Development of the visual inspection system for the top of the tube sheet in steam generators

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1. Introduction

Steam Generators at Nuclear Power plants have a important function to isolate Radioactivity between the primary side radioactive fluid running through tubes and the secondary side with non-radioactive fluid through out of a tube bundle, in addition to a function of steam generation. Therefore, To obtain integrity of Steam Generator is really important for safety in the nuclear power plant. At the same time, sludge and foreign objects in steam generators are known as major sources causing the damage of SG tubes. But there is no way to prevent those coming to steam generators until now. Therefore, a periodic inspection and removal of those in steam generators is the only way for those

Generally, Most of the Nuclear Power Plants have been inspecting visually every outage for the top of the tube sheet in which sludge and foreign objects lead to the buildup to know how these are. But in the case of the OPR1000 type's steam generators, it is a reality that this rule is not adapted. Because the gap between tube and tube of OPR1000 type's steam generator is too narrow than other types to have visual inspection and any inspection systems are not developed yet.

Research and Development Institute in KPS developed KISS to solve this problem. KIIS can have a visual inspection for the top of the tube sheet of OPR 1000 type's steam generators

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2. Composition of KIIS and Results of Performance Test

In this section, Composition of KIIS, performance tests and the result will be recounted shortly.

2.1 Composition and Functions

KIIS adapted visual inspection techniques with CCD sensor and consists of inspection robot, LCU(local control unit) and RCU(remote control unit).

Inspection robot with CCD sensor is inserted into the inside steam generator through it's hand hole, installed on the wall of the shell in the annulus space and carries out visual inspection using method of inserting a very thin inspection probe with CCD sensor into the very narrow gap between tube and tube, driving around the annulus space. KIIS is equipped with tools to remove foreign objects when those are found.

Local control unit installed near Steam Generator makes it easy to install into steam generator and to remove robot from steam generator. And this unit is equipped with a number of monitors to recognize all working condition while inspecting and operating inside.

Remote control unit allows workers to control robot remotely to reduce radiation exposure dose. Specialized operation program offers worker's convenience and operation integrity. this unit is equipped with video recording system to analyze results of visual inspection later.

KIIS has a number of safety equipment for emergency. KIIS is designed to have operation under safe condition in views of mechanism and removal for emergency all the time. the worst situation is that Inspection probe should be failed while a inspection probe with CCD

sensor is inserted the most deeply into the gap between tube and tube. Inspection robot is removed compulsively. Even that situation, robot should be removed safely from steam generator without any damage to tubes.

To operate robot with safe position and condition and to remove robot even under any conditions, KIIS has some safe mechanism, such as some monitoring cameras, inter lock system and some removal equipment for emergency situation.

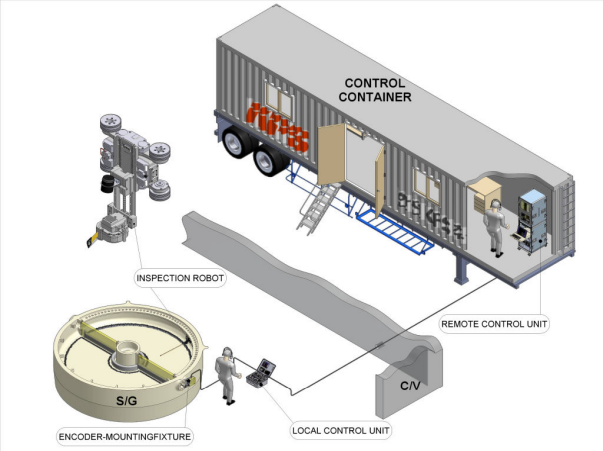

Fig. 1. KIIS Layout

2.2 Results

After developing KIIS, Results of operating test, inspection available position, Safety test and performance verification are all satisfied. Performance verification was carried out with Mock-up of the same size of OPR1000 Steam Generator many times until having reliable results. the procedure was developed to apply KIIS to field and curriculum for KISS operators was made in KPS in-house training center. operators was nurtured from this course.

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3. Conclusions

Periodic visual inspection for the top of the tube sheet in OPR1000 type's steam generators was not possible Owing to none of visual inspection equipment KISS must be the only one equipment to inspect the top of the tube sheet in OPR1000 types steam generators

KIIS has been carried out many tests to verify safety and functions. Results of Performance and safety verification was satisfied.

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REFERENCES

[1] Final Report of Development of the visual inspection system for the top of the tube sheet in KSNP Steam Generator, by KPS, 2008..