Application of the Severe Accident Management Guidance to manage the SGTR Accident in Wolsong plants

Youngho JIN, Soo Yong PARK
Korea Atomic Energy Research Institute
P.O. Box 105 Yusong, Daejeon KOREA
yhjin@kaeri.re.kr

1. Introduction

The severe accident management guidance (SAMG) for the Wolsong plants[1], which is CANDU 6 type heavy water reactor, has been developed by KAERI. This guidance consists of a Diagnostic Flow Chart (DFC) which helps to select an appropriate guidance, and six severe accident guidances (SAGs). These guidances are : (1) Injection into the primary heat transport system (PHTS) (2) Injection into the calandria vessel (3) Injection into the calandria vault (4) Reduction of fission product release (5) Control of the reactor building condition (6) Reduction of the reactor building hydrogen. Figure 1 shows the Diagnostic Flow Chart (DFC) of generic SAMG for Wolsong plants.

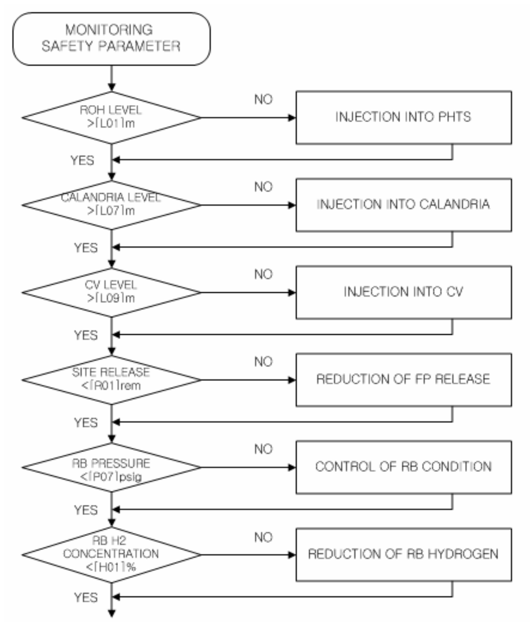

Figure 1 Diagnostic Flow Chart of generic SAMG for Wolsong plants (Part of DFC)

This paper presents the effectiveness of the SAMG for the steam generator tube rupture (SGTR) accident in Wolsong plant. The accident progression including severe accident phenomena was evaluated by ISAAC 3.0 (Integrated Severe Accident Analysis Code for CANDU Plant) computer program[2].

2. Accident Simulation and Results

2.1 Accident Progression without Mitigation Actions

A base case scenario is SGTR accident with the failure of major safety systems. The 10 tubes are assumed to be experienced the double-ended-break. The equivalent break area is 2.9×10^{-3} m^3. The emergency core cooling (ECC) systems except high pressure injection, the moderator cooling system, the end-shield cooling system, and the local air coolers are assumed to be inoperable to simulate the severe core damage cases. Also all feeder water to the steam generators are assumed failed. The high pressure emergency core cooling and the dousing spray are assumed available, which are passive.

The major events occurred are summarized in Table 1.

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

	Base Case (sec)	ECC+LAC (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
Pressure tube rupture (loop 2)	10,116	10,116
Core uncover (loop 1)	13,109	13,109
Corium relocation start (loop 2)	17,187	17,187
Pressure tube rupture (loop 1)	17,908	17,908
Corium relocation start (loop 1)	17,967	17,967
Core collapsed (loop 1)	31,970	31,970
Core collapsed (loop 2)	32,149	32,149
SG dry (loop 1)	36,009	36,009
SAMG entry condition	54,476	54,476
MPI turn on	-	58,076
MPI terminated, LPI turned on	-	59,889
LAC turn on	-	61,676
Calandria vessel failed	149,929	-
R/B failure	150,350	-
End of calculation	259,200	259,200

The collapsed water level of caladria vessel is shown in Figure 2. Figure 3 shows the amount of fission product (CsI) released to the atmosphere.

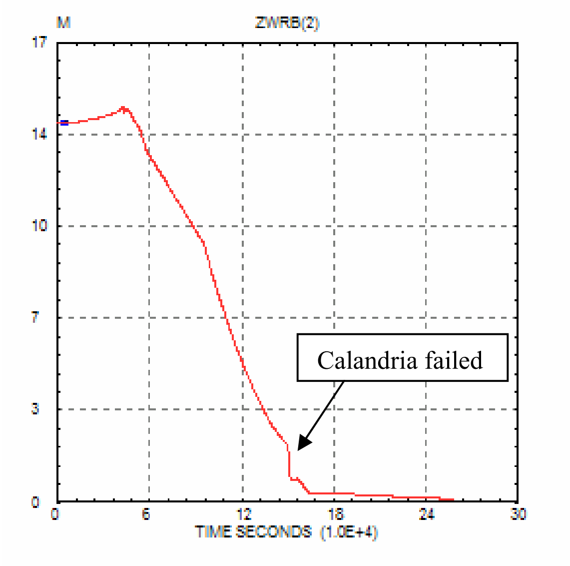

Figure 2 The collapsed water level in the calandria.

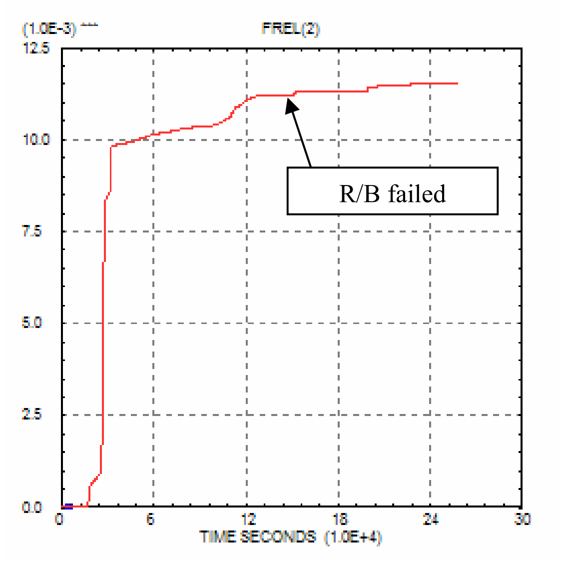

Figure3 The amount of CsI released to the atmosphere

2.2 Accident Progression with Mitigation Actions

Two mitigative actions are assumed: (1)recovery of ECC pump at 58,076 seconds (1 hour after the entry of SAMG), (2) recovery of local air coolers at 61,676 seconds (2 hour after the entry of SAMG). The major events occurred are summarized in Table 1. The water injected into the PHTS by the operation of the medium pressure ECCS and the low pressure ECCS flows to the calandria through the ruptured pressure tubes and filled the calandria with water. This prevented the failure of the calandria vessel. The operation of local air coolers reduced the reactor building pressure and prevented the failure of the reactor building due to the overpressurizaton.

3. Conclusions

The SAMG was applied to manage the severe accident progression induced by SGTR in Wolsong plants. ISAAC calculation showed that the recovery of the ECCS and LACs after the core collapse prevented the failure of the calandria and the reactor building. This concludes that the SAMG is an effective means to manage the severe accident progression initiated by SGTR in Wolsong plants.

ACKNOWLEDGEMENTS

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REFERENCES

[1] "Severe Acicdent Management Guidance for Pressurized Heavy Water Reactors," KAERI/TR-xxxx, To be published in 2006

[2] "User Manual of ISAAC Code," KAERI/TR-xxxx, To be published in 2006