Sensitivity Analysis of Input Parameters for the Dose Assessment from Gaseous Effluents due to the Normal Operation of Jordan Research and Training Reactor

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1. Introduction

On August 2013, the construction permit for the Jordan Research and Training Reactor (hereinafter referred to as JRTR) was issued from the Jordan Nuclear Regulatory Commission (i.e. JNRC) on the condition of implementing the additional requirements.

As part of the follow-up actions for the permit, JNRC required the applicant to reflect the site-specific data as many as possible in the dose assessment of the public due to the normal operation of JRTR.

Even though input variables used in the assessment on the exposure dose are significantly based on the available references to the environmental characteristics related to the site and surrounding areas, a certain parameter could be changed with time and period, and in many cases, it is difficult to apply the accurate value with the property of variables.

In this study, therefore, the sensitivity analysis of input variables for the dose assessment was performed for reviewing the effect of each parameter on the result after determining the type and range of parameters that could affect the exposure dose of the public. (Since JRTR will be operated by the concept of 'no liquid discharge,' the input parameters used for calculation of dose due to liquid effluents are not considered in the sensitivity analysis.)

2. Methods and Results

2.1 Computer Code System

For benchmarking for the assessment results shown in the Radiological Environmental Report (i.e. R-ER) [1] of JRTR and performing the sensitivity analysis, a code package of GASPAR-II [2] was used.

For emissions of the noble gases, radioiodine and particulate, the air release dose models of the NRC Regulatory Guide 1.109 [3] is implemented in GASPAR code.

For the individual dose calculations, human beings is subdivided into the four (4) age groups of infant, child, teenager, and adult. Eight (8) body organs (i.e. total, gastrointestinal (GI) track, bone, liver, kidney, thyroid, lung, and skin) are taken into account in each of these calculations.

Parameters inputted into the code include data on the site (e.g. population and production), general and local meteorology (e.g. dispersion and deposition factors), and radionuclide release source terms.

2.2 Establishment of the Base Case

The base case is the individual exposure dose due to gaseous effluents in the vicinity of the site boundary. The input parameters for this case were established on the basis of values presented in Tables 5.2-1 through 5.2-3 of the R-ER [1]. Since the corresponding variables are prepared for a computer program of ENDOS, however, some parameters as below were adjusted to GASPAR-II.

- Growth period of farm products
- Feed ingestion by livestock
- Farm product throughput
- Period from harvest to consumption of farm product
- Annual consumption rate of meat and crops

The atmospheric dispersion and deposition factors were calculated from the measurement data in the on-site meteorological tower in 2013, and those for the direction representing the maximum value were applied to the analysis for the base and subject cases.

2.3 Subject Case of the Sensitivity Analysis

For the sensitivity analysis, the subject cases were classified into four (4) categories as below.

- Farm products
  - Growth period of farm products
  - Farm product throughput
  - Period from harvest to consumption
- Livestock
  - Feed ingestion by livestock
  - Storage period of livestock feed
- Environment
  - Effective surface density of soil
  - Average absolute humidity during growth period
  - Period of deposit of nuclide in soil
- Age groups
  - Annual respiration volume
  - Annual consumption rate of meat and crops

Variation trend of the individual effective dose from gaseous effluents was analyzed with the increase and decrease scenarios on the basis of applied values for the base case. For each subcategory, range of input parameters were determined considering the survey results for the site-specific data and a reasonable level of margin.

2.4 Results and Discussion

The sensitivity analysis was performed for a total of thirty-five (35) cases classified into four (4) categories and ten (10) subcategories. Table I summarizes the type of input parameters applied to the analysis and the variation trend with the increase of the corresponding variable.

In addition, for the input variables that have an significant effect on the individual effective dose, detailed results of the sensitivity analysis are shown in Figures 1 through 7, respectively.

Table I: Summary of variation trend in the individual effective dose with increasing each type of input parameter

Type of Input Parameter			Trend*
Category	Subcategory		
Farm products	Growth period		-
	Throughput	Grass	Decrease
		Others	-
	Period from harvest to consumption	Meat	-
		Milk	-
		Crops	Decrease
Livestock	Feed ingestion by livestock		Increase
	Storage period of livestock feed		-
Environment	Effective surface density of soil		-
	Average absolute humidity		Decrease
	Deposit Period of nuclide in soil		-
Age groups	Annual respiration volume		Increase
	Annual consumption rate	Meat	-
		Milk	Increase
		Crops	Increase

* Variation with the increase of the corresponding variable

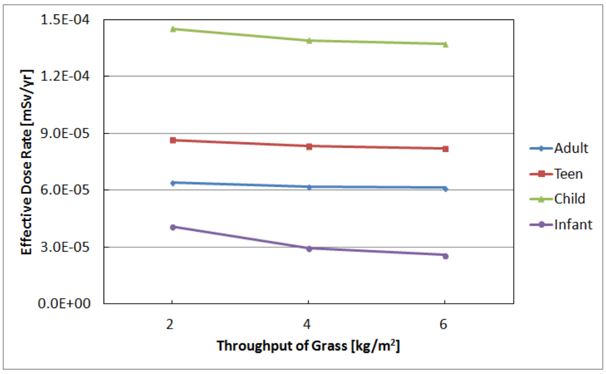

Fig. 1. Detailed results of the sensitivity analysis with varying the throughput of grass

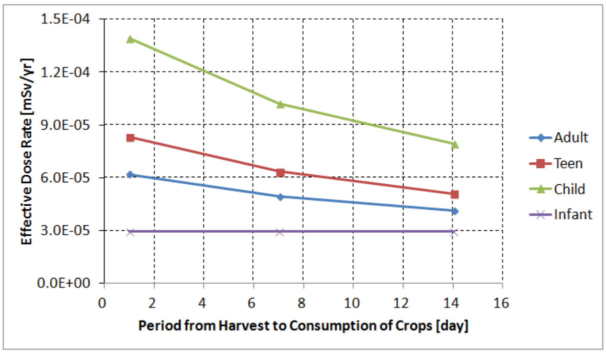

Fig. 2. Detailed results of the sensitivity analysis with varying the period from harvest to consumption of crops

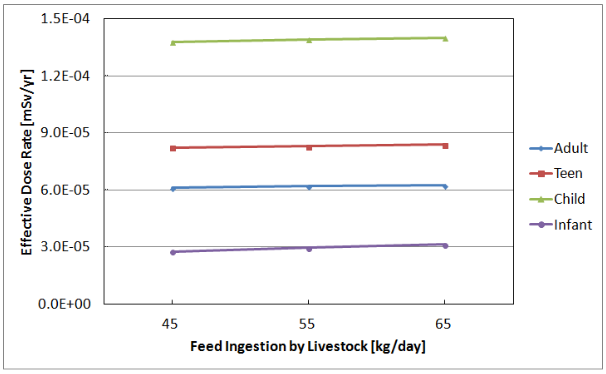

Fig. 3. Detailed results of the sensitivity analysis with varying the feed ingestion by livestock

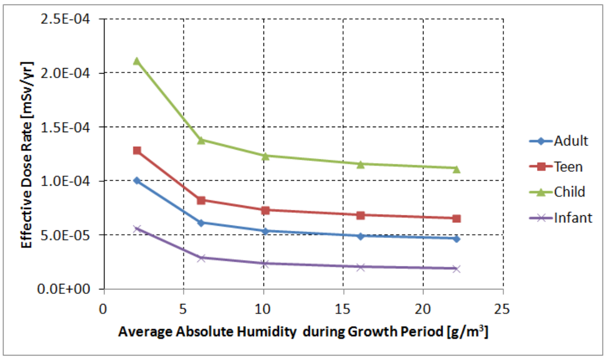

Fig. 4. Detailed results of the sensitivity analysis with varying the average absolute humidity during growth period

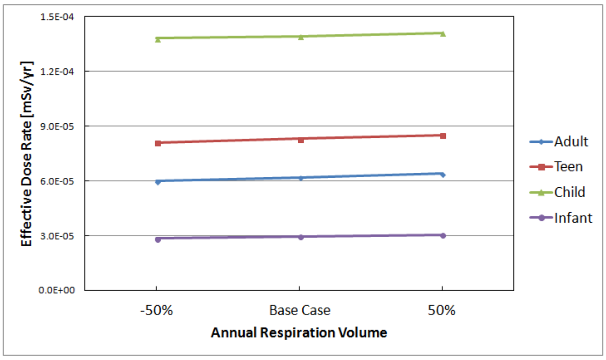

Fig. 5. Detailed results of the sensitivity analysis with varying the annual respiration volume

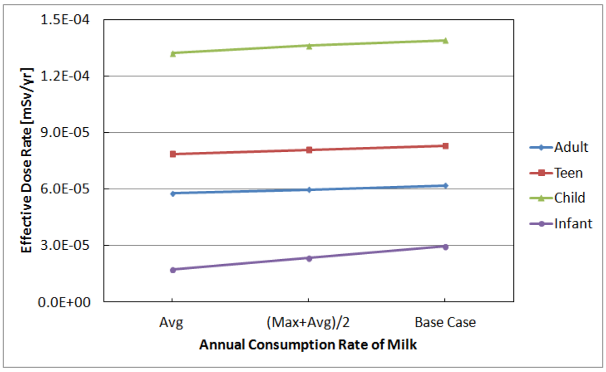

Fig. 6. Detailed results of the sensitivity analysis with varying the annual consumption rate of milk

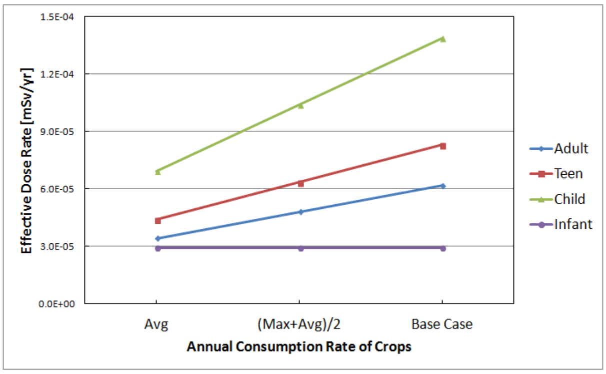

Fig. 7. Detailed results of the sensitivity analysis with varying the annual consumption rate of crops

3. Conclusions

In this paper, the sensitivity analysis of input parameters for the dose assessment in the vicinity of the site boundary due to gaseous effluents was performed for a total of thirty-five (35) cases. For each type of input parameter, variation trend in the individual effective dose with increasing the corresponding variable is summarized in Table I. And, detailed results for the input variables that have an significant effect are shown in Figures 1 through 7, respectively.

For preparing a R-ER for the operating license of the JRTR, these results will be updated by the additional information and could be applied to predicting the variation trend of the exposure dose in the process of updating the input parameters for the dose assessment reflecting the characteristics of the JRTR site

ACKNOWLEDGMENT

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