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Analysis of the Unexpected HANARO Trip History(1996~2005)

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1. Introduction

Since its first criticality in February 1995, the HANARO has been utilized for nuclear fuel and material irradiation tests, radioisotope production, neutron beam applications, neutron activation analyses, and a neutron transmutation doping, etc.

In the early HANARO operations, the unexpected reactor trip occurred frequently during a power ascension test which was one of the reactor performance tests. They were most due to a system problem and an operator's error. Some cases originated from an experimenter error and the failure of an electric power supply.

To reduce the unexpected reactor trips due to system problems, the neutron power measuring system was improved. A retraining of the operators was performed to reduce the human errors. When the reactor power increases, the reactor is tripped in the case that the difference of the neutron and thermal power is larger than 3 MW. To prevent a reactor trip by the thermal and neutron power mismatch, the neutron power is calibrated during an increasing power when the neutron power and thermal power differences are above 1.5MW. In this paper, the cases of unexpected reactor trips are analyzed from 1996 to 2005 and the efforts to reduce the unexpected reactor trips and their effects are described.

2. Analysis of the Unexpected Reactor Trip History

Table 1 shows the unexpected reactor trip history from 1996 to 2005.

Table 1. The unexpected Reactor Trip History from 1996 to 2005[1,2,3,4,5,6,7,8,9,10].

Year	System problem	Operator error	Experi-menter error	Loss of class 4 power	Total
1996	32	29	3	1	65
1997	9	5	0	3	17
1998	9	1	0	2	12
1999	7	0	0	2	9
2000	5	1	1	0	7
2001	2	0	0	2	4
2002	1	0	1	1	3
2003	1	0	0	0	1
2004	2	0	0	2	4
2005	0	0	0	1	1

In 1996, the 65 unexpected reactor trips occurred. Most cases were due to system problems and operator errors. Most of the operator errors occurred during a measurement of the isothermal temperature coefficient. This experiment needed to change of the trip set point of the primary cooling system. In 1997, the unexpected reactor trips was decreased by 17 times, because the systems problems were solved and the operators became proficient in reactor operations. The reactor trips due to the failure of an electric power supply occurred 3 times. In 1998, unexpected reactor trips occurred 12 times, one time by an operator's error and 9 times by system problems.

In 1999, unexpected reactor trips occurred 9 times. From 2001, the frequency of the unexpected reactor trips has been reduced.

From 2001, the number of the unexpected reactor trips except for the system problems and the failure of an electric power have been few.

3. Action for decrease the unexpected reactor trip

For the neutron and thermal power mismatch, in that case that difference of the neutron power and thermal power is larger than 3MW, a reactor trip occurs. It usually occurs when cooling pump and cooling fan start and water is supplied in the reactor pool.

To prevent this type of reactor trip, the cooling fan, primary and secondary pumps start operation in the state that the reactor power is stable. Also the water supply into the reactor pool to supplement the pool water being evaporated is performed in the state that the reactor power is stable. When the reactor starts up, the reactor power increases by 0.5MW or 1MW and after a reactor power increase, an operator waits until the reactor power is stable. During the power increase, a reactor power calibration is performed if the difference of the neutron and thermal power is larger than 1.5MW.

One of the main factors for an unexpected reactor trip was the fluctuation of a signal from the neutron power monitoring system. At a low power range, the fluctuation of the signal makes the reactor protection system recognize log rate a high. To prevent a reactor trip by this phenomenon, the circuit of the reactor protection system was changed to change the response time of the log power

For the reactor operator errors, they had no experiences in a reactor operation before. But they had participated in commissioning tests, they know the system well. Through the retraining and education for the reactor and system operation, nuclear engineering, they have accumulated the knowledge and skills for the HANARO operation. These efforts made the operators

cope with problems rapidly and safely during a reactor operation.

4. Conclusion

During the early stage of the HANARO operation, there were many unexpected reactor trips which originated from system problems and operator errors. To reduce the unexpected reactor trips, the system has been improved and reactor operation procedures have been modified on the basis of operation experiences. Through the training and education, the quality of the reactor operators has been improved and the unexpected reactor trips by operator errors have been reduced. HANARO has been operated for 11 years. From now on, the unexpected reactor trips may occur from an aging of the system. To prevent this problem, HANARO needs to inspect the system and component intensively in parallel with training and education for the reactor operators. And it needs to improve the electric system to reduce the failure of the electric power.

REFERENCES

[1] J.B. Lee et al., Year-1996 HANARO Operation, KAERI /MR-295/1996, 1997. 1.
[2] J.B. Lee et al., Year-1997 HANARO Operation, KAERI /MR-314/1997, 1998. 1.
[3] J.B. Lee et al., Year-1998 HANARO Operation, KAERI /MR-328/1998, 1999. 1.
[4] B.J. Jun et al., Year-1999 HANARO Operation, KAERI /MR-344/1999, 2000..1.
[5] B.J. Jun et al., Year-2000 HANARO Operation, KAERI /MR-358/2000, 2001. 1.
[6] B.J. Jun et al., Year-2001 HANARO Operation, KAERI /MR-379/2001, 2002. 1.
[7] B.J. Jun et al., Year-2002 HANARO Operation, KAERI /MR-395/2002, 2003. 1.
[8] B.J. Jun et al., Year-2003 HANARO Operation, KAERI /MR-411/2003, 2004. 1.
[9] B.J. Jun et al., Year-2004 HANARO Operation, KAERI /MR-429/2004, 2005. 2.
[10] B.J. Jun et al., Year-2005 HANARO Operation, KAERI /MR-443/2005, 2006. 3.