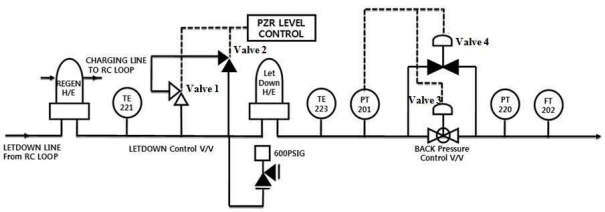

Fig. 1. Diagram of Letdown Line Control

The flow control valve (Valve 1, Valve 2) generates a control signal for controlling the valve by a signal from the pressurizer water level control system control module and adjust the air pressure of the actuator to control the letdown flow rate. The two valve or a one, operated automatic or manually depending on the letdown flow rate.

Back pressure control valve(Valve 3, Valve 4) is automatically controlled to the signals from the pressure control instruments. Letdown H / E exit low pressure alarm set points are as Table I.

Table I: Problem Description

	Set Pressure[psig]	Pressure Measuring Point
Low Pressure Alarm	360	Letdown H/E Exit
High Pressure Alarm	500	Letdown H/E Exit

2.2 Review the Research about Control Valve Troubleshooting

Looking at the cause of the fluctuation phenomenon of the control valve as follows.

2.2.1 Irregular Supply Air Pressure

If the air supply line to the actuator is blocked or a lack air supply, the air supply according to the IP input signal does not occur immediately it may result in an unstable control valve[1].

2.2.2 Feedback Linkage Loose Connections

If become loosen the feedback linkage connected between the valve and positioner, the Linearity and HD error of the positioner are increased because the valve stem position is not accurately measured and transferred and may cause an unstable phenomenon during valve operation[1].

2.2.3 Insufficient Spring Preload of Actuator

If spring pre-load is not sufficient it can not only make it difficult to control the normal operation but also delay the spring stroke[2].

2.2.4 Improper Calibration of Positioner

If the air supply line to the actuator is blocked or a lack air supply, the air supply according to the IP input signal does not occur immediately it may result in an unstable control valve[1].

3. Diagnostic Test Results Analysis

By analyzing the nuclear power plant diagnostic test and review the research about control valves, the following actions were carried out

3.1 Positioner Replacement and Calibration

It knows that valve performance to control is significantly reduced by excessive HD error of the positioner for the valve travel, and replacement of the positioner and through the calibration process is expected to significantly improve the control performance of the valve. The control valve performance has been significantly improved through replacement and calibration of the positioner.

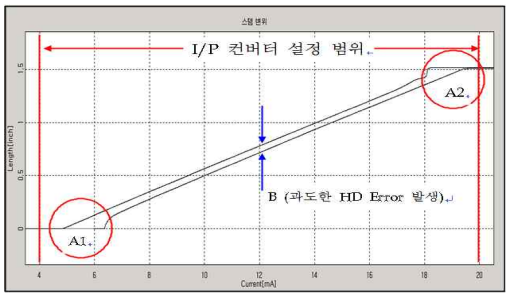

Fig. 2. Positioner Operation before Calibration

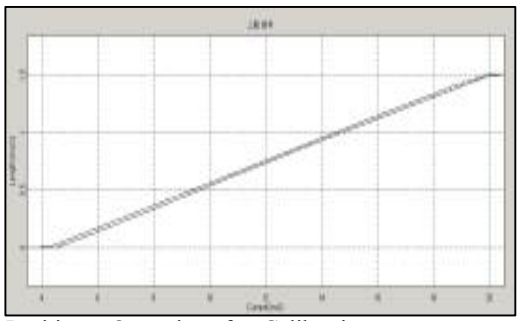

Fig. 3. Positioner Operation after Calibration

3.2 Remove Air Bubbles in the Pressure Transmitter

If the air bubbles present inside the pipe coming to the sensing portion of pressure transmitters, it is impossible to accurately measure the fluid pressure by formation of air layer. The bubble formation was found in the pressure transmitter during diagnostic test and removal operation was performed. If an incorrect pressure signal is transferred to the controller, the valve is difficult to control the normal operation.

3.3 Preload Adjustment of Actuator Spring

By adjusting spring preload of the three control valves through analysis the pressure signal supplied to the actuator according to the displacement of stem, it is expected to improve the responsiveness of the valve relative to the input signal.

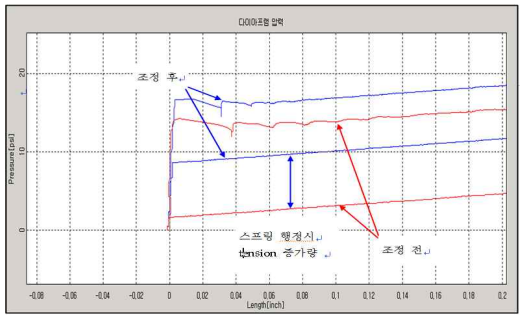

Fig. 4. Signature of Actuator Supply Air Pressure

Table II. Control Valve Error Rate after Calibration

Valve	A	B	C	D	Criteria
Input [mA]	4.3	4.4	4.3	4.6	4.1~4.5
	19.6	19.6	19.1	19.8	19.6~20.2
HD Error [%FS]	1.8	2.2	2.6	2.1	< 5
Linearity Error[%FS]	0.2	0.2	0.1	0.1	< 2

3. Conclusions

As a results completion of the corrections and diagnostic tests, it shows the control performance of the valve is sufficient to control the letdown flow. Table II shown that the control valve error rate after corrections. We confirmed that the control of the control valve is operating normally.

REFERENCES

[1] L. Loflin, Valve Positioner Principles and Maintenance Guide, EPRI TR-1003091, 2001
[2] J. Holstrom, Application Guide for Evaluation of Actuator for Air Operated Valves in NPP, EPRI TR-107321, 1997