# Compensation by RGMS for misreading reactor power in case of D2O dilution

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## 1. Introduction

In a research reactor Neutron Measurement System (NMS) which uses wide range fission chamber as neutron detector is applied to measure the reactor power. This system has rapid response to power and stable accuracy for wide range. But this has some concerns of (1) relative measured values depending on the installed location of neutron detector and also (2) may cause the loss of accuracy when dilution of heavy water in the D2O tank happens. The NMS is not only used for reactor control and but also used for reactor protection system. Accordingly faulted reactor power with high deviation for second case (2) may lead unexpected increase of the reactor power. In order to prevent this occurrence, Reactor Gamma Measurement System (RGMS) is necessarily applied. Herein the structure, measuring method and application of RGMS will be introduced.

## 2. RGMS application in case of D20 Dilution

### *2.1Reason of RGMS application in reactor with D2O*

If a pipe rupture inside the pool happens, light water flows into the heavy water system and the heavy water starts to be diluted. As the absorption of light water is much larger than the heavy water, the dilution of heavy water in D2O (reflector) tank provides the sheltering effect on the neutron detectors located with surrounis ng D2O tank. It leads to the decrease of neutron flux reading and the detectors generate the faulted reactor power decent signal since measured neutron power of the regulating system shows lower than actual reactor power.

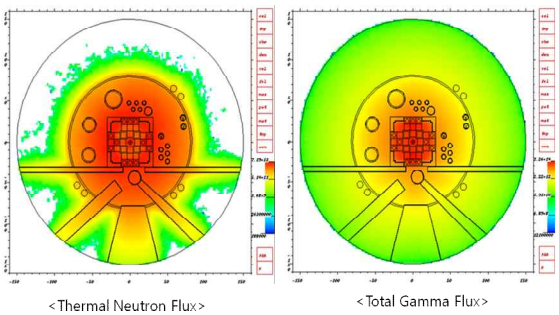


Fig 1. Thermal neutron flux & Total gamma flux

Consequently the reactor regulating system on auto control mode ends up withdrawing control rods based on faulted neutron flux reading at detectors. It also results in increase of the actual reactor thermal power gradually. Due to increase of actual reactor power, the reactor core will generate the high gamma power contrary to neutron power. The RGMS is to measure the gamma power generated in the reactor in proportional with thermal power as shown in Fig 1. This is why RGMS is required to measure the reactor power in case of D2O dilution.

### *2.2 Structure of RGMS in the research reactor*

As mentioned above, the RGMS measures gamma radiation level around the reflector tank. The gamma radiation activity at this location has a good linearity proportional to the reactor power. This allows RGMS to be used for backup parameter of reactor protection in case of reflector tank rupture. The RGMS consists of gamma detector assembly to be installed the boundary of D2O tank with interconnection cables, preamplifier and signal processor as shown in Fig 2.

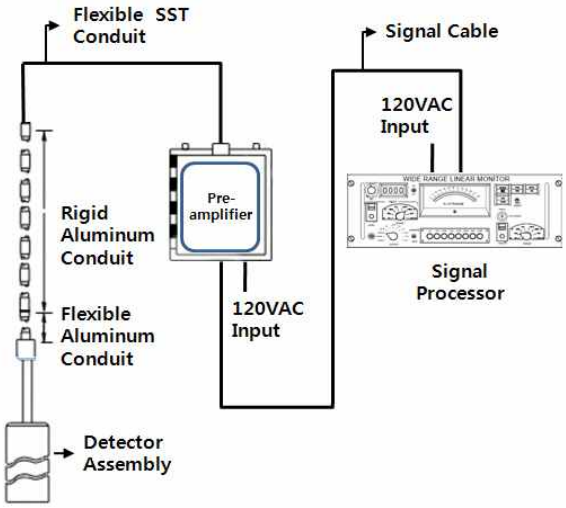


Fig 2. Basic scheme of RGMS

The gamma ion chamber is the type of a guarded gas ion chamber which is filled with 10% argon, 90% nitrogen gas. It is sensitive enough to gamma radiation compared to other forms of radiations. It has less than 5% sensitivity to thermal neutrons and 1% to alpha and beta particles. The signal from coaxial cable connected with inner cylinder transfer the linear power and the HV from cable connected with middle cylinder provides the log power as shown in Fig 3. Its detection range is about from 1Gy/hr to $10^7$Gy/hr covering from 0~150% reactor full power. Its linearity is also less than +/-1% for linear power and +/-2% for log rate.

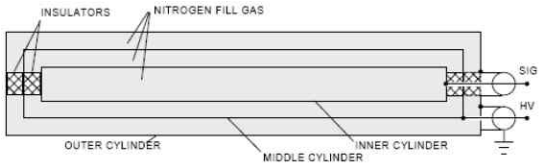


Fig 3. Guarded gamma ion chamber

The preamplifier provides the high voltage to the detector and amplifies the electrical DC current signal input from detector. The signal processor generates multiple 4~20mA analogue output signals and display gross gamma radiation and alarm set-points. It also provides the alarms related with equipment failure status.

### *2.3 Proper installation of RGMS in the reactor*

The RGMS is independently installed with separated three channels on outer wall of the reflector tank. The detector is submerged in the reactor pool and has sufficient withstanding against radiation and corrosion by light water. Its housing supports and contains the gamma detector in horizontal direction as shown in Fig 4. The upper side of the housing is open so that any heat generated in detector is transferred to the pool water and replacement is easily conducted.

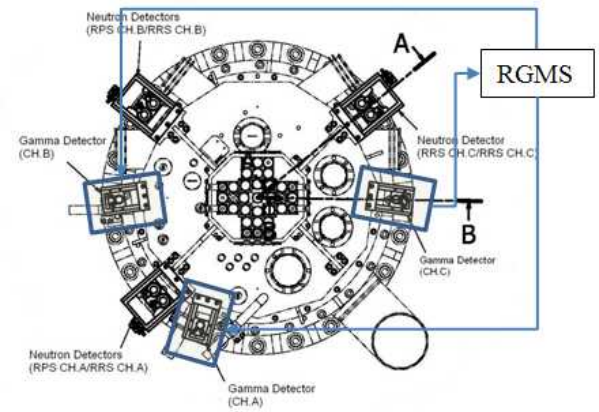


Fig 4. RGMS location in the horizontal view

To minimize the effect from radiation in the reactor core, mineral insulated flexible cable is preferred to be installed water-tight and to mitigate the noise from partial dielectric breakdown, N2 gas is fully backfilled regularly. The preamplifier and the signal processor are installed on the outer wall of reactor. After completion of proper installation, pre-energization checkout and full range of power alignment is performed. For this, remote test module is required to be installed in the main control room.

## 3. Conclusion

Herein the RGMS on research reactor is considered to backup the postulated reactivity induced accident such as D2O dilution which may cause misleading the decent power. Also the RGMS can be used for an absolute reference power because of reflecting the gross gamma generated in the reactor core. Furthermore this system is expected to enhance the reliability and accuracy of RPS trip actuation.

## REFERENCES

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