Offsite Consequence Analysis of the Hypothetical Severe Accident of Ulchin unit 3, 4

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1. Introduction

The previous offsite consequence analysis of the hypothetical severe accident of nuclear power plants has considered the accident occurrence probability only. But it is necessary to compute offsite consequence in the case that the specific accident occurs with the probability of 1. In this study, the offsite consequence analysis was performed when large break loss of coolant accident(LBLOCA), small break loss of coolant accident(SBLOCA), and station black out(SBO) would occur in Ulchin unit 3, 4, Korea standard nuclear plant(KSNP).

2. Methods and Results

2.1 ORIGEN-S

The basic data of the source term for the offsite consequence analysis are the core inventory of in-core fission products and its release fraction according the accident. First, ORIGEN-S was used for the core inventory calculation. For the conservative approach, it was assumed that one year is 1 cycle and the fuel burn up continuously during 1095 days, 3 cycles without the cooling term. Also it was assumed that the core thermal power is 37.5 MWth per UO_2-ton, the total amount of UO_2 is 78 ton, and the uranium enrichment is 3.5w/o U-235. Table I shows the accident core inventory of Ulchin unit 3, 4 nuclear power plants as the ORIGEN-S result.

Table I: Accident core inventory of Ulchin 3, 4 nuclear power plants.

Radionuclides	Radioactivity(Bq)	Radionuclides	Radioactivity(Bq)	Radionuclides	Radioactivity(Bq)
Kr-85	2.98977E+16	Te-129m	1.43E+17	La-142	3.91E+18
Kr-85m	5.63937E+17	Te-131m	5.33E+17	Nb-95	4.1E+18
Kr-87	1.09641E+18	Te-132	3.71E+18	Nd-147	1.67E+18
Kr-88	1.45107E+18	Sr-89	2.04E+18	Pr-143	3.65E+18
Xe-133	5.24883E+18	Sr-90	2.31E+17	Y-90	2.42E+17
Xe-135	1.23993E+18	Sr-91	2.63E+18	Y-91	2.75E+18
I-131	2.62269E+18	Sr-92	2.9E+18	Y-92	2.93E+18
I-132	3.81363E+18	Co-58	4.2E+13	Y-93	3.41E+18
I-133	5.23848E+18	Co-60	3.82E+14	Zr-95	4.06E+18
I-134	5.82636E+18	Mo-99	4.75E+18	Zr-97	4.24E+18
I-135	5.02458E+18	Rh-105	3.05E+18	Ce-141	4.14E+18
Cs-134	5.29092E+17	Ru-103	4.47E+18	Ce-143	3.74E+18
Cs-136	1.62219E+17	Ru-105	3.34E+18	Ce-144	3.34E+18
Cs-137	3.36651E+17	Ru-106	1.79E+18	Np-239	5.89E+19
Rb-86	5.79186E+15	Tc-99m	4.21E+18	Pu-238	9.76E+15
Sb-127	2.58888E+17	Am-241	4.07E+14	Pu-239	8.99E+14
Sb-129	7.9281E+17	Cm-242	1.47E+17	Pu-240	1.51E+15
Te-127	2.54955E+17	Cm-244	1.38E+16	Pu-241	4.26E+17
Te-127m	4.34493E+16	La-140	4.59E+18	Ba-139	4.55E+18
Te-129	7.4313E+17	La-141	4.1E+18	Ba-140	4.39E+18

2.2 MELCOR

LBLOCA, SBLOCA, and SBO were selected as the representative hypothetical severe accident event referring to the probabilistic safety assessment report for the Ulchin units 3, 4 nuclear power plants. The accident sequence was computed using MELCOR code for the selected representative event and the activity release amount and energy of radioactive nuclide were calculated. Table II shows the Release fraction of radioactive nuclide as the MELCOR result.

Table II: Release fraction of radioactive nuclide.

Group	Major Element	LLOCA	SLOCA	SBO
1	Noble Gases (Xe/Kr)	5.60E-01	5.540E-01	5.52E-01
2	Iodine (I)	9.827E-05	2.575E-04	1.230E-02
3	Cesium (Cs)	3.350E-02	8.365E-04	2.617E-04
4	Tellurium (Te)	3.512E-04	1.928E-05	2.886E-05
5	Strontium (Sr)	3.886E-02	3.152E-04	4.931E-04
6	Ruthenium (Ru)	7.652E-03	4.950E-03	5.054E-03
7	Lanthanium (La)	1.836E-06	1.166E-06	2.238E-06
8	Cerium (Ce)	3.167E-06	6.261E-07	7.28E-07
9	Barium (Ba)	3.886E-02	3.152E-04	4.931E-04

2.3 MACCS2

The offsite consequence analysis was performed using MACCS2 when the hypothetical severe accident of Ulchin unit 3, 4 nuclear power plants occurs. The core inventory and release fraction that were calculated previously was used as the source term, and in other input parameters case, site specific data were used referring to the final safety analysis report of the Ulchin units 3, 4 nuclear power plants.

The models in MACCS2 are implemented in three modules: ATMOS, EARLY, and CHRONC. Figure 1 depicts the progression of a MACCS2 consequence calculation.

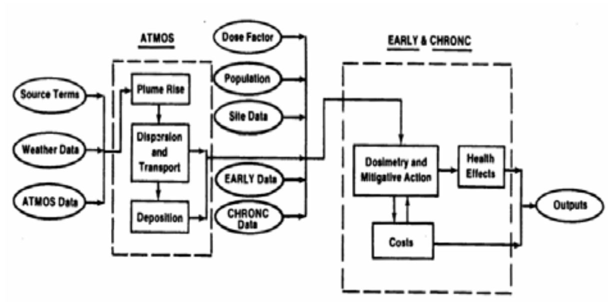

Fig. 1. The progression of a MACCS2 consequence calculation.

2.4 Results

Figure 2 and figure 3 show the MACCS2 calculation results. Because none value is exceeding the threshold dose of the red marrow, lungs, and lower liver that effect early fatality, early fatalities of SBLOCA and SBO are zero. Early and cancer population weighted risk range are 0 ~ 2.0 x 10^{-3}.

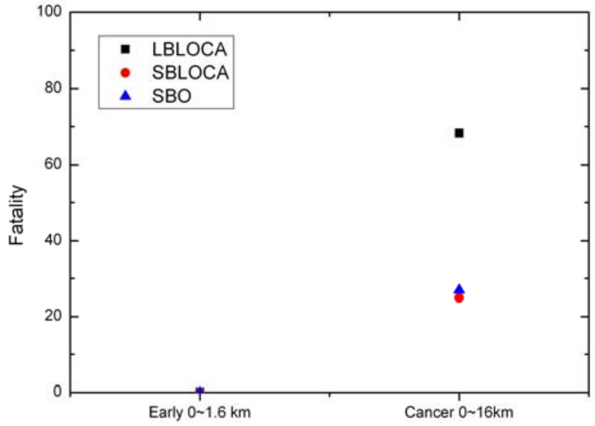

Fig. 2. Fatality of severe accidents (MACCS2 code result)

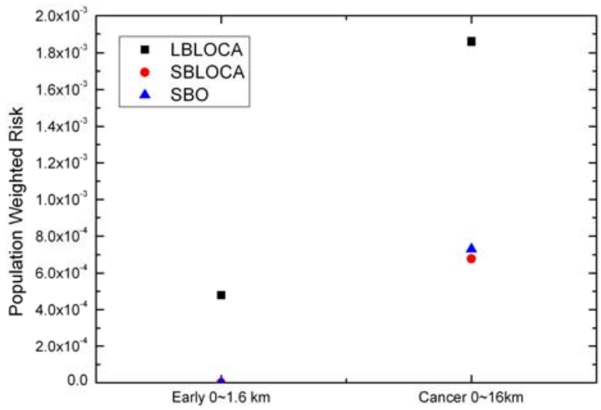

Fig. 3. Population weighted risk of severe accidents (MACCS2 code result)

3. Conclusions

The offsite consequence analysis was performed using ORIGEN-S, MECOLR, and MACCS2 simultaneously. In contrast with the general consequence analysis, results of early fatality and cancer fatality are relatively high because the severe accident occurrence probability is assumed as 1. This study is meaningful when estimating health effects after severe accident.

REFERENCES

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