Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 29-30, 2009

The Program of the Second 10-Year Periodic In-Service Inspection in HANARO

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1. Introduction

HANARO[(1)], an open-tank-in-pool type research reactor of 30 MWth power in South Korea, has been operating normally since its initial criticality in February, 1995. For the last ten years, HANARO has carried out the first 10-year periodic in-service inspections (ISI, as below) in accordance with Subsection IWD in ASME SEC. XI to verify the mechanical and structural integrities of an examined part[(2)]. In 2004, HANARO updated the ISI program for the second straight year in accordance with the applicable code last edited in 1998[(3)]. This paper describes the second ISI program, including the first ultrasonic volumetric test results of each primary pump flywheel bore and keyway according to the second ISI program.

2. The second ISI program

2.1 Applicable code

An ISI is a long-term inspection to verify the mechanical and structural integrity of pressure retaining and safety-related systems, structures, and components (SSCs, as below) for maintaining a reactor safety operation. As HANARO is designed based on the requirements of Class 3 Components in ASME SCE. III, Subsection IWD in ASME SEC. XI is applied to conducting the ISI of HANARO. The first ISI program was made out based on the requirements of ASME SEC. XI edited in 1989[(4)]. As the same method, the second ISI program was made out based on the requirements of the code edited in 1998[(5)].

2.2. Inspection Scope

ASME SEC. XI is classified as Subsection IWB, IWC and, IWD for safety class 1, 2, and 3, respectively. Subsection IWF is applied commonly to the inspection of the supports for each safety class. As a primary cooling system (PCS, as below) is classified as safety class 3 and is pressurized by the PCS pump during normal operation for removing a reactor residual heat , the scope of the ISI contains the PCS, including connected systems with PCS within the specified boundaries, as shown in Fig. 1[(5)].

In the figure, as the reactor connected to the PCS is operated under an atmospheric pressure, the reactor is excluded in the ISI boundary. Since the primary purification system (PPS, as below) and the emergency water supply system (EWSS, as below) connected to the PCS respectively are classified as a non-nuclear safety class (NNS, as below), these systems are excluded in the ISI boundary, as shown in Fig. 1.

Each flywheel, attached to each PCS pump motor shaft, provides an inertia force to ensure a slow decrease in the coolant flow in order to prevent a fuel melting. As each flywheel is not a pressurized component, it is excluded in the ISI boundary up to now. But it is necessary to perform a periodic inspection of each flywheel for verifying the mechanical and structural integrity. Therefore, this inspection is added in the second ISI program.

2.3 Inspection method

2.3.1 System pressure test

For Subsection IWD, the required tests and examinations are a VT-2 visual examination of a system pressure test for pressure retaining components and, a VT-3 visual examination of a welding integrity test for the pipe supports of the SSCs, which are NPS 4 and above, to be within the specified boundaries.

The system pressure test is composed of a system leak test and a system hydrostatic test. The scope of the system pressure test contains the PCS, the connected pipe lines, including the first inlet and the outlet isolation valves of the PPS which is joined to the core bypass line of the PCS,

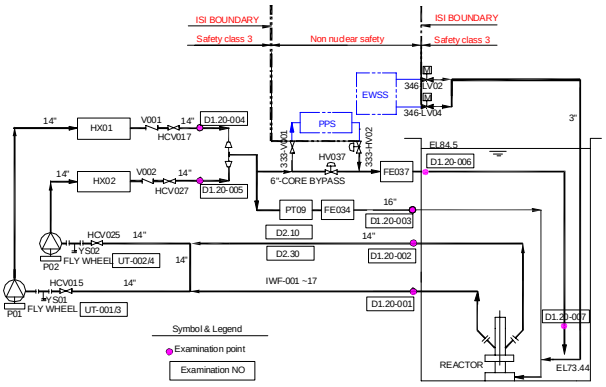

Fig. 1. The second ISI boundary in HANARO

Table 1 The second ISI program in HANARO

Inspection no.	Examination method	Inspection interval (year)									
		1	2	3	4	5	6	7	8	9	10
D2.10	System leak test under reactor operation						X				
D2.20	System hydrostatic test under reactor shutdown						X				
D1.20-001 ~ 007	VT-3 for integral attachment pipe support welds										X
IWF-001 ~ 019	VT-3 for non-integral attachment pipe support welds										X
UT-001	UT for bore and key way of no.1 pump fly wheel			X			X			X	
UT-002	UT for bore and key way of no. 2 pump fly wheel			X			X			X	
UT-003	UT for the surface and whole body of no. 1 pump fly wheel										X
UT-004	UT for the surface and whole body of no. 1 pump fly wheel										X

and the connected pipe lines, including the first isolation valves of the EWSS which is joined to the reactor cooling water inlet line of the PCS.

The system leak test (inspection no. D2.10) will be conducted during a 4 hour PCS normal operation under a reactor normal operation condition. For monitoring a water leak, the normal flow rate is maintained within a limit and there is no leak alarm during the test.

As the system isolation valves cannot maintain the hydrostatic test pressure, the system hydrostatic test (inspection no. D2.20) will be conducted during a 4 hour PCS operation under a reactor shutdown condition based on the requirements of the code. For monitoring a water leak, the flow rate will be maintained within a limit during the test. After the PCS pump stop, an inspector shall walk down for checking any traces of a leak.

2.3.2 Visual examination

A VT-3 will be applied to the verification of the mechanical and structural integrity for supports within the ISI boundary. As the supports are only installed in the system pipelines, the VT-3 will be performed to all integral welding attachments of piping supports based on the IWD (inspection no. D1.20-001 thru 007) and to the 10% of the rest of the pipe supports based on the IWF (inspection no. IWF-001 thru 019)[(6)].

2.3.3 Ultrasonic volumetric test

An ultrasonic volumetric test (UT as below) will be applied to the verification of the mechanical and structural integrity of a flywheel attached to each PCS pump motor shaft. To verify the integrity, the bore and keyway of each flywheel should be examined by the UT every three years, and the whole surface and body of each flywheel should be examined by the UT every ten years. The tests will be performed and the results will be evaluated by qualified people. When the result exceeds a limit, the evaluation results shall be reported to the related regulation body.

2.4 ISI program

Fig. 2 shows the second ISI program in HANARO. As the parts examined is not lot, the ISI will be conducted in the 3rd, 6th, 9th, and 10th year within a ten year period by the required test period of the UT for pump flywheels. By the program, the first UT was conducted to verify the integrity of the bore and keyway of each flywheel in the last year. It was confirmed through the test results that each flywheel maintained the mechanical and structural integrity [(7)].

3. Conclusions

Based on the revised requirements of Subsection IWD of ASME SEC. XI edited in 1998, HANARO made out the second ISI program in 2004. The scope of the ISI program was that the SSCs were larger than the NPS 4 of the PCS which is classified as safety class 3, and they retained pressure under a normal operation condition. And the second ISI program included a 10% visual test of none integral welding pipe supports and a ten-year periodic ultrasonic volumetric test of each flywheel attached to the PCS pump motor shaft. By the second ISI program, it was confirmed through the results of the first UT that each flywheel bore and keyway maintained a mechanical and structural integrity.

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