Transactions of the Korean Nuclear Society Autumn Meeting
PyeongChang, Korea, October 25-26, 2007

Calibration and Application of the Field Instruments of a Fuel Test Loop

Young-San Choi, Won-Ho In, Sang-Hoon Bae, Sang-Jin Kim, Hoan-Sung Jung.
KAERI, 150 Duckjin-dong, Yusung-gu, Daejon, Korea, 305-353
**yschoe@kaeri.re.kr*

1.0 Introduction

The Fuel Test Loop in HANARO is now in commissioning[1]. The field instruments of the FTL were selected to secure stability and reliability of signals and they were self calibrated by the plant prior to the installation. The field instruments consist of thermometer, flowmeter, manometer, level meter and analyzer, and the standard measuring devices used for calibration were certified by the national calibration laboratory before use.

This paper describes the calibration methods and results of field instruments for each parameter as well as any particulars and corrections identified during calibration. Also, it describes problems in using standard measuring devices employed for calibration.

2.0 Calibration for each measuring device

Field instruments that were calibrated are a total of 111 sets, including 27 sets of thermometers, 9 sets of flowmeters, 49 sets of manometers and 26 sets of level meters[2]. Depending on the calibration methods, standard measuring devices and local instruments are connected and a calibration is performed as exactly as the calibration procedure. Also, field instruments calibrations which had been completed by a third-party calibration lab were re-calibrated by comparing the calibration records to secure reliability.

2.1 Resistance Temperature Detector(RTD)

RTD for which a calibration was performed were a total of 27 sets with a ± 0.5℃ accuracy and a calibration of them was completed by an outside calibration lab, but they were re-calibrated to evaluate a reliability of the calibration and a prudence of the equipments[3].

Figure 1. Dry block and Installed RTD

The range of the measurement is up to 650 ℃ and the temperature was raised by using a dry block and it was measured with a standard thermometer. Resistance for each temperature was measured and compared with the true values.

Of 27 RTDs, three Q-class RTDs (weed) were too short to be calibrated. The minimum requirement of a dry block for a calibration is 14cm but the actual length of a sensor was 9 cm, so a self calibration was not performed. These RTDs were re-calibrated by their manufacturers.

2.2 Flow Transmitter (simens & rosemount)\

Calibration was performed for a total of 9 sets of flow transmitters and they have ± 0.01% accuracy and all are differential types. To verify the linearity and repeatability, five blocks in the span were divided with the same interval and current is repeatedly measured for each impressed pressure[4].

When an accurate measurement is difficult because the span is too narrow with the scope of a measurement, 0 ~ 20mmH_2O, it should be compared with the calibration records to confirm there is nothing unusual. Also, in the case of a measuring device transfer function which is indicating square root values, a calibration was performed after changing the linear values of a transfer function.

Figure 2. Flow Transmitter and Dead weight tester

2.3 Pressure Transmitter (simens)

26 sets of pressure transmitters which were calibrated had a ± 0.01% accuracy. For calibration, the same method for a flow transmitter was used but its measured pressure was too large, thus a standard pressure was applied by using a deadweight tester. The 100% span section was pressurized for 25% at a time and the 4-20mA output was measured with a digital multimeter.

The case with 0.05MPa that cannot be pressurized with a deadweight tester was calibrated by using a hand pump, and 6 sets of Q-Class RTD, that should be pressurized with a high pressure of 25MPa were calibrated by their manufacturers as no appropriate calibrator was available.

- Pressure Differential Indicator Switch (wise)
Total of 5 sets were calibrated by pressurizing the whole section with a deadweight tester and checking the indicated values. A digital multimeter was used to check if the contact signal is generated to clean up the default pressure.

- Pressure Indicator (wise)
Total of 16 sets were calibrated in the same ways as PDIS. It was checked to see if the indicated value of the pressure was accurate by pressurizing it with a deadweight tester. Also, the linearity was verified by pressurizing the 100% span section for 25% at a time.

- Pressure Switch (wise)
Total of 2 sets were pressurized with a hand pump to check to see if the contact output is normally generated at the set pressure.

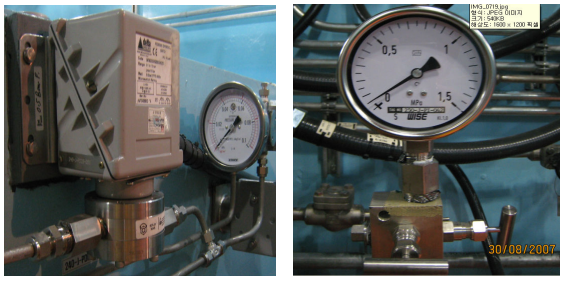

Figure 3. Pressure switch and Indicator

2.4 Level Transmitter (simens)

Calibrated LT is 6 sets and the calibration method is the same as the one for the pressure transmitter. 6 sets of LT all showed different results from the calibration reports submitted by the manufacturers and re-calibration was completed for a normal operation.

- Level Switch (hitrol & FCI)
Total of 20 sets of LS were calibrated. The level of water in the tank was measured by using the level stand pipe that was installed with the same height as the tank. A tape measure was attached to the LSP and the water level was checked while the water was poured into the LSP; and a switch operation was checked simultaneously. The following characteristics were found in the calibration process.

* In pipe arrangement, all LS were welded to be installed so uncertainty is about ±10mm.
* When LS with High and Low of measuring ports in reverse was found, wiring method for signals at contact points were changed from NO to NC.
* Thermal type LS was operated depending on a wet condition and a dry condition of a sensor, so a sufficient time was needed to stabilize it.
* In the case of the electrode-type LS, service water was detected but the demi-water used in the system was not, so the measuring device was replaced.

2.5 Gas Leak Detector(hitrol & gastron & ABB)

2 sets of gas leak detectors were calibrated by using 2% hydrogen. For a calibration, 2% hydrogen was pressurized at the sensor and it was checked to see if an alarm went off at the controller. Methane was going to be used for a calibration but at the manufacturer's recommendation, 2% hydrogen was used for a more accurate result.

3.0 Conclusion

FTL is a research facility that allows for obtaining research data needed to develop and improve a nuclear fuel and testing designs of a nuclear fuel through tests. In this facility, local instruments detect the state of a system operation, transmit the information to users, and when an abnormal situation is detected, the information is provided for a user to assess the situation.

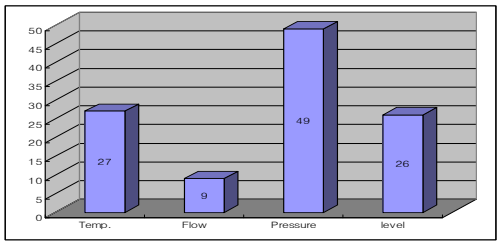

Figure 4. FTL-related field instruments

FTL-related field instruments were a total of 111 sets related to the temperature, flow, pressure, and water level, as shown in Figure 4. All were successfully calibrated and the findings are as follows:

* The length of sensors in 3 sets of Q-class RTD was too short so they were calibrated by the manufacturer
* 6 sets of Q-class flow transmitter had too high calibration pressure so they were calibrated by an outsider institution.
* 6 sets of level transmitters had considerable calibration deviations between the calibration report by the plant and the calibration report by the manufacturer.
* All instruments were installed into the FTL system for a normal operation.

REFERENCES

[1] "Safety Analysis Report", KAERI/TR-710/96 Rev. 10, KAERI, 2006.
[2] "Design Manual of I&C," HAN-FL-E-076-DM-H001 Rev.1, KAERI, 2005.
[3] "Operating Instructions for Jupiter 650 Series", Dry Block, ISOTHERMAL Tech.
[4] "User Guide book for Multifunction Calibrator", Multifunction Calibrator, BEAMEX Tech..