# An Estimation of a Risk by an Anticipated Transient Without Scram in terms of a Level 1 PSA for KORI 3&4 unit

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## 1. Introduction

As a part of risk informed regulation (RIR) framework, KAERI are developing a PSA models for the NPPs (nuclear power plant Using the existing model [1]developed by the utilities, the PSA model under development uses the criteria described in the ASME PSA standard [2], which means that the excessive conservatism or optimism in the existing model would be eliminated. This paper describes the risk evaluation of ATWS (anticipated transient without scram). The risk by an ATWS is assumed to occur by over pressure of the RCS while most of event scenario in a PSA model invoke RCS core melting event according to the over temperature. ASME code for pressure vessel was used to decide whether the core will be damaged. The criteria of ASME code is 22 Mpa(3200 psi) for the reactor pressure vessel.

## 2. Calculation procedures and Results

In this section a procedure and result for an ATWS risk calculation are described. The procedure includes component/system information for the T/H calculations and the event scenario in the PSA model.

### *2.1 Event Tree Modification*

To best estimate the risk by an ATWS event, the state of RCS or components that may change the accident scenario should be fully included in the event tree. Figure 1 shows the event tree of ATWS used in the PSA model developed by utility. As shown in the figure, the event tree does not include any event tree heading and assumed core damage if the AMSAC which is the redundant trip system independent of normal trip system is failed. Here, the failure of AMSAC means that the turbine was not tripped. However, although the AMSAC is failed, the reactor may not failed depending on the reactivity feedback which is normally negative if the RCS is heated and pressurized. The reactivity feedback is usually called as moderator temperature coefficient (MTC). The MTC is a function of burn-up of the reactor. To reflect the effect of the reactivity feedback the new heading named as UET was included in the new model. By including the new heading, the accident scenario by the failure of AMSAC is divided into two scenario, one for no core damage by sufficient reactivity feedback and the other for core damage by insufficient reactivity feedback. The heading of UET may apply to the scenario of a success of AMSAC. However, when AMSAC succeed its function, there is no core damage because the reactivity feedback is sufficient to mitigate the over pressure of the RCS. The analysis result is given in Section 2.

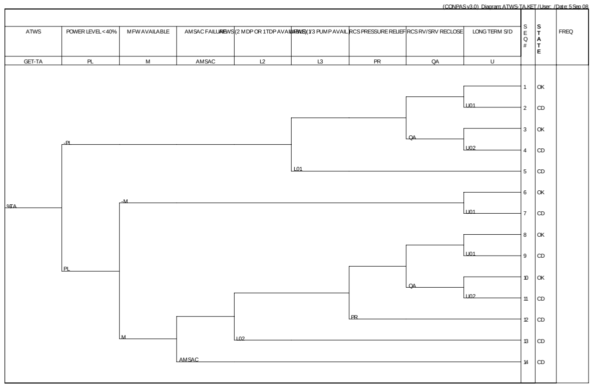

Fig. 1. ATWS event tree developed by utilities

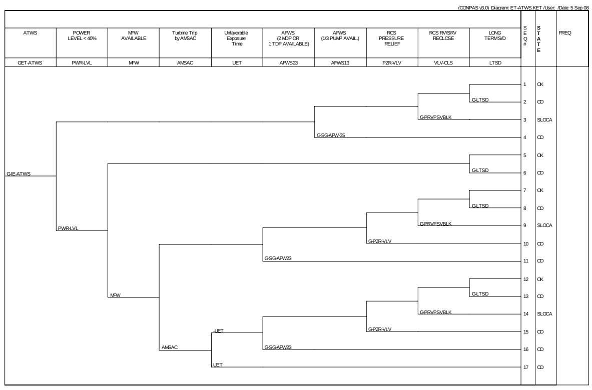

Fig. 2. new event tree for ATWS

### *2.2 UET evaluation*

To calculate the failure probability of the heading named as UET in the figure 2, information for the Doppler effects and the MTC should be given for the reactor core. The present study used the nuclear design report for the KORI 34 cycle 18 [3]. Figure 3 and 4 shows the MTC and Doppler defect for the KORI 34 cycle 18 respectively.

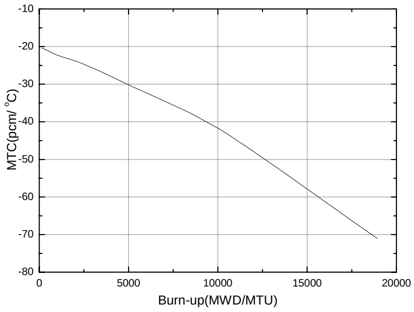


Fig. 3. Moderator temperature coefficient as a function of reactor core bunu-up.

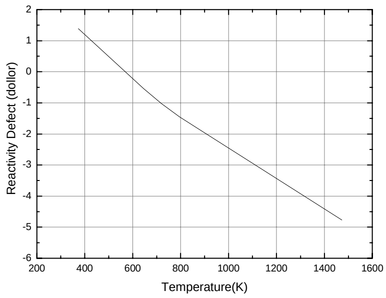


Fig. 4. Doppler reactivity defect of kori unit 4 cycle 18.

Since the MTC is dependent on the boron concentration in the reactor core, the value is described as a function of burn-up. The failure probability of the UET is defined as the faction of unfavorable period in the whole cycle as follows

$$UET = T_u / T_t$$

where $T_u$ = unfavorable period of reactivity feedback
$T_t$ = total burn-up cycle

The MARS code was used to calculate the RCS pressure behaviors. The MARS code simulates the reactor core using point kinetics model which can simulate reactivity feedback. Figure 5 and 6 shows the RCS pressure for the success of AMSAC and the failure of AMSAC respectively. .

As shown in Figure 5, if the turbine is tripped, the pressure of the RCS does not reach the criteria defined in the ASME code for pressure vessel. On the contrary, as shown in Figure 6, the RCS pressure exceeds the criteria depending on the burn-up of the reactor core under the condition of turbine non trip. This is due to the fact that the reactivity feedback is not sufficient if the RCS is pressurized and heated in the early phase of the accident. The UET record 0.1797 at the non trip of turbine

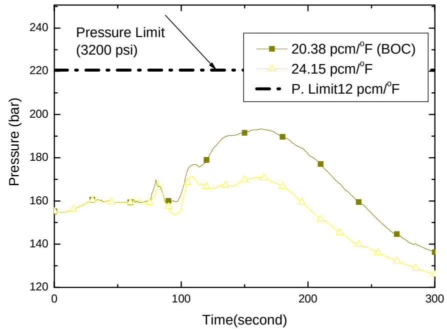


Fig. 5. RCS pressure depending on the MTC when the turbine is tripped.

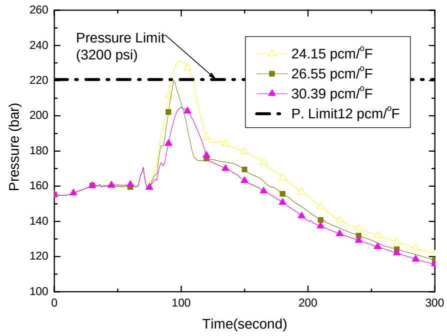


Fig. 6. RCS pressure depending on the MTC when the turbine is not tripped.

### *2.3 Comparison of the risks*

The KORI3&4 PSA model developed by KAEIR and that by utility use same initiating event frequency for ATWS. The core damage frequency of the ATWS event was estimated as 1.626e-8 compared to 6.328e-8 of the PSA model of utility. This is due to the fact that the PSA model by utility ignored the UET for the case of AMSAC failure.

## 3. Conclusions

The present study re-estimated the risk by ATWS using best-estimation of the UET. The result showed that the risk by ATWS in the KORI3&4 PSA model developed by KAERI was lower than that using the PSA model developed by utility.

## REFERENCES

[1] KSNP, final report of probabilistic safety assessment for KORI 3&4 unit, 2003
[2] ASME, Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications, ASME RA-Sb-2005
[3] KSNP, the nuclear design and core physics characteristics of the KORI nuclear power plant unit 4 cycle 18, 2007