

Upgraded Steam Generator Lancing System for Uljin NPP#2

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1. Introduction

KEPRI(Korea Electric Power Research Institute) has developed various types of steam generator lancing systems since 1998. In this paper, we introduce a new lancing system with new improvements from the previous steam generator lancing system for Uljin NPP#2(nuclear power plant) constructed by KEPRI. The previous lancing system is registered as KALANS[®]-II and was developed for System-80 type steam generators. The previous lancing system was applied to Uljin unit #3 and it lowered radiation exposure of operators in comparison to manually operated lancing systems. And it effectively removed sludge accumulated around kidney bean zone in the Uljin unit #3 steam generators.

But the previous lancing system could only clean partially the steam generators of Uljin unit #4. This was because the rail of the previous lancing system interfered with a part of the steam generator.

Therefore we developed a new lancing system that can solve the interference problem. This new lancing system was upgraded from the previous lancing system. Also, a new lancing system for System-80 S/G will be introduced in this paper.

2. Lancing System for System-80 steam generator

The previous lancing system interfered with the Uljin unit #4 steam generator due to a manufacturing error in the steam generator. It required a repairman to grind a patch plate of the steam generator with a general electric tool. Also, the debris from grinding the patch plate harms the steam generator when in operation. The previous lancing system as well as the new lancing system will be introduced in this paper.

2.1 System-80 steam generator

A total of 8 nuclear power plants having System-80 steam generators are operated in Korea, including Youngkwang #3, 4, 5, 6 and Uljin #3, 4, 5, 6. The system-80 steam generator has a triangular tube arrangement, and Figure 1 shows that the gap of the inter-tube is narrow. We couldn't insert our equipment into the inter-tubes, so we decided to install the lancing system in a no-tube lane of the steam generator and this enabled the nozzles to shoot high pressure water at 30, 45, 90 degrees with respect to the rail.

Steam generators are not always constructed as designed. Although manufacturing errors in steam

generators do not cause any harm when operating nuclear power plants, they may cause problems when installing a lancing system in the steam generator.

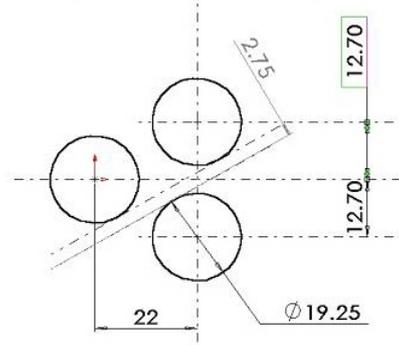


Figure 1. Triangular tube arrangement in the System-80 steam generators

2.2 Previous Lancing System for System-80 S/G

The previous lancing system solved problems when cleaning the steam generator. In contrast to the manual lancing system, the previous lancing system lowered the radiation exposure of the operator through automation, and minimized the possibility of damaging the tube of a steam generator by being installed along the no-tube lane through the hand-hole, as shown in Figure 2. Its rail was bent at 45 degrees and installed on the left and right side of the stay cylinder. The lancing robot which ejected high pressure water moved along the groove on the rail.

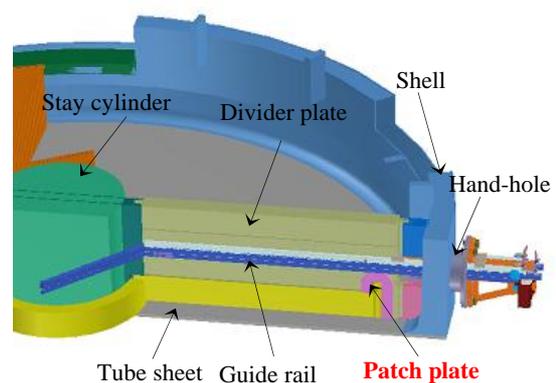


Figure 2. Installment of the previous lancing system.

But the previous lancing system was designed for System-80 steam generators constructed exactly as designed. The rail of the previous system interfered with the patch plate of the Uljin unit #4 second steam generator by 10mm. So the rail of the previous system or the patch plate of the steam generator needed to be

grinded. We determined that improving the lancing system was more recommendable than grinding the patch plate, considering the dangers involved in grinding. And we expect the new lancing system to be applied to general System-80 steam generators, including Youngkwang #3, 4, 5, 6 and Uljin #3, 4, 5, 6.

2.3 Upgraded Lancing System for System-80 S/G

This system consists of 3 units (KALANS- II unit, master unit, processing unit. The KALANS- II unit has two robots and a rail that installed in the steam generator. The design of the processing unit and master unit are equal to that of the previous lancing system. But the robots and rail of this system are different from that of the previous system.

Its rail is installed along the no-tube lane above the patch plate through the hand hole. The end portion of the rail is segmented into several parts so that it can be bent. The rail guide bends the rail to 45 degrees. The rail of the previous system interfered with the patch plate of steam generator. So we designed a new rail for the lancing system as thinner than the previous one. The cross section of the rail is 28mm wide and 60mm high (cf. The cross section of the previous rail is 29mm wide and 70mm high). The result is no more interference with the patch plate of the Uljin unit #4 steam generator. Also, the robots of the new lancing system were improved in size and function. The new lancing system has two lancing robots in contrast to the previous system consisting of three robots. The lancing robots of the new system have various nozzles which can shoot high pressure water into the sludge piled up on the tube-sheet of a steam generator. Unlike the lancing robots of the previous system, we designed a tilting nozzle assembly that drives sludge accumulated around the center stay cylinder to annulus of the steam generator. A servo motor enables the nozzles to tilt by using the spur and rack gears. And an operator can observe how high pressure water from the nozzles cleans the tube and tube-sheet through the flexible video scope.

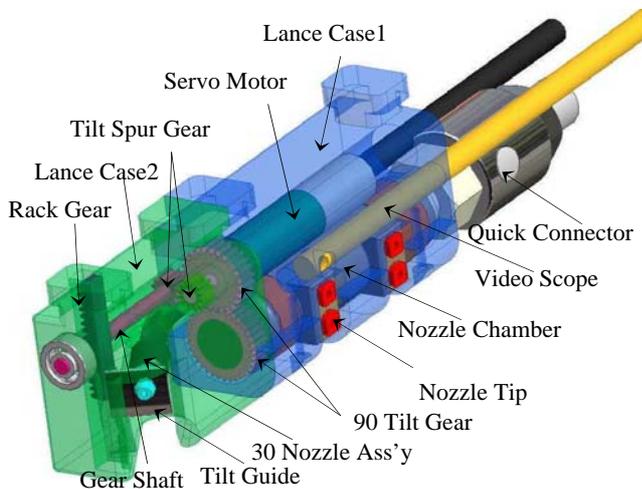


Figure 3. Perspective representation of Robot-30&90

The shooting angles with respect to the rail in the Robot-30&90 are set as 30 and 90 degree (Figure 3). Especially, we adopted a quick connector in Robot-30&90 because nozzle assemblies directed at 90 degree have to eject a lot of high pressure water. Robot-30&90 has side-view lens in a video scope. The cross section of Robot-30&90 is reduced to 23.5mm wide and 43.0mm high (cf. The cross section of the robot of the previous lancing system is 24.5mm wide and 44mm high).

Robot-45 has the shot angle of nozzle assemblies set at 45 degrees (Figure 4). An operator can make observations of the shooting through a flexible video scope. The cross section of Robot-45 is 22.5mm wide and 40.0mm high, which is smaller than the previous one.

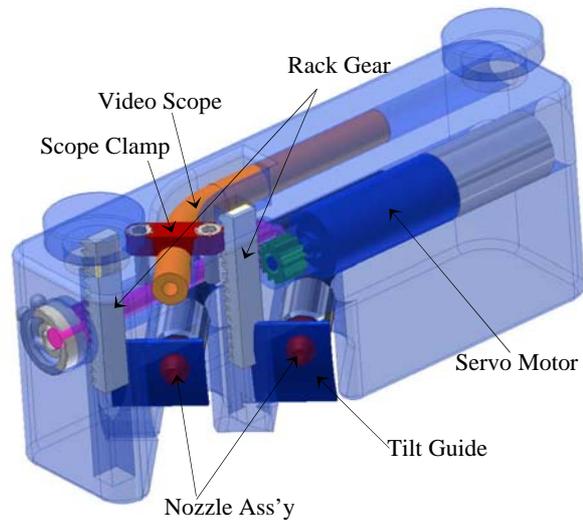


Figure 4. Perspective representation of Robot-45

3. Conclusion

This new design of lancing robots and a rail gives us a solution for the interference problem with the patch plate owing to slimmer lancing robots and a rail than the previous ones. The new lancing system will have great ability to remove sludge accumulated around a kidney bean zone of a steam generator by using the function of tilting nozzles. This upgraded lancing system will be applied to the Uljin NPP#2 and 3.

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