An Analysis of the Secondary Cooling System Repair Status after the Initial Operation of HANARO

Young-Chul Park, a
[a] Research Reactor Design Division, Korea Atomic Energy Research Institute 150 Deokjin-dong Yuseong-gu Daejeon, 305-353, R. O. Korea, Tel: 82-42-868-8474, E-mail: ycpark@kaeri.re.kr

1. Introduction

HANARO[1], an open-tank-in-pool type multi-purpose research reactor of 30 MWth power in Korea, has been operating normally since its initial criticality in February, 1995. During the last operation period of HANARO, when a trouble occurred, the trouble was fixed. As preventive maintenance can reduce the corrective maintenance, the reasons of the occurred troubles are reviewed. And the results are useful for planning the preventive maintenance of an open pool type research reactor. About one thousand cases of work requests and non-conformance reports (NCRs) have been issued since the initial criticality of HANARO. The cases are analyzed according to the issued date, the trouble equipment and the cause of the trouble.

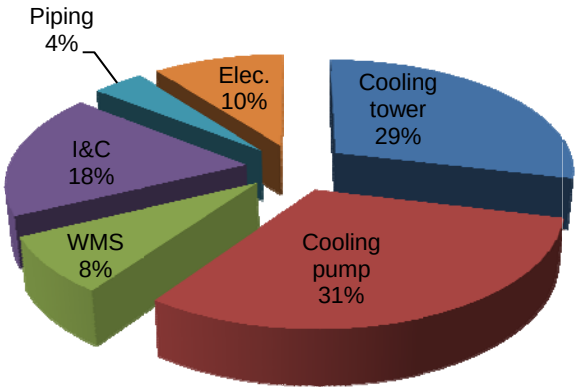
2. Methods and results

2.1 Secondary cooling system

A secondary cooling system[2] (SCS, hereinafter) is composed of three fifty percent capacity circulation pumps in parallel, a cooling tower, a basket strainer, a cooling water management system, piping and, valves and instruments. The secondary cooling water absorbs the heat generated by the reactor through heat exchangers composed of primary cooling system. Through the cooling tower, the absorbed heat is cold by forced air blowup of each cooling fans installed in the four cells of cooling tower. The cold water is re-circulated to the primary heat exchangers. The water management system (WMS, hereinafter) maintains the secondary cooling water quality for protecting corrosion and scale deposit.

2.2 Review of trouble

Until the end of 2008 from the initial criticality of HANARO, about one hundred eighty cases of work requests in the SCS were issued[3],[4]. It is about sixteen percent of the total cases issued in HANARO. As shown in figure 1, it is classified by the case of the major trouble equipment, thirty one percent for cooling pump, twenty one percent for cooling tower, eighteen percent for I&C, ten percent of electric, eight percent of WMS, and five percent of piping. Most troubles were found by periodic system check and repaired by maintenance people with manufacturer's assistance.



2.2.1 Secondary cooling pump

The major sources of cooling pump trouble are seal leak, high vibration, temperature and noise of bearing, electric trouble, discharge pressure switch abnormal, motor winding temperature high etc. Seal leak was major trouble. As the seal type is grand packing, it is normal practice a leak in grand packing after long term operation to cool the friction parts. It is recommended that grand packing be replaced with mechanical seal to reduce the occurrence of seal leak.

High vibration, noise and temperature of pump bearing occurred occasionally in no. 1 pump. After we checked closely the reason, it was found that the center of shaft was eccentric and the weight balancing is miss-matched. After fixing it, the pump was operated normally[5].

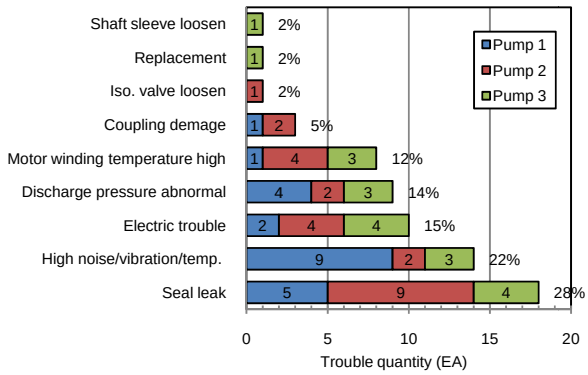


Figure 2 Troubles of secondary cooling pumps during operating years

From this practice, as the trouble could not fix in sit, it is recommended that each pump should be overhauled in manufacturer's shop by 10 year operation period.

During last operation period, sixty five troubles occurred in three pumps. As the average trouble of one pump is two cases for one year, it is acceptable to maintain three month periodic pump check.

2.2.3 Cooling tower

In case of cooling tower, the sources of major trouble are cooling fan trouble (64% of cooling tower trouble) and basin screen clogging (the rest of cooling tower trouble). In case of cooling tower basin, as twenty one cases of screen clogging occurred in the cooling tower for one year operation. Six month periodic cleaning is recommended.

The sources of the cooling fan troubles are fan high vibration, electric trip, water distributer damage, oil loss etc. as shown in Fig. 3. As the high vibration occurred 21 cases for four cooling fans for thirteen year operation, the trouble occurrence is two cases for one year-a fan. It is acceptable to change visual check period from a month to three month.

Each cooling fan real time vibration is recorded in HANARO control room. Twenty one high vibration troubles occurred. As the blade length is about two meter, It is too big to maintenance it. Hence it is necessary to maintenance those by manufacture. And it is recommended that the gear reducer be overhauled by ten year operating period to maintenance a wear of gear reducer. In case of cooling fan no. 4, a high vibration occurred by a wear of a pinion gear composed of gear reducer[6].

To maintain cooling tower cooling capacity, the fill was replaced by about five year period due to fill broken by long term operation. And ten year periodic overhaul of cooling tower is recommended.

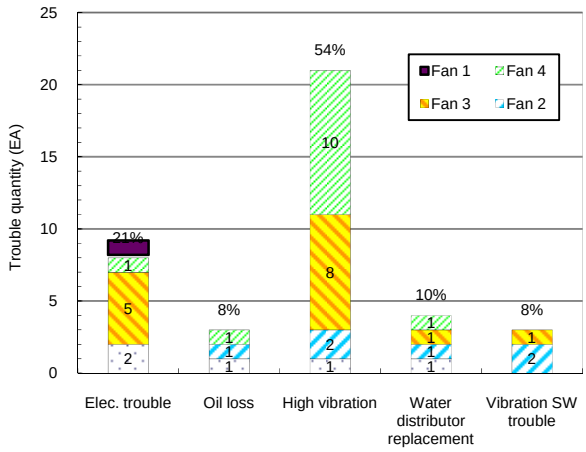


Figure 3 Troubles of cooling fans during operating years

2.2.4 The others

As the troubles of WMS, electric, I&C and piping were not occurred in period, it is acceptable to check them based on system check schedule.

3. Conclusions

When we reviewed the trouble status of the secondary cooling system based on work requests issued by HANARO during last thirteen year operating period, we came to the following conclusions.

1. In case of cooling tower, the sources of major trouble are cooling fan high vibration and basin screen clogging.
2. It is acceptable to change monthly cooling tower visual check period from one month to three months.
3. It is recommended that the cooling tower including cooling fan and fill be overhauled by ten year operating period to maintain cooling capacity.
4. It is recommended that cooling tower screen be cleaned by six month period.
5. It is acceptable to maintain three month periodic pump check and to overhaul ten year period to confirm pump operating performance.
6. It is acceptable to maintain twelve month periodic pump check.

References

[1] Y. C. Park, J. S. Wu, 1996, "System Performance Test in HANARO," the Proceeding of the 5th ASRR Vol. 1, pp. 240-246.

[2] KOPEC, "Design Manual of Secondary Cooling System", KM-711-DM- P01, KAERI, 1992. 7.

[3] Y. C. Park, J. H. Lee, Y. S. Lee and H. S. Jung, 2009, "An Analysis of the Primary Cooling System Repair Status after the Initial Operation of HANARO," 2009 HANARO symposium.

[4] HANARO, 2008, HANARO Application System Operation," KAERI MR-493/2008, pp.163-165.

[5] Y. C. Park, 2002, "The Solution of High Vibration of Secondary Cooling Pump in HANARO", J of Fluid Machinery, Vol. 5 No. 4, pp. 26 ~ 31.

[6] Young-Chul Park, et, al., 2007, "Cooling Tower Overhaul of Secondary Cooling System in HANARO," Proceedings of the KSME 2007 Spring Meeting.