# Korea-UK round robin test to establish international standards for ETG

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## 1. Introduction

Radioisotope thermoelectric generators (RTGs) are devices that convert thermal energy into electrical energy by converting the radiation energy emitted by radioactive isotopes and shielding it from radiation. RTGs are highly useful for planetary exploration missions with high temperature differences and exploration missions where solar panels cannot be used [1-2].

Currently, the countries that produce RTGs worldwide are the United States and Russia, and the countries currently developing them are Korea and the United Kingdom. In 2019, the Korea Atomic Energy Research Institute (KAERI) and the United Kingdom signed an MOU on international standardization for nuclear battery technology cooperation and safety verification. Accordingly, after conducting domestic tests in 2022[3] for calibration and cross-testing of the testing evaluation facility, cross-testing was conducted in the United Kingdom.

## 2. Methods and Results

### *2.1 Methods*

In Korea, one cycle was set at eight hours of operation at $10^{-3}$ torr vacuum. A total of 90 cycles were conducted, and the performance evaluation between the initial and final cycles was compared. In the cross-evaluation conducted at the University of Leicester in the UK, 8 hours and 30 hours of continuous operation were performed.

During the experiment, the temperature was measured at four points in the ETG. The four parts are TC1 (hot shoe) above the thermoelectric component, TC2 (cold shoe) where the chiller solution passes, TC3 where the heat sink dissipates heat, and TC4 on the ETG surface.

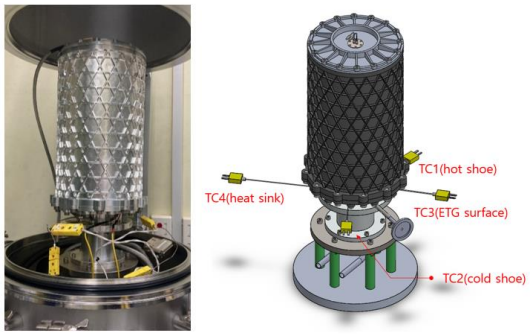


Fig. 1. Position of thermocouples in the RTG prototype

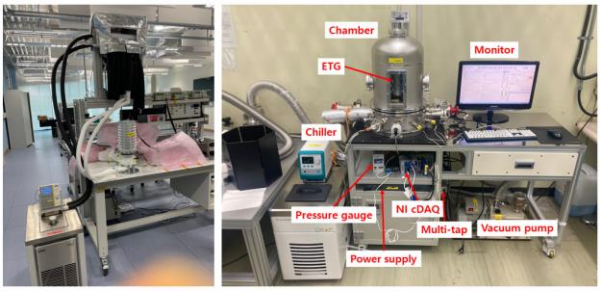


Fig. 2. Evaluation equipment set up in the UK and Korea

### *2.2 Results*

When 90 cycles were conducted in Korea, the average temperature of hot shoe was 209°C and that of cold shoe was 27°C. On the other hand, in the UK experiment, the average temperature of hot shoe was 194°C, and that of cold shoe was 26°C. This difference occurred due to the method of making the inside of the ETG vacuum and the chiller. In Korea, the ETG is placed in a vacuum chamber to create a vacuum environment, while in the UK a vacuum line connected to the ETG is used to create a vacuum environment. The British approach is to maintain low temperatures through convective heat loss as a vacuum is created directly inside the ETG.

Since the thermoelectric component generates electricity based on the temperature difference of the component, the experiment in the UK, where the temperature difference was smaller, resulted in a decrease in output of about 0.1 W compared to the experiment conducted in Korea, with an output of 5.2 W.

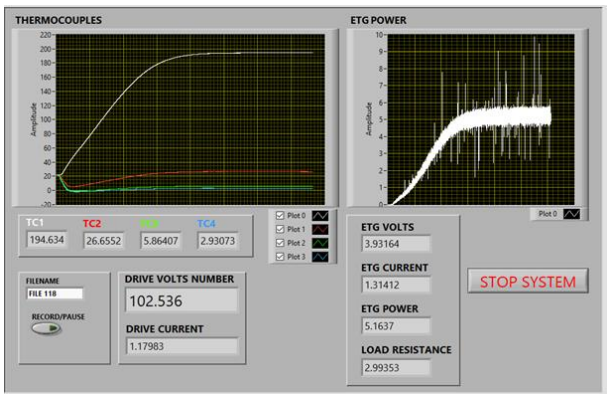


Fig. 2. Results measured by a performance evaluation program for 30 hours in the UK

## 3. Conclusions

As a result of the MOU signed to establish international standards for nuclear batteries, experiments on nuclear batteries were conducted not only in Korea but also in the UK, and round robin test was completed. Although there were differences in equipment and environmental conditions between the two countries, the ETG developed by the KAERI showed an output of 5.2W with a 2% error in the UK. Based on this, we will continue to exchange and verify various nuclear batteries and establish international standards.

## REFERENCES

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