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The trend of Leak Rate of HANARO Reactor Building after Seismic Reinforcements

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1. Introduction

HANARO has been operating at low temperature and low pressure, so in the event of a nuclear accident, the pressure inside the reactor building is not high. The confinement approach in HANARO's reactor building differs notably from conventional power reactors, utilizing a confinement building instead of a containment structure.

If a radiation level is still higher than the limit value despite the emergency ventilation or if the emergency ventilation is inoperable due to offsite power failure, the reactor hall must be isolated by shutting the dampers out. Under this condition, radiation release could occur by pressure difference between the inside and outside of the reactor building, produced by a high-speed wind. To verify that radiation release under this accident condition is being maintained lower than the predefined limit of 570 m^3/h, the leak rate for the reactor hall is periodically checked out as an important surveillance requirement. [1][2]

The leakage rate test of the confinement building is performed when the reactor starts to operation, refueling, and the leakage rate is less than 570 m3/hr at a pressure difference of 25 mmWG with the supply fan running.

Between 2015 and 2017, seismic reinforcement construction was undertaken for the HANARO in response to safety inspection results following the Fukushima Nuclear Accident.

In this paper, the effect of this construction on the reactor building leak rate was described by comparing the leakrate measured before and after Seismic reinforcement construction.

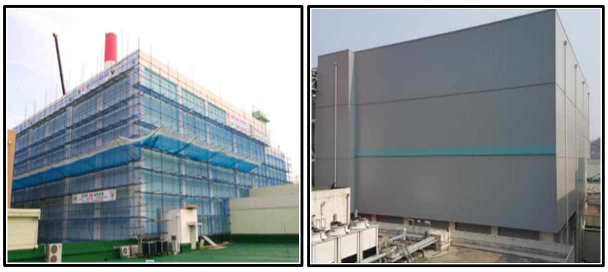

Fig. 1. Before and after seismic reinforcement construction for reactor building

2. Methods and Results

2.1 Measurement Method

To conduct the leakage rate test, the reactor hall ventilation system is deactivated, and all entrances and isolation dampers are closed, allowing air to be introduced into the reactor hall through an air volume control device.

After fine-tuning the rotation speed of the supply fan to stabilize the leakage rate test pressure of 25 to 26 mmWG, measure the injection air volume at that time. Since the reactor hall volume is a large volume of about 39000 m^3, it cannot react sensitively to changes in the injected air volume. The configuration of the air supply device control device is shown in Figure 2 . [3]

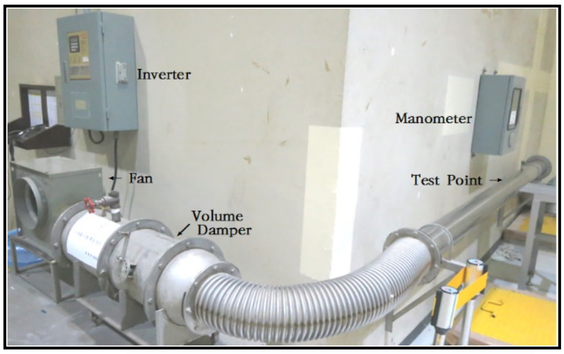

Fig. 2. Configuration of the air supply device

2.2 Measurement Instruments

For the measurement of differential pressure within and outside the reactor hall, two Differential Pressure Transmitters (DPT) were utilized, while four Resistance Temperature Detectors (RTD) were applied for temperature measurements within the reactor hall. To improve the accuracy and reliability of the leak rate measurement values, the average value of each measurement value is used to calculate the leakage rate.

The differential pressure measurement points are located on the eastern and western walls of the reactor hall, while the temperature measurement points are located in four locations: (1) the underground floor of the reactor hall, (2) the upper part of the reactor pool, (3) the crane rail area, and (4) the upper part of the new fuel storage room.

The differential pressure transmitter is designed to measure pressures ranging from 0 to 50 mmWG and transmits an analog output of 4-20 mA to the signal processor in the control room. The instrument exhibits a total error, inclusive of linearity and repeatability, of ±0.5%, with a response time of up to 250 msec.

Conversely, the RTD measures the air temperature inside the reactor hall and transmits the resistance output signal to the control room signal processor. The measurement range is 0°C to 100°C , and the accuracy is ± 1°C. The configuration of the air supply device control device is shown in Figure 3.

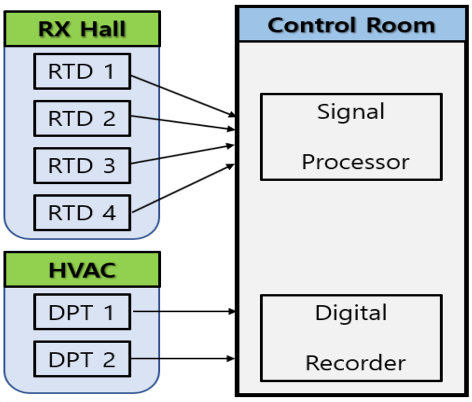

Fig. 3. Configuration of the measurement instrument

2.3 Analysis of Measurement Results

The average of the leakage rate was measured as 469.9m^3/hr for the 5-year period before seismic reinforcement work, and 458.7m^3/hr for the 7-year period after seismic reinforcement work. The results of 11 measurements before seismic reinforcement work are 431.4 ~ 485.4m^3/hr, and the results of 17 measurements after reinforcement work are 434.2~ 482.5m^3/hr. This is shown in Table 1 and Figure 4 below.

Table I: Measurement Results

Leak rate	Year	SPT [inch H2O]	Air Press. [mbar]	Temp. [deg]	Leak Rate [SPT]
Before reinforcement	1st 2012	0.139	1000.9	22.15	485.4
	2nd 2012	0.121	1006.6	28.28	462.3
	1st 2013	0.136	1013.1	19.74	482.5
	2nd 2013	0.107	996.4	27.07	431.4
	3rd 2013	0.128	992.5	25.93	476.6
	1st 2014	0.136	1013.2	20.96	475.0
	2nd 2014	0.110	1002.5	25.84	474.4
	3rd 2014	0.136	1001.3	20.15	478.3
	1st 2015	0.129	997.7	26.09	449.2
	2nd 2015	0.134	1011.7	19.67	479.3
	1st 2016	0.131	1005.6	18.84	474.9
	Total Average	0.128	1003.8	23.2	**469.9**
After reinforcement	1st 2017	0.113	999.5	23.41	434.2
	2nd 2017	0.108	995.8	29.99	454.3
	3rd 2017	0.110	1005.7	27.62	442.6
	4th 2017	0.134	1006.4	24.24	445.8
	5th 2017	0.126	1014.7	16.37	456.2
	1st 2018	0.138	1006.3	21.39	467.5
	2nd 2018	0.148	1005.9	24.03	475.8
	1st 2019	0.136	1003.2	21.60	452.9
	2nd 2019	0.122	1007.5	27.23	459.5
	1st 2020	0.120	1004.3	22.07	476.7
	2nd 2020	0.126	1003.2	27.97	419.5
	1st 2021	0.140	1006.5	25.96	479.8
	2nd 2021	0.130	1011.5	21.30	482.3
	1st 2022	0.122	1003.1	21.60	451.1
	2nd 2022	0.132	1011.7	23.54	482.5
	1st 2023	0.140	998.9	25.35	471.3
	2nd 2023	0.113	991.5	29.41	446.4
	Total Average	0.127	1004.5	24.3	**458.7**

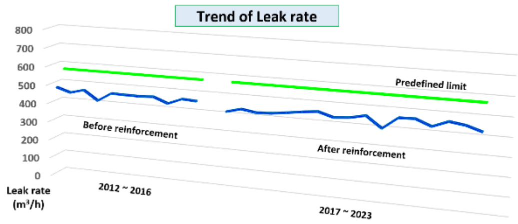

Fig. 4. Trend of Laek Rate

Following the seismic reinforcement work, a slight decrease in leakage was observed, indicating an enhancement in the building's airtightness.

3. Conclusions

The investigation conducted from 2016 to 2017 sought to explore the influence of seismic reinforcement construction on reactor building leakage rates. Prior to the commencement of seismic reinforcement work, the average leakage rate stood at 469.9 m^3/hr , a figure that marginally decreased to 458.7m^3/hr following the completion of the reinforcement project. Notably, seismic reinforcement efforts were concentrated on a specific segment of the reactor building's wall, and careful monitoring revealed no adverse effects attributable to this construction.

Moreover, it is worth emphasizing that the newly implemented seismic reinforcement measures effectively met the established leakage rate tolerance standard of 570 m^3/hr at the reference pressure of 25 mmWG. Consequently, the findings of this study provide assurance regarding the ongoing safety and structural integrity of the reactor building.

REFERENCES

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[3] Y.S. Choi, “A Study on the Leak Rate Measurement for HANARO Reactor Hall”, KAERI-TR-1335/99.