Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 10-11, 2007

Design Modification of Kori Unit 1 for the Equipment Qualification

J.W. Park,[a] M.Y. Kim,[a] K.T. Han,[a] J.D. Park,[a]
[a] *KOPEC,360-9 Mabuk-Dong, Giheung-Gu, Yongin-Si, Gyeonggi-Do, jpark@kopec.co.kr*

1. Introduction

There has not been a strict regulatory requirements for the Equipment Qualification(EQ) in 1970's when Kori Unit 1 had begun the construction and the commercial operation. The Korean regulatory body requested the EQ on the various safety-related components, as a result of Periodic Safety Review. However, the EQ itself is impossible in some areas, due to the high pressure/temperature and flooding environment conditions from the pipe breaks[1]. Design modification is being considered in the Auxiliary Building, the Intermediate Building, the Component Cooling Water Heat Exchanger Building and the Turbine Building, in order to mitigate the environmental conditions for the EQ.

2. Design Modification

In this section examples of the design modification for the mitigation of the EQ condition in the Kori Nuclear Unit 1 are described. The design modification includes additional openings, new wall, emergency drain facilities, and installation of detectors for the operator actions.

2.1 Main Steam Header Area

In the main steam header area, two major vent openings are installed at the ceiling, in order to relieve steam and subsequently lower the pressure loadings in case of the main steam line break in this compartment. One is the opening with the area of about 300 ft^2, and directly connected to the atmosphere with the blowout panel. The other, with the opening area of 100 ft^2, penetrates into the fan room in elevation 70'-0" and finally to the atmosphere through the blowout panel. Besides, two flood relief openings are installed with the grating barrier at the bottom slab of the compartment. The sizes of these flood relief openings are 85.25 ft^2 and 10.33 ft^2, respectively. The door toward the auxiliary building is changed as a blast door to limit the harsh environment. Consequently, with all these design modification, the peak pressure can be decreased lower than 2.5 psig and the maximum flood height less than 2 ft.

2.2 Feedwater Line Penetration Area

The most conspicuous design change in this area is the installation of the new wall to separate the aux. feedwater pump area and the air compressor room in the elevation 20'-0" from the feedwater line area in the elevation 33'-0". During and following the feedwater line break, steams can be vented through the modified door that is connected to the atmosphere. Also, additional openings toward the turbine building and the containment annulus access area, and the openings for the flood relief at the bottom slab of the main steam header area can contribute to the steam vent and increase the depressurization capability in case of feedwater line break at the elevation 33'-0". The design modification in this area could make the mild environmental condition at most elevation 20'-0" area, such as the aux. feedwater pump rooms, the air compressor room, the battery & battery charger rooms, the RSP rooms and the EDG room. And, even in the harsh area at the elevation 33'-0", the peak pressure can be decreased lower than 3 psig and the maximum flood height less than 1.5 ft. Figure 1 shows the configuration of the proposed design modification.

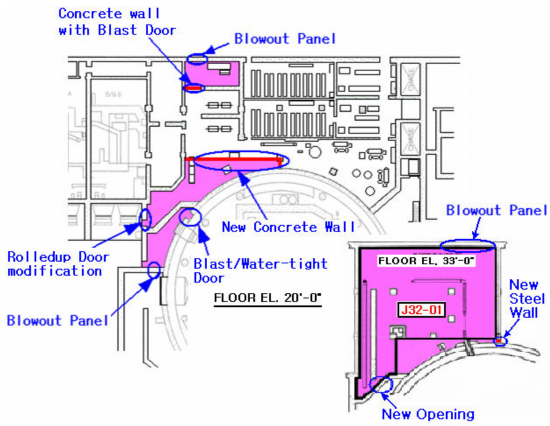

Figure 1. Design Modification in the Intermediate Building

2.3 Turbine Driven Aux. Feedwater Pump Room

The turbine-driven aux. feedater pump room is devided into an independent HELB area with the new wall and the new blast door to separate from the motor-driven aux. feedwater pump area. To relieve the steam in case of the main steam branch line break, an opening with blowout panel is installed toward the turbine building. The peak pressurization is limited less than 3 psig.

2.4 Auxiliary/CCW Heat Enchanger Building

The problems in the sub-basement of the auxiliary building and the CCW heat exchanger building stem from the internal flooding due to pipe cracks in moderate energy systems. Because the time to reach any significant flood level under this condition is sufficiently long, the active flood protection design by the operator actions is proposed beyond the MCR actions. Flood level switches are installed at the floor drain sump areas with the alarms and the indication signals in MCR. Following the recognition of flood accident in the MCR, it is required to dispatch operators to the site and to close the isolation valve on the cracked pipes within 1 hour. The doors of the CS pump and the RHR pump rooms are changed as water-tight doors, and emergency overflow lines are installed to quickly drain the flood into the sub-basement in case of pipe cracks in the SI pump rooms. Due to the active flood protection by operator action, the maximum flood heights at the sub-basement of the auxiliary building and the CCW heat exchanger building are 7 ft and 0.5 ft, respectively. The elevation 20'-0" are of the auxiliary building has CVCS letdown lines that are classified as a high energy lines. Temperature switches are installed near the CVCS letdown lines with the alarms and the indication signals in MCR. Following the recognition of CVCS letdown line break, it is required to isolate the CVCS system in the MCR within 30 minutes. These operator actions can help to minimize the harsh areas in case of the high energy line breaks.

2.5 Turbine Building

The turbine building has numerous piping system with potential of flooding accident that can challenge the safety-related components housed within the adjoining the auxiliary building and the intermediate building. The most significant source of flooding is the circulating water(CW) piping. It takes too long to ensure that flood protection could be implemented solely by operator action, compared to the speed that the flood level increases. Therefore, it is proposed to interlock the CW pumps with the flood detection. Flood level switches are installed to automatically shutoff the CW pumps on the CW system failures. In addition, passive flood protection is implemented through the installation of dikes around existing entrance doors to the auxiliary and the intermediate building and the design changes on the flood relief louver toward the outside building. By the combined design changes of the CW pump trip and the passive protection, the maximum flood height of the turbine building is lower than 1.5 ft.

3. Structural Integrity

The structural integrity analysis was required to ensure the stability of the structure as a result of the design modification. The SAP2000 computer program[2] was used to evaluate the structural integrity of the auxiliary building complex including the auxiliary building, intermediate building, the control building, the fuel handling building, CCW heat exchanger building and the EDG building. The pressure loads due to the high energy line breaks were inputted with the consideration of the new walls and the openings on shear walls. Figure 2 shows the SAP2000 modeling for the auxiliary building complex. The result of the analysis showed that the structure is still robust with the design modification.

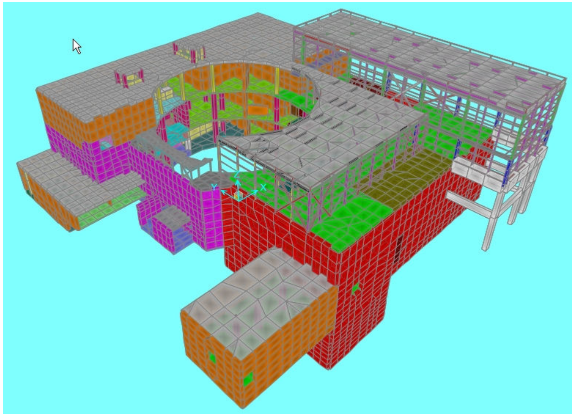

Figure 2. SAP2000 Modeling for the Aux. Building Complex

4. Conclusion

Several design changes are being implemented to make ease the equipment qualification of the safety-related components of Kori Unit 1. The environmental conditions such as pressure, temperature and flood level could be significantly mitigated through the design modification. The results of the structural integrity analysis confirmed that the design modification does not deteriorate the stability of the auxiliary building complex.

REFERENCES

[1] Accident Analysis and Determination of Environmental Condition for Equipment Qualification of Kori Unit 1
[2] SAP2000 User's Manual
[3] Kori Nuclear Unit 1, Final Safety Analysis Report, KHNP.