P/T Analysis for the Environmental Qualification of Ulchin 1,2

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1. Introduction

In 1983, NRC enacted 10 CFR 50.49 considered as the best of Environmental Qualification (EQ) to the current. These laws specified that all U.S operations for nuclear power and nuclear power under construction should complete EQ in accordance with RG 1.89, NUREG-0588 and IEEE 323 until May 1985. So the regulatory system of equipment EQ was established and EQ of nuclear power plants in operation should be fulfilled in accordance with consolidated requirement.

Since 2000, in Korea, KINS required the operating nuclear power plants to perform the periodic safety assessments in accordance with the recommendation of IAEA. Accordingly, EQ of Ulchin 1, 2 reflecting RSG and PU based on 10 CFR 50.49 was carried out recently.

Since pressure and temperature is EQ factor of 10 CFR 50.49, High Energy Line Areas were selected and pressure and temperature (P/T) were analyzed in EQ of Ulchin 1, 2.

In this paper, the double-ended break accident of high Energy Line, the Steam Line and Feedwater Line, was selected as one of the most serious accident. By analyzing double-ended break, the adequacy of current design and safety improvements were evaluated.

2. Analysis

2.1 High Energy Line Break Area

High Energy Lines of Ulchin 1, 2 are defined as a fluid system in whole or in part to meet maximum operation temperature above 100°C or maximum operation pressure above 20bar.

However, in the case that the period of operation of the plant with high energy condition is within 1% of normal operation life time or is within 2% of the required time to perform the inherent design features of fluid system, the fluid piping system, even if high energy line system operation condition is satisfied for a short period, are classified as medium energy piping system.

The selected high energy lines in Ulchin units are Main Steam System (VVP), Auxiliary feedwater system (ASG), Steam Generator Blowdown System (APG), Chemical and Volume Control System (RCV), Boron Recycle System (TEU), Hot Water System (SES), and Auxiliary Steam Distribution System (SVA). The double-ended break accidents of each steam line and feedwater line in Steam Bunkers (VVP) and Feedwater Bunkers (ARE) located between 11.5m and 15.5m elevation of connect building, selected as the most serious accident, were analyzed.

2.2 Nodalization and Analysis

The initial temperature used in pressure/temperature analysis of this study was 50℃ (122˚F), the maximum temperature among temperature values described in FSAR of Ulchin 1, 2. The humidity of 7% and the pressure of 1bar (14.6psia) were assumed.

Feedwater Bunkers(W530～W532) and Steam Bunkers (W630～W638, W730～W738) of Ulchin 1, 2 were located at EL. 11.5m, 15.5m, 19m of connect building.

According to the P/T analysis of Steam Bunkers and Feedwater Bunkers described in FSAR of Ulchin 1, 2, maximum differential pressure was 1.75bar (25.4psid) and maximum pressure was 160 ℃ (320 ˚F). Fig. 1 shows the schematic diagram and the nodalization for P/T analysis.

The node and flow path were set up with considering the geometric boundaries, the fracture part and each the pressure gradient in each node. In particular, because no wall exist between W630~W638 and W730~W738, the nodes were modeled as a single space along the vertical direction and were modeled separately depending on the room numbers in the horizontal direction.

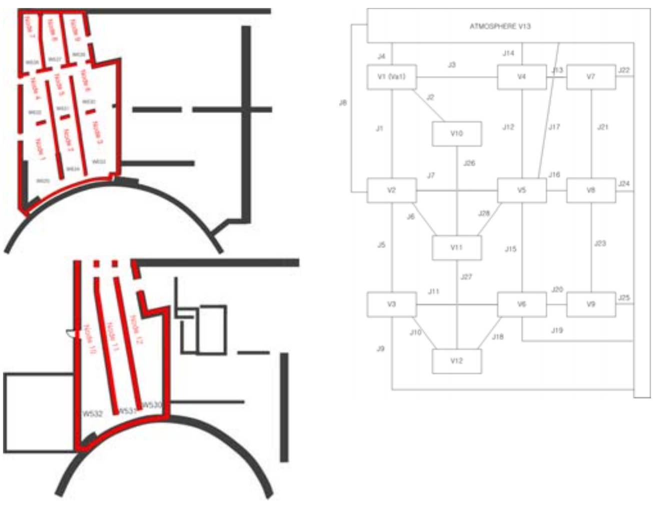

Fig. 1. Schematic diagram and nodalization for P/T analysis

P/T analysis was performed with COMPARE Mod-1A program. As shown Fig 1, the analysis model was composed of 28 flow paths and 13 nodes. Effective volumes of each node were calculated with reflecting the design drawing and walk-down. The 20% margin was given to the volume calculation for room facilities and other structure conservatively.

3. Results

Mass/energy discharge rate is the most important factor in P/T analysis. In this study, P/T analysis were performed by applying each the mass/energy discharge rate used in FSAR and newly calculated by Future and Challenge Co., Ltd (FNC). First, when the mass/energy discharge rate with same data presented in FSAR were used for COMPARE code input, the maximum temperature was 175.5℃ (347.7˚F) and maximum differential pressure was 1.67 bar (24.2 psid). The results of P/T analysis are shown in Fig. 2

Secondly, when the mass/energy discharge rate calculated by FNC was used for COMPARE code input, the maximum temperature was 209.05℃ (408.3˚F) at about 130 second. The maximum pressure was 0.74 bar (10.8 psid). The results of P/T analysis are shown in Fig. 3

As shown Fig. 3, after the temperature reached the maximum value of 209.05℃ (408.3˚F) at about 130 second, the temperature gradually declined, which was judged because the superheated mass/energy was discharged

Lastly, to compensate the effect of the superheated mass/energy, the mass/energy data of FNC were adjusted the release condition to be saturated after 130 seconds. The maximum temperature was 173.5 ℃ (344.3 ˚F) and the maximum differential pressure was 0.74 bar (10.8 psid). The adjustment of the release condition after 120 seconds did not affect the result of the maximum differential pressure, only affected the distribution of temperature. Fig. 4 shows the profile of temperature and pressure in case of saturated condition.

It is believed that the super heated mass/energy discharge rate caused the peak problem of temperature in the calculation of COMPARE code. Therefore, within the range that does not affect the results, it is desirable that the discharge rate of the saturation state is used. If the saturation condition is applied, the trends of temperature with modified FNC Mass/Energy data is expected to be similar with that of with M/E data of FSAR.

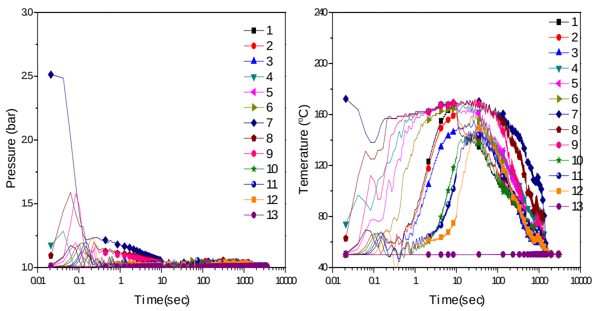

Fig. 2. Profile of temperature and pressure in steam bunkers due to the break of high energy line (FSAR M/E Data)

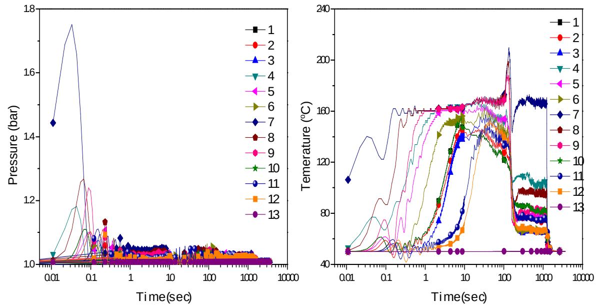

Fig. 3. Profile of temperature and pressure in steam bunkers due to the break of high energy line (FNC M/E Data)

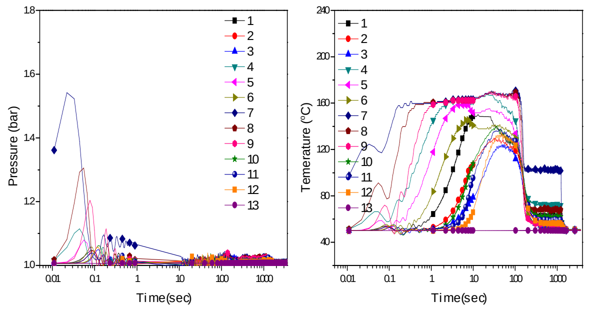

Fig. 4. Profile of temperature and pressure in steam bunkers due to the break of high energy line (Modified FNC M/E Data)

4. Conclusion

According to the criteria of selection of High Energy Ling described FSAR 3.6.1, HELB areas from each building areas were selected and the pressure and temperature in Feedwater Bunkers and Steam Bunkers were analyzed.

The maximum pressure difference was 1.51bar and the maximum temperature was 209.05℃. The maximum differential pressure was less than the criteria of FSAR (1.52bar), but the maximum temperature exceeds 160 ℃. However, because the times for more than 160℃ is relatively short, about 40 seconds, it is necessary to analysis with other methods such as thermal lag analysis. In a addition, mass/energy discharge rate appeared to be a big change, a further review about the mass/energy discharge rate is needed.

REFERENCES

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