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Validation of the Severe Accident Management Guidance for Wolsong Plants

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1. Introduction

The severe accident management guidance (SAMG) for the Wolsong plants, which is a CANDU 6 type heavy water reactor, has six accident mitigation guidelines(AMGs)[1]. These are : (1)AMG-1; Injection into the primary heat transport system (PHTS) (2) AMG-2; Injection into the calandria vessel (3) AMG-3 ; Injection into the calandria vault (4) AMG-4; Reduction of fission product release (5) AMG-5; Control of the reactor building condition (6) AMG-6; Reduction of the reactor building hydrogen. AMG does not separate guidelines corresponding to plant status like Westinghouse Owners Group(WOG) SAMG which has severe accident guideline (SAG) and severe challenge guideline (SCG) [2].

Previous paper showed that the proper use of AMG-1 and AMG-3 can terminate the severe accident progression initiated by steam generator tube rupture as the validation of SAMG[3]. This paper is the continuation of validation process and describes the result of other combination of mitigation guidances to mitigate and to terminate the severe accident progression. ISAAC (Integrated Severe Accident Analysis Code for CANDU Plant) computer program [4] is used to simulate the severe accident progression.

2. Accident Simulation and Results

2.1 Accident Progression without Mitigation Actions

A base case scenario is a SGTR accident with the failure of major safety systems. 10 tubes are assumed to experience the double-ended-break. The equivalent break area is 2.9×10^{-3} m^3. The emergency core cooling pumps, the moderator cooling pumps, the end-shield cooling pumps, and the local air coolers are assumed to be out of order to simulate the severe core damage scenario. Also all the feeder water to the steam generators is assumed to have failed. The high pressure emergency core cooling and the dousing spray systems are assumed to be available, which are passive. The major events which occurred are summarized in Table 1.

Table 1. The time of the major events occurred with/without severe accident management actions.

	Base Case (sec)	With Recovery (sec)
Reactor scram	58	58
HPI on	203	203
SG dry (loop 2)	2,777	2,777
Dousing spray on	7,285	7,285
HPI tank depleted	7,892	7,892
Core uncover (loop 2)	9,058	9,058
Dousing tank deleted for spray	9,963	9,963
Core uncover (loop 1)	13,104	13,104
SAMG entry condition	**17,623**	**17,623**
Pressure tube rupture (loop 2)	18,050	18,050
MPI on	-	**19,528**
Pressure tube rupture (loop 1)	19,705	19,531
Corium relocation start (loop 1)	19,762	-
Corium relocation start (loop 2)	20,552	-
LPI on	-	**20,219**
LPI off	-	**27,419**
D_2O Supply Pump on		**34,194**
Core collapse (loop 1)	34,212	-
SG dry (loop 1)	34,732	-
Core collapse (loop 2)	35,361	-
LPI on		**49,019**
LAC on		**53,623**
Calandria vessel failure	153,020	-
R/B failure	153,445	-
End of calculation	259,200	259,200

2.2 Accident Progression with Mitigation Actions

Following assumptions are used to simulate various operator actions, such as AMG-1, 2, 4 and 5 of SAMG;

- ECC pump A is recovered 0.5 hour after SAMG entry and operator turned it on at 19,528 seconds
- Fission products start to release to the auxiliary building through leak in the ECC pump A 1 hour after its operation
- Stop ECC pump A and isolate it at 27,419 seconds (2 hour after LPI operation)
- D_2O supply pump is recovered and operator turns it on when moderator level becomes less than 6.732 m (34,194 seconds)
- ECC pump B is recovered at 36,419 seconds (2.5 hour after ECC pump A stop)

- LACs in fuel machining room are recovered at 10 hours after SAMG entry (53,623 seconds)

The major events are also summarized in Table 1. Assumptions and operator actions are written in bold characters.

Figure 1~ 3 shows the response of various parameters in plants following assumptions and operator actions. The moderator level recovered when ECC pump or D_2O supply pump turns on. The water level does not decrease in the calandria vault and the calandria is covered with water during whole period of accident progression. The pressure in the reactor building decreases after ECC operation and keep it below 100 kPa after LACs are recovered.

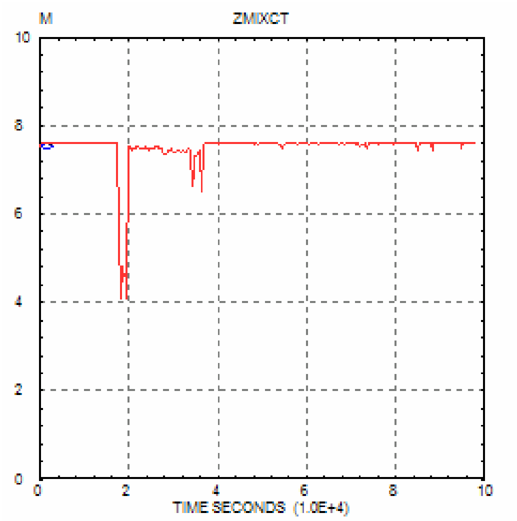

Figure 1. The mixture level of moderator in calandria

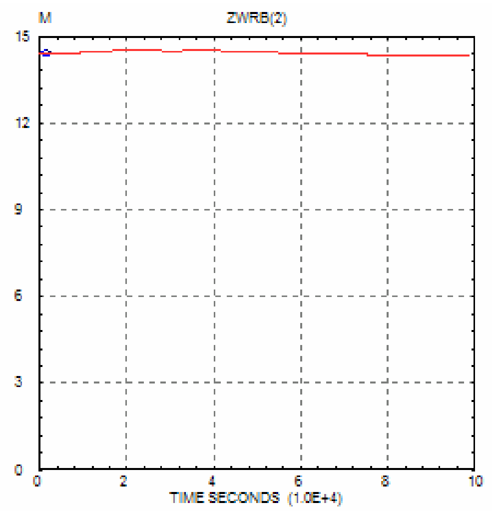

Figure 2. The water level in calandria vault

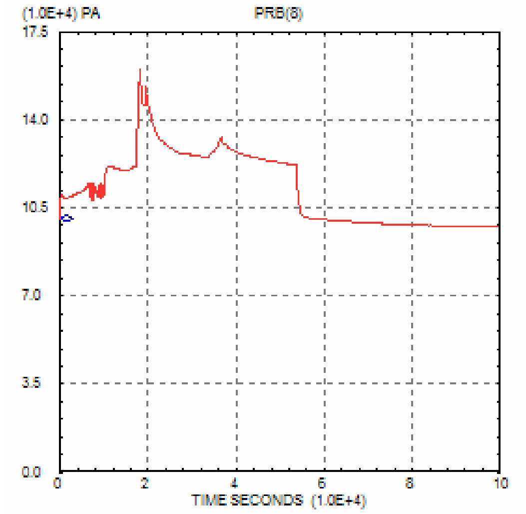

Figure 3. The pressure in the reactor building dome

3. Conclusions

Four of six AMGs in SAMG were applied to manage the severe accident progression induced by a SGTR in Wolsong plants. The result of ISAAC code calculation showed that the proper use of AMGs terminates the severe accident progression and keeps the reactor building intact during severe accident. This concludes that the SAMG is an effective means to manage the severe accident progression initiated by a SGTR in Wolsong plants.

ACKNOWLEDGEMENTS

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