Visual Inspection of the Flow Distribution Plates of Ulchin NPP #3 SG

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1. Introduction

An equipment for visually inspecting the joining bolts of the flow distribution plates (FDP) of the OPR1000 steam generators(SG) of Ulchin NPP #3 had been developed and tested during plant outage from 25th to 26th of February, 2010. By using the equipment, we could visually identify that most of the FDP joining bolts were in good condition. During the hot test of the equipment, we further found that the surface of the internal structure of Ulchin #3 SG was covered with light absorbing powder mostly composed of metal oxides. Therefore, we could not take good images for certain bolts which were relatively far away. Even though the development and hot application was successful, we concluded that further experiments are necessary using SG mockup which is prepared to be similar to the actual SG internal covered with metal oxide powder.

2. Visual Inspection of FDP Bolts

2.1 Visual Inspection System

Two FDPs were installed in central cavity area of Ulchin NPP #3 SG to prevent flow induced vibration (FIV) of SG tubes as shown in figure 1. We designed a visual inspection system to identify 16 bolts of each FDP. The positioning subassembly was designed to be attached on the secondary man-way to adjust the location of the probe guide subassembly[2]. The probe guide subassembly is inserted through the secondary man-way, wrapper hole, and the gap between wrapper and SG tube bundle. Finally, a quartz video-probe is inserted through the holes in the positioning subassembly, reaching the FDPs.

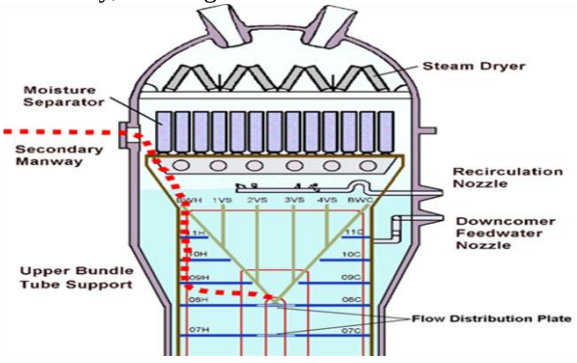

Fig.1 Flow Distribution Plates

2.2 Visual Inspection Results

Fig.2 Visual Inspection System

Figure 2 shows the visual inspection system which was installed for the first time to the man-way flange of Ulchin #3 SG on 25th of February during outage period. Two men were involved in the installation and operation of the inspection system. A man adjusted the length, and another man adjusted the direction of the video probe.

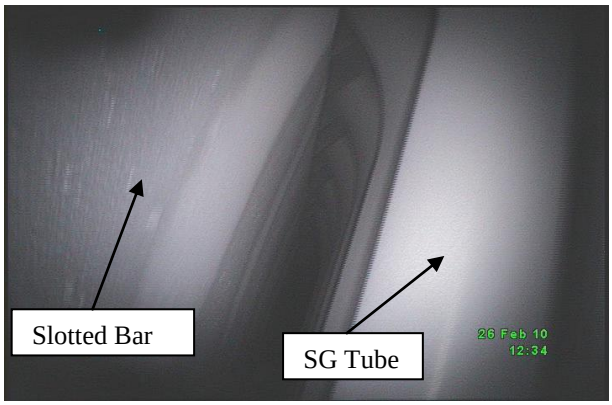

Fig.3 SG tubes and Slotted Bar

Figure 3 shows the tubes and the slotted bar of Ulchin NPP #3 SG which was taken when an operator inserted the video probe through the gap between the slotted bar and the SG tubes. The surface of the slot bar and the tubes were covered with black sludge powder. Therefore, when the lens of the video probe contacted

the surface of the slot bar or the tubes, we often had difficulty in getting bright image. We found that the black sludge power on the surface of the lens of the video probe prevented light from emitting.

2.3 Visual Inspection Results

When the tip of the video probe reached the FDP, we could see the FDP bolts as shown in figure 4. Figure 4 was taken when we approached a FDP bolt. As we see in the picture, we could easily identify that the bolt, hex head cap screw, was in good condition. We could not find any defect or loss of the FDP bolts.

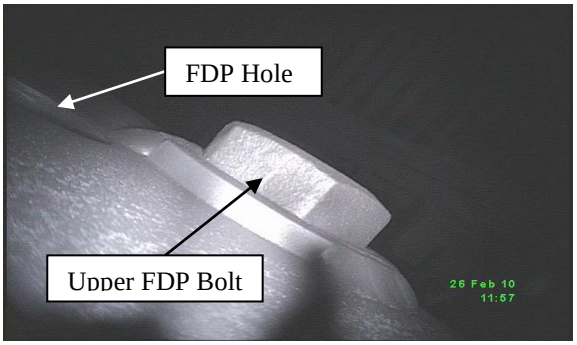

Fig.4 Upper FDP bolt

However, we could not approach several FDP bolts located at the outer edge. Figure 5 is a picture of the FDP bolt located at the outer edge. In this case, we could confirm that the bolt exists and has no defect in washer.

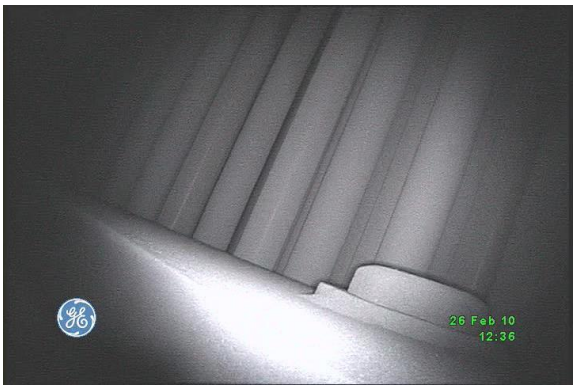

Fig.5 Upper FDP bolt at the Edge

We inserted the tip of the video probe through the FDP hole to see the lower FDP bolts. When we insert the video probe tip, it was so dark that capturing a bright image of the FDP bolts was not easy. Therefore, we changed setup of the video probe system to long exposure mode and took image of the bolts as shown in figure 6. However, flow of moisture and dust prevented us from acquiring bright and clear image. Only several lower FDP bolts could be observed because of the distance of 1,008mm between the two FDPs.

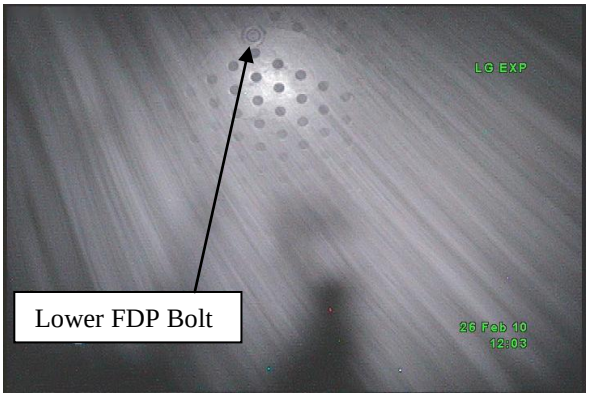

Fig.6 Lower FDP bolt

3. Conclusions and Recommendations

3.1 Conclusions

We successfully developed and hot tested a visual inspection system of FDP bolts of Ulchin NPP #3 SG during plant outage from the 25th to the 26th of February 2010. There has never been any such development in the world to inspect the FDP bolts of nuclear steam generator. Although visual inspection of all the FDP bolts was not possible in this case, we concluded that further minor upgrade and change in inspection procedure would lead to completely successful development.

3.2 Recommendation for Further Upgrade

From the image of figure 5, we suggest to fill water in SG to remove blurring effect caused by moisture and dust after inserting the video probe through the upper FDP hole. Secondary coolant water is so clean that clear and sharp image having no blurring effect may be obtained. However, it should be tested whether the probe floats or not in water. If the probe does not float, water may be filled before inserting the video probe through the upper FDP hole.

We could enlarge the bolt image of figure 5 by making the video probe to approach to the bolt. In this case, experiments should be made to confirm that the probe may be retrieved without any problem. By replacing of the video probe lens with narrow view angle, we also could have larger image.

REFERENCES

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