Transactions of the Korean Nuclear Society Autumn Meeting
PyeongChang, Korea, October 25-26, 2007

An Analysis of HANARO Operation Results in 2006

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1. Introduction

HANARO is being used for various research fields such as a neutron beam utilization, RI (Radio Isotope) production, NTD (Neutron Transmutation Doping) capsule irradiation, NAA (Neutron Activation Analysis) and fuel performance test. A stable operation and reliable management of HANARO are important parts to provide a good service for the researches mentioned above. The reactor operation in 2006 was planned from the 40th period to the 46th one, but the 46th period planned was delayed by the Fuel Test Loop (FTL) construction. Therefore, the operation results from the 40th to the 45th one in 2006 were analyzed.

This paper describes the operation records such as the amount of power generation, the delayed hours for a full-power arrival and those for a shutdown as parameters of HANARO in 2006.

2. An analysis of the Operation Results

2.1 An analysis of amount of power generation

Table 1 shows differences between the planned power generation and the actual one for each period. The amount of power generation scheduled from the 40th period to the 45th period was 4,177 MWD, but the actual one was 4,113 MWD [1].

Table 1. The differences between the planned power generation and the actual one

Period	P.G(MWD)		Different P.G (MWD)
	Plan	Actual	
40	696.2	699.84	3.64
41	696.2	699.49	3.29
42	696.2	693.02	-3.18
43	696.2	700.09	3.89
44	696.2	615.84	-80.36
45	696.2	705.09	8.89
Total	**4177.2**	**4113.37**	**-63.83**

As shown in table 1, the mount of the actual power generation (P.G) was more than expected for four periods and less for two periods. In case of the 42nd period, the planned power generation was not accomplished even though the reactor operation was extended due to an abnormal reactor trip by a loss of class IV power. In the 44th period, the reactor couldn't be operated as scheduled for the sipping test of the fuel bundle in accordance with a concentration increase of Xe-133 in the primary coolant. In Figure 1, the 44th period was not shown because a difference of the power generation was out of range.

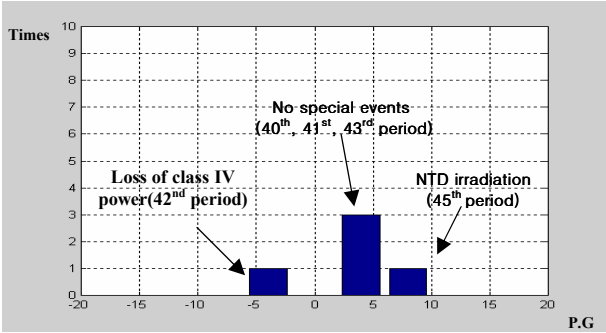

Figure 1. A frequency table of differences between the planned power generation and the actual one (bar thick.: 4 MWD)

2.2 An analysis of the delayed hour for a full-power arrival

Table 2 shows the causes of the delayed time for a full-power arrival. The reactor operation was done normally in the 40th, 41st and 43rd periods, but the 42nd one was delayed for 0.87 hours because the flow rate was not enough from the secondary outlet of the heat exchanger of the primary cooling system. In the case of the 44th period, reactor operation was delayed by as much as 126 hours because a sipping test was performed to find the cause of pool water radiation increase. Also, it was delayed for 1.18 hour in the 45th period since a low oil level alarm in the primary pump occurred.

Table 2. The causes of the delayed hour in full-power arrival

Period	Delayed time (hour)	Causes for delay
40	-0.27	No cause
41	-0.42	No cause
42	0.87	Abnormality of the primary pump
43	-0.17	No cause
44	126	Sipping test caused by Xe-133
45	1.18	Oil level low in the primary pump

Figure 2 shows the frequency table of the delayed hour for the full-power arrival each period. For 6 periods of the reactor operation, a full-power was accomplished within one hour in four periods, and it was delayed for two periods.

As shown in Figure 2, the reactor start-up was delayed for about 126 hours because the late start-up brought the late full-power arrival for the 44th period. A low oil level alarm occurred in the primary pump and the reactor start-up was postponed for 1.18 hour in the 45th period.

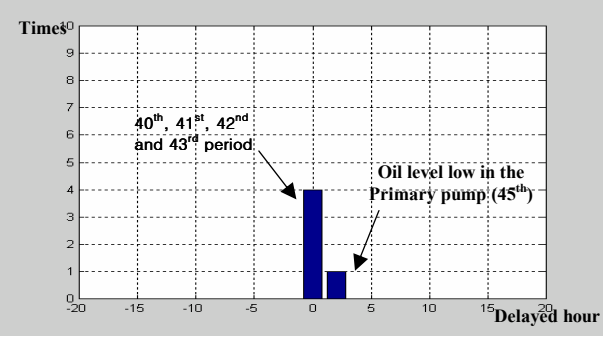

Figure 2. A frequency table of the delayed hour in full- power arrival (bar thick. : 2 hour)

2.3 An analysis on the delayed hours of shutdown

Table 3 shows the period and the cause of a delay when the reactor was shut down. Reactor was shut downed as planned without any problems in the 40th, 41st, and 43rd periods. But the reactor operation was extended due to an unexpected reactor trip by a loss of class IV power while being operated in the 42nd period.

Table 3. The causes of the delayed hour in the reactor shutdown

Period	Delayed time (hour)	Causes for delay
40	0	No cause
41	0	No cause
42	37	A loss of class IV power
43	0	No cause
44	32	Sipping test caused by Xe-133
45	7	NTD irradiation

The reactor shutdown was delayed to compensate the late start-up in the 44th period and the time of the reactor shutdown was delayed by more than that planned to fit into the time for the NTD irradiation in the 45th period.

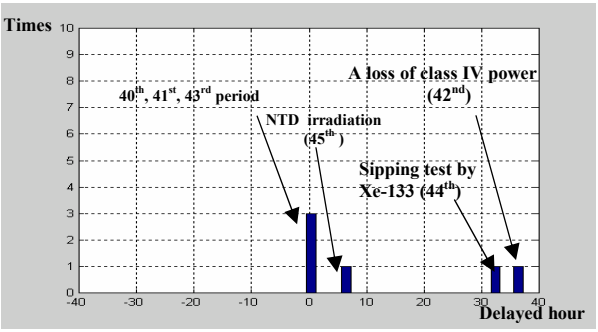

Figure 3. A frequency table of the delayed hour in shutdown

Figure 3 shows the frequency table of the time delay for the reactor shutdown. The frequency of a reactor shutdown within one hour was three times and the reactor shutdown was delayed by more than one hour for a three times.

3. Remarks

The amount of planned power generation in 2006 was 4177.2 MWD, but the actual one was 4,113 MWD, 98.5 % of the initial aim.

Among 6 reactor operation periods, a full-power was accomplished within one hour in four periods, and it was delayed in two periods.

The frequency of the reactor shutdown within 1 hour of plan was three times and the reactor shutdowns after more than one hour of plan were three times.

The reactor operation in 2006 had been recorded for 140 days, which was 30 days longer than in 2005 [2].

When experimental facilities effect the HANARO operation thorough plans should be established in advance. In addition, a delay of a reactor start-up and an earlier shutdown than planned should be prevented through an inspection beforehand and a preparation against an aging of the reactor system.

[1] H.Y. Choi et al., KAERI Internal Document, KAERI, 2007. 3.
[2] I.C. Lim et al., HANARO Operation Report, KAERI/MR/-465, KAERI, 2007. 6.