Radiological Consequence Analysis of LOCA for Kori Unit 2 Applying RG 1.183

S.J.Yoon*, C.S.Jang, K.M.Yoon, J.D.Choi, G.S.Lee
KEPCO NF., #242 Daedeok-daero 989beon-gil, Yuseong-gu, Daejon, 305-353, Korea
**Corresponding author: sjyoon@knfc.co.kr*

1. Introduction

Kori Unit 2 Loss of Coolant Accident (LOCA) dose has been determined for individuals at offsite and operators in the control room using the guidance of Regulatory Guide (RG) 1.195[1]. To compare the radiological consequences of RG 1.195 with RG 1.183[2], this paper calculates total effective does equivalent (TEDE) for the Kori Unit 2 LOCA with the methodology of RG 1.183. This analysis calculates the Large-Break LOCA doses from the containment leakage, the engineered safety features (ESFs) recirculation leakage outside containment using the RADTRAD code. These offsite doses are determined for individuals at the Exclusion Area Boundary (EAB) and the Low Population Zone (LPZ) and for operators in the Control Room (CR) using RG 1.183.

2. Methods and Results

2.1 Methods

A LOCA is assumed to result in the presumed major fuel melting of the core. Activity from the damaged core is released to the containment and immediately begins leaking out to the environment. Additionally, there is a release path due to the postulated leakage of sump solution as the solution is recirculated by the ESFs. The offsite and control room doses are calculated for all release paths. The control room TEDE dose includes the contribution from the activity cloud outside of the control room with credit for shielding by the control room walls. All inputs were taken from Kori Unit 2 Final Safety Analysis Report (FSAR) [3]. Major differences between RG 1.195 and RG 1.183 for Kori Unit 2 LOCA dose analysis are shown in Table 1.

Table 1. RG 1.195 and RG 1.183 assumptions for LOCA

Parameter	RG 1.195	RG 1.183
Radionuclide Composition	Noble Gases Iodines	Noble Gases Halogens Alkali Metals Tellurium Group Noble Metals Lanthanides Cerium
Release Phase	Immediately	Gap Release Early In-Vessel
Iodine Chemical Fraction	Aerosol:5% Elemental:91% Organic:4%	Aerosol:95% Elemental:4.85% Organic:0.15%
Criteria	Thyroid Whole-Body	TEDE

Code run is required to calculate the offsite and control room TEDE doses for the both cases described below:

- Containment leakage of activity released to the sprayed and unsprayed regions in containment
- ESF leakage

Note that the containment leakage case is composed of separate 2 runs, one modeling activity released to the sprayed containment and the other modeling release to the unsprayed containment.

The dose to control room operators from the cloud of activity outside of the control room is calculated in each of these code runs by specifying a dose location with χ/Q values that correspond to the control room and multiplying a conservative attenuation factor. The total dose for each location is the sum of the doses from the containment leakage and the ESF leakage.

The code runs are defined by plant scenario files (.psf). The following three input files are additionally required in each of the code runs:

- The nuclear information file (.nif) which contains the nuclide activities and half-lives (2 files are used, one for core inventory and the other for RCS activity).
- The DCF (Dose Conversion Factor) file (.inp) which contains the nuclide dose conversion factors (1 file is used for TEDE dose).
- The release fraction timing file (.rft) which defines the release rates and fractions (2 files are used: one for the activity released to the containment atmosphere, the other for the activity released to the sump).

2.2 Results

The EAB, LPZ and CR TEDE doses are tabulated in Tables 2 to 4. The limiting 2-hour interval for the containment leakage case is not identical to the limiting 2-hour interval for the ESF leakage in EAB dose. It is conservative to combine the limiting doses from the different intervals and to report it as the total limiting 2-hour dose. Since the containment leakage provides most

of the dose, the limiting interval for the containment leakage case is reported as the limiting 2-hour interval. RG 1.183 specifies limits for the TEDE dose at the EAB for the limiting 2-hour interval, at the LPZ outer boundary for the duration of release (defined as 30 days) and to operators in the CR for 30 days following the start of release. In according to Tables 2 through 4, all doses are well below the limits specified by RG 1.183. The results of Kori Unit 2 LOCA doses using RG 1.195 are presented in Table 5. As can be seen in Table 5, CR thyroid dose is almost close to the limit. There are more margins in CR dose results when RG 1.183 is applied instead of RG 1.195.

Table 2. EAB Doses

Cases	TEDE Dose (rem)
Sprayed Containment Leakage (0.5 to 2.5 hours)	4.5905E+0
Unsprayed Containment Leakage (0.5 to 2.5 hours)	2.4404E+0
ESF Leakage (1.8 to 3.8 hours)	2.6958E-1
Total	7.3005E+0
Criteria	25

Table 3. LPZ Doses

Cases	TEDE Dose (rem)
Sprayed Containment Leakage	5.1951E-1
Unsprayed Containment Leakage	2.6806E-1
ESF Leakage	1.0169E-1
Total	8.8926E-1
Criteria	25

Table 4. CR Doses

Cases	TEDE Dose (rem)
Sprayed Containment Leakage - Internal Activity	4.8090E-1
Sprayed Containment Leakage - External Activity	3.9200E-1
Unsprayed Containment Leakage - Internal Activity	2.3156E-1
Unsprayed Containment Leakage - External Activity	1.6028E-1
ESF Leakage - Internal Activity	2.4038E-1
ESF Leakage - External Activity	2.2775E-2
Total	1.5279E+0
Criteria	5

Table 5. LOCA Doses with RG 1.195

Location		Dose (rem)	Criteria (rem)
EAB	Thyroid	85	300
	Whole Body	1.6	25
LPZ	Thyroid	17	300
	Whole Body	0.25	25
CR	Thyroid	49	50
	Whole Body	1.4	5
	Beta-Skin	11	50

3. Conclusions

To identify the effect of RG 1.183 method on dose results, LOCA dose calculation for Kori Unit 2 is performed using RG 1.183 method. According to dose calculation results, all doses are well below the limits in RG 1.183. Comparing with dose results using RG 1.195, the CR dose results of RG 1.183 have more margins to the limits. Therefore, RG 1.183 method can be applied to dose calculation for LOCA and possible to mitigate the dose calculation results.

REFERENCES

[1] Regulatory Guide 1.195, Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light-Water Nuclear Power Reactors, 2003.
[2] Regulatory Guide 1.183, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors, 2000.
[3] Kori Unit 2 Final Safety Analysis Report.