Consideration of long term shutdown effect

There is no operating experience that shows new degradation mechanism and accelerated growth of known degradation due to long-term shutdown since the disaster 2011 in Japan.

Following items are combination of component and degradation there is possibility to be accelerated during long-term shutdown comparing with normal operation (extracted from Aging Management Technical Evaluation Report in Japan).

All degradation mechanism is able to be managed by inspection, preventive maintenance.

IⅠ. Typical examples of evaluation of degradation due to a long-term shutdown of a PWR

1. Charging/High Pressure Injection Pump (shaft cracking due to fretting fatigue)

Flow rate of Chemical Volume Control System is reduced and Charging/High Pressure Injection Pump discharge flow rate is decreased during cold shutdown. If pump rotating speed is same with during operation, lower flow rate makes stress to shaft higher so that this aging effect becomes more severe than during continued operation.

However, it is confirmed low possibility of fretting fatigue cracking of pump shaft because bending stress amplitude is still lower than fatigue limit even though considering this situation. So the integrity of pump shaft is still maintained.

These pump shafts have been replaced with grooved shafts for stress mitigation as well.

1. Charging flow control valve bypass control valve, primary cooling water pump seal charging flow control valve bypass control valve (loss of material of valve body, valve sheet due to erosion/corrosion

There valves are depressurized from high pressure charging/high pressure injection pump outlet line to primary coolant system which is lower pressure during cold shutdown. Therefore status of large pressure difference between the inlet and outlet of valve is continued longer and more severe than usual operation.

However, possibility of erosion/corrosion effect of disk and valve seat on component integrity can be small by inspecting valve inside during disassemble. Significant erosion/corrosion can be detected by visual inspection during these routine maintenance activities, which is determined as appropriate method to maintain integrity.

3) RHR pump motor stator coil and lead wire/connection (loss of insulation due to organic material degradation)

During long term shutdown, operating time/year would be longer than continued operation. However, frequency of insulation diagnosis is determined based on operating duration, which makes the diagnostic interval short and is considered as appropriate to maintain the component integrity during long term shutdown. Also replacement of these components would be done based on operating period and the result of insulation diagnosis.

II. Typical examples of evaluation of degradation due to a long-term shutdown of a BWR

1) Wear of the sliding parts of the Residual Heat Removal (RHR) pump, RHR seawater pump, RHR cooling water pump, emergency auxiliary component cooling water pump

If a component that is usually in a standby mode is continuously operated to maintain the reactor in a stable shutdown condition, we cannot deny the possibility of the sliding parts (the main shaft, impeller, casing ring, bearing (slide bearing)) being worn. However, no significant wear was found in an overhaul during a long-term shutdown.

The integrity of the RHR pump, the RHR seawater pump and the RHR cooling water pump can be ensured by routine inspections such as operational condition monitoring and visual inspection by walkdown. The frequency of inspection has been changed so that inspection can be performed during a period equivalent to the usual operating period before an overhaul. The integrity of the emergency auxiliary component cooling water pump can be ensured by routine inspections such as operational condition monitoring and visual inspection by walkdown. Therefore, it is inconceivable that there is any factor that causes a change in these tendencies.

We have determined that as a result of these, the integrity of the pumps can be maintained to maintain the reactor in a stable shutdown condition for the time being.

2) Degradation of the insulation properties of the stator coil, lead wire and connecting parts of the RHR pump motor, RHR seawater pump motor, RHR cooling water pump motor, and emergency auxiliary equipment cooling water pump motor

Since the operating time of the pumps will be longer in a state to maintain the reactor in a stable shutdown condition than during the normal operation of the plant, the degrading tendency of the insulation properties may be affected.

However, we changed the interval of inspection based on the operational performance of similar components, taking into account the operational state required to maintain the reactor in a stable shutdown condition. We have determined that in maintaining the reactor in a stable shutdown condition at the moment, the integrity of the pumps can be maintained by continuing to perform routine maintenance and state monitoring, including regular switching and testing, as well as by taking necessary actions as needed.

3) Wear of the main shaft of the RHR pump motor, RHR seawater pump motor, RHR cooling water pump motor, and emergency auxiliary equipment cooling water pump motor

Due to continuous operation, the shaft is likely to continue to degrade. We changed the interval of inspection of the RHR pump motor for a longer operating period resulting from continuous operation, based on the operational performance of similar components. Since no significant wear was found in other continuously operated pumps, it is less likely that the main shaft of the RHR seawater pump motor, the RHR cooling water pump motor, and the emergency auxiliary component cooling water pump motor continues to degrade.

We have determined that as a result of these, the integrity of the pumps can be maintained to maintain the reactor in a stable shutdown condition for the time being.

4) Corrosion and erosion of the casing and cover of the blow line flow control valve in the reactor coolant cleanup system and the feedwater control valve in the reactor coolant cleanup system

Wall thinning due to corrosion or erosion may occur in control valves, which are often used at an intermediate opening. Since the flow velocity and temperature is lower in a state to maintain the reactor in a stable shutdown condition at the moment than during plant operation, we have determined that it is less likely that wall thinning occurs and continues.

5) Wear of the stem nut and gear of a motor-operated valve

The stem nut and the gear have engaged sliding parts. We cannot deny the possibility that wear may occur due to the actuation of a motor-operated valve. We will continue routine maintenance, including regular switching and testing of system components, taking into account the operational state required to maintain the reactor in a stable shutdown condition at the moment, and repair and replace the motor-operated valve drive unit as needed.

We have determined that with these activities, the integrity of the valve can be maintained to maintain the reactor in a stable shutdown condition for the time being.