

# The Calibration of the Fuel Central Temperature System in Fuel Test Loop

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## 1. Introduction

The 3-Pin Fuel Test Loop (FTL) which is essential for developing new nuclear fuel and high performance nuclear fuel was installed to meet the increasing demand for irradiation tests at HANARO in 2007. Also, it was installed to conduct in-core fuel performance tests in operating conditions and has performed operations conforming to the functional and performance requirements of the system. A commissioning test for normal operation, including on-power experiments with the test fuel loaded in the FTL, was successfully accomplished in September, 2009 [1][2]. The centerline temperature resulting from the irradiation properties of the nuclear fuel is an important factor for evaluating nuclear fuel properties in pile, and instrumentation and measurement techniques for nuclear fuel are necessary to measure the exact temperature [3].

This study concerns the measurement and calibration to confirm the soundness of the datum measured at the fuel central temperature measurement system installed in FTL facility.

## 2. Methods and Results

### 2.1 Configurations

The fuel central temperature measurement system of the FTL is shown in Fig. 1. To measure the central temperature of the test nuclear fuels for irradiation tests, this system was installed as the following:

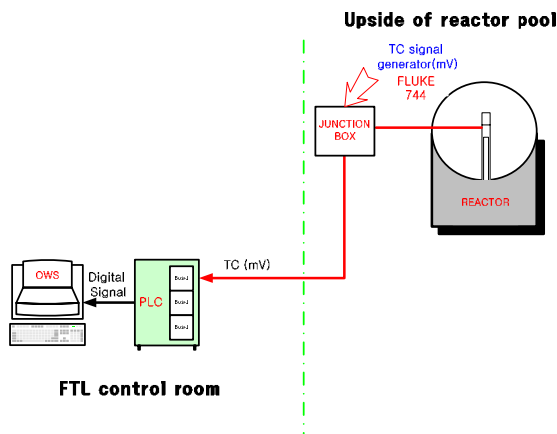


Fig. 1 Fuel central temperature measurement system of FTL facility

1) A junction box has 3 mini-connectors (TE-012, TE-013, TE-014) to join the signal cables from the sensors instrumented in the test fuel rod. 2) PLC is data acquisition system which consists of an A/D converter and signal conditioning unit. 3) OWS (Operator-WorkStation) is operator interface which are consisted of the computer with CRT monitor and printer.

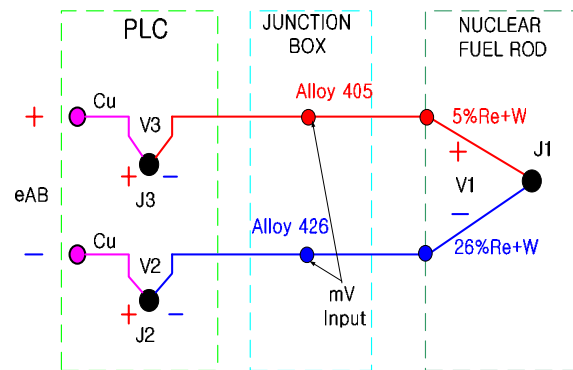


Fig. 2 Equivalent circuit of a fuel central temperature measurement system of FTL

An equivalent circuit of the fuel central temperature measurement system in FTL is shown in Fig. 2. The sensor used to measure the fuel central temperature is the C-type thermocouple. The hot junction of C-type TC is the point jointed a positive wire (5%Re+W) and a negative wire (26%Re+W). The TC is connected by means of a miniature welded sleeve to an extension (compensation) cable. And the wires inside a compensation cable sheath consists of Alloy 405 and Alloy 426. It is connected through a junction box to the terminal in PLC panel and same materials. The principle of the temperature measurement (Seebeck Effect) is that a voltage (EMF) is created in the presence of a temperature difference between two different metals. This causes a continuous current in the conductors if they form a complete loop.

### 2.2 Measurement

The soundness test of the fuel central temperature measurement system was carried out using a FLUKE 744 (documenting processing calibrator). The temperature values (mV) using FLUKE 744 input through each TC connector in a junction box, and then

it was simultaneously measured at an OWS of FTL. A fuel central temperate measurement system first installed in FTL was calibrated by a software method, which is automatically to input the temperature values of J2 and J3 junction in FTL control room to compensate the temperature values of J1 junction in a test fuel.

### 2.3 Calibration

The error temperature curve drawn with the difference between a reference temperature and a temperature measured at a fuel central temperature system in this test are shown in Fig. 3. It was increased to 600 and regularly decreased from 600 to 1800 with increasing the input source (mV). The maximum error value at 600 was about 9 and all the lines of a fuel central temperate measurement system show similar trends.

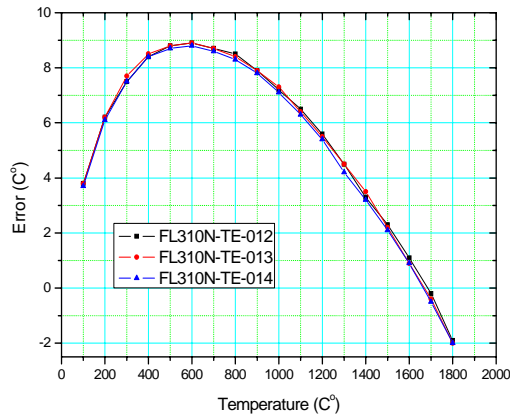


Fig. 3 Error temperature curve between a reference temperature and a real temperature measured at a fuel central temperature system

To measure the exact temperature using a fuel central temperature measurement system, the OWS program of the FTL will be upgraded by applying the error temperatures.

### 3. Conclusions

The soundness test of the fuel central temperature measurement system installed in FTL facility was conducted by using the measurement tool and calibration methods to compensate its lines. To confirm the measurement condition of fuel central temperate measurement system, the mV source for a temperature using FLUKE 744 input through each TC connector in a junction box, and then simultaneously measured at the computer. The maximum error temperature in this test was about 9 . Therefore, the OWS program of the FTL will be upgraded by applying the error temperatures.

### REFERENCES

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