# The Pool Top Radiation Level under a Full Power Operation of 30 MWth in HANAROR

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## 1. Introduction

HANARO(1), a 30MW research reactor, was installed at the depth of about 13m of an open pool. 90 % of the primary coolant was designed to pass through the core and to remove the reaction heat of the core in HANARO. The rest, 10 %, of the primary coolant was designed to bypass the core. And the reactor coolant through and bypassing the core is inhaled at the top of the chimney by a coolant pump to protect that the radiated gas was lifted to the top of the reactor pool(2).

But, a part of the core bypass coolant was not inhaled by the reactor coolant pump and reached the top of the reactor pool by a natural convection and increased the radiation level at the top of the reactor pool. To reduce the radiation level by protecting the natural convection of the core bypass flow, a hot water layer (HWL, hereinafter) was installed with a depth of 1.2 m from the top of the reactor pool(3).

This paper describes the pool top radiation level variation as per the reducing effects based on the operation data measured during a full power operation in the first half of 2006.

## 2. Test method

The HWL is safely maintained by compensating for a heat loss of evaporation, convection and conduction of the water depth of 1.2m from the top of the reactor pool. To compensate for the heat loss, two heaters of the HWL system are automatically operated by two temperature detectors (347-TE03 and 347- TE04) respectively installed in the suction and the discharge pipe of the heater as shown in fig. 1.

As shown in the figure, a service pool water temperature detector (Ts, 333-TE05) is installed at the top of a service pool to measure the temperature of the HWL. A chimney water temperature detector (Tc, 331-TE01) is installed to measure the water temperature around the chimney top, at a seven meter (7 m) depth below the top of the reactor pool, below the HWL (4).

Pool top radiation detectors (RU-10A, RU-10B and RU-10C) are installed to measure the pool top radiation level. Each detector is composed of an ion chamber, a measuring unit, a connection box, a recorder, a signal unit and a test source(5). The ion chamber is installed at

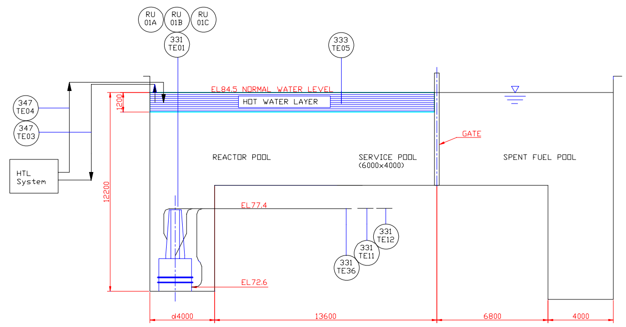


**Figure 1 Schematic diagram of hot water layer system**

the height of fifty centimeter (50 ㎝) from the top of the reactor pool and a space of one hundred and twenty degree (120°).

## 3. Test Results and Discussion

3.1 Reducing effect by a HWL temperature

Fig. 2 shows a pool top radiation level measured during a full power operation in HANARO in the first half of 2006. The figure shows a trend that the larger the HWL temperature difference was, the more the pool top radiation level was reduced. When the HWL temperature difference is higher than ten point five degree Celsius (10.5 ℃), the figure shows that the pool top radiation

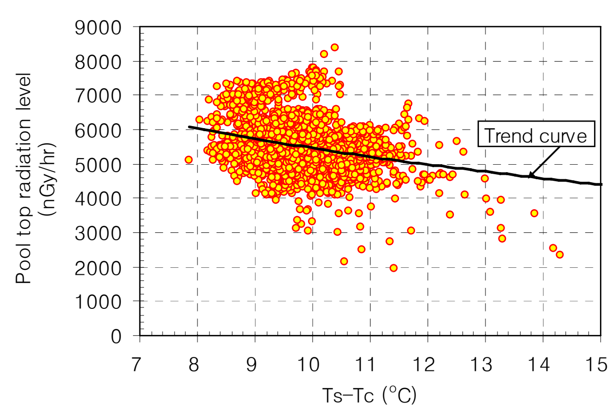


**Figure 2 Pool top radiation level as per HWL temp. difference between the temps. of the service pool top water (Ts) and the chimney top water (Tc)**

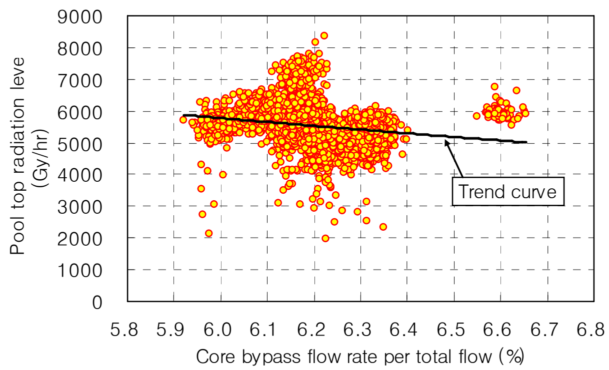


**Figure 3 A pool top radiation level as per a percentage ratio of the core bypass flow about a full flow of primary coolant**

level is reduced below about sixty hundred nano Gray per hour (nGy/hr).

This means that the higher the temperature of the HWL was, the more the convection flow of the part of the core bypass flow to the top of reactor pool was restrained below the HWL.

3.2 Reducing effect by core bypass flow

Fig. 3 shows a pool top radiation level as per the core bypass flow ratio regarding a full flow of the primary coolant. When the bypass flow ratio is maintained from six point two five percent to six point four percent (6.25~6.4 %), the figure indicates the pool top radiation level to be sixty hundred nano Gray per hour (6000 nGy/hr) and below. But, when the bypass flow ratio is maintained in about six point six percent (6.6 %), the pool top radiation level is indicated to be sixty hundred nano Gray per hour (6000 nGy/hr) and above.

Therefore, it is recommended through the test data that the core bypass flow ratio is maintained from six point two five percent to six point four percent (6.25~6.4 %) to further reduce the pool top radiation level.

We reviewed an effect of the inlet and the outlet temperatures of the core coolant for reducing the pool top radiation level. The temperature is not related to a reduction of the pool top radiation level. It is that the coolant flows below the HWL and the temperature of the coolant is absorbed into a higher temperature of the HWL.

## 4. Conclusions

As for the results, it is confirmed through the test data that the larger the HWL temperature difference was, the more the pool top radiation level was reduced. When the HWL temperature difference is higher than ten point five degree Celsius (10.5 ℃), the pool top radiation level is reduced to below about sixty hundred nano Gray per hour (nGy/hr).

It is recommended through the test data that the core bypass flow ratio is maintained from six point two five percent to six point four percent (6.25~6.4 %) to further reduce the pool top radiation level.

And the reactor coolant inlet and outlet temperatures are not related to a reduction of the pool top radiation level because the coolant flows below the HWL and the temperature of the coolant is absorbed into a higher temperature of the HWL.

## References


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