A Study on Method to Reduce the Sludge Attachment of the Secondary System for Nuclear Power Plant

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1. Introduction

The purpose of this study is to present the method to reduce the sludge attachment of the secondary system through the cases of reduction in electric power by the sludge of the Main Feed Water System of Younggwang #5 and #6 Nuclear Power Plant.

In the event of YGN #5 and #6, the clogging phenomenon in the Feed Water Control Valve cage has continued to have severe changes in the Feed Water Flow, as a result, it has experienced several problems in reduction of electric power at the end of the cycle, loss of power from the increase of speed in Main Feed Water Pump, replacement of the Feed Water Control Valve cage for each period and others.

This phenomenon is thought to be accelerated after modifying the secondary system of water treatment method from ammonia to ethanolamine and resolved by optimizing the density of the chemical substances (ETA/NH3/N2H4) as used in the water treatment.

2. Methods and Results

In order to solve this problem, the solution is found through various reviews of causes and operation actions for each field of secondary water quality control, analysis of sedimentation, cause of Feed Water Control Valve hunting and others.

2.1 Major problems

2.1.1 Main Feed Water Pump

The Main Feed Water Pump & the Feed Water Booster Pump impeller had the foreign substance deposited, and the Main Feed Water Pump speed and discharge pressure increasing phenomenon occurred, and as a result, there was loss of power due to the increase of the pump rotation speed.

2.1.2 Feed Water Control Valve

EFCV (Economizer Flow Control Valve) & DFCV (Downcomer Flow Control Valve) cage had the foreign substance deposited to have the DFCV flow reduction and EFCV opening increase phenomenon by the increase of flow resistance.

In addition, At approximately 80% opening of the EFCV Cage (Fig. 1), it is the zone that enlarges the diameter of the valve cage hole that this zone enlarges the width of change for the Feed Water Flow that is used as the input variable of the power operating limit of the NPP to enable the licensed power of the NPP to approach the limit, resulting in maintaining the low electric power.

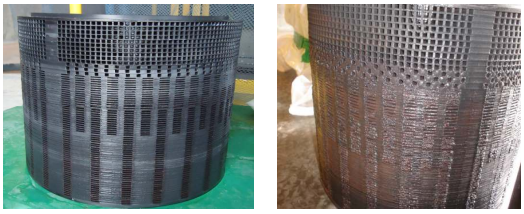

Fig. 1. Photos before and after the EFCV Cage clogging of YGN #5 and #6

2.2 Analysis of cause

2.2.1 Time of foreign substance sedimentation phenomenon to occur

As a result of pressure and flow analysis of the main feed water, the sedimentation phenomenon was confirmed to occur around October 2004 for both YGN #5 and #6.

2.2.2 Location and type of foreign substance sedimentation

The iron oxidation substance was discovered with the phenomenon to deposit in certain thickness on pipes, pump impeller and others and it has deposited in the thickness of approximately 0.1 mm on the Feed Water Booster Pump impeller, and the surface was analyzed as Magnetite while the surface lower part as the impeller surface was analyzed as Hematite.

On the Feed Water Control Valve cage hole part, the precipitation hardening phenomenon in the needle-shape was discovered.

2.2.3 Review of type and material of the Feed Water Control Valve cage

The material is the magnetic substance with the alloy in SS400 line of Martensite, in the event of magnetized, the magnetic substance, Magnetite, could be deposited on the cage surface, but as a result of disassembling, there was no magnetization phenomenon.

2.2.4 Review of influence of FAC (Flow Accelerated Corrosion)

Most of deposited foreign substances are collected by the Condenser Hot Well to have a part of it to mix into the feed water system, and as a result of comparing with other NPP, it is not the direct cause to increase the cage clogging.

2.2.5 Mixture of chemical substance used at the time of maintenance

There is a possibility of mixture of residue substances, such as, rust-proof, cleansing and penetrated grease and others, when disassembling and maintenance of various pumps, valves, and tanks of secondary system.

2.3 Major operation actions and result
2.3.1 Additional operation of the condensate polishing vessel

For the purpose of removing the particle substance to improve the Feed Water quality, the Condensate Polishing Vessel was increased from 2 units to 4 units, but there was no improvement effect.

2.3.2 Adjustment of the density of the hydrazine and ammonia

As a result of increasing the density of hydrazine and ammonia step-by-step to heighten the pH of Main Steam and Feed Water, the iron density within the system (Table I) was reduced to improve the Feed Water flow and opening of the DFCV and EFCV.

Table I: Reduction of the iron density in the system following the increase in pH

NH_4/ETA(ppb)	400/1,900	600/2,000	800/2,200
pH	9.52	9.55	9.57
Fe	2.71	2.50	2.96

In addition, with the reduction of the flow resistance in the system, the Feed Water Pump speed and discharge pressure have recovered to the status previous to the valve clogging phenomenon.
This is considered to have the improvement in the hydro-chemical environment of the secondary system water to reduce the corroded generation and removal of the deposited foreign substance to make such improvement. (Fig. 2)

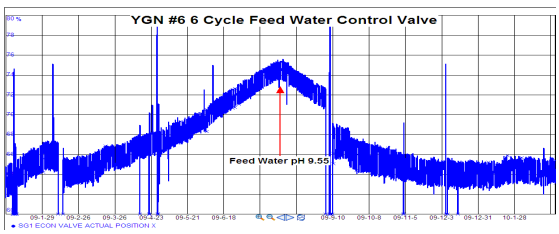

Fig.2. Change of the EFVC opening before and after pH adjustment

3. Conclusions

Under this study, as a result of focusing on the plan to reduce the generation of iron oxidation substance through the hydro-chemical environment adjustment, the time of clogging up the cage of the Feed Water Control Valve to increase the Main Feed Water pressure and the flow of the DFCV reduced was considered as accelerated after October 2004 when the secondary system of water treatment method from ammonia to ethanolamine that it is resolved by optimizing the density of the chemical substances (ETA/NH3/N2H4) as used in the water traetment.
Through this study, optimal hydro-chemical conditions and operation method for minimizing the corrosion in the secondary system of the Pressurized Water Reactor have been prepared, and as a result, it enhances the production efficiency of the electric power and contributes to the extension in safe operation and life cycle of the Steam Generator.

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