DOSE ASSESSMENT OF RADWASTE MANIPULATION IN TAIWAN

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ABSTRACT

To provide the dose assessment from radwaste drums manipulation in plant and at Lan-Yu storage site for the purpose of handling improvement to reduce radiation exposure as low as reasonably achievable, a computer program RAMDA has been developed by Institute of Nuclear Energy Research (INER) under a cooperative program with Radwaste Administration of ROC-AEC and Taiwan Power Company. Simulating the realistic handling procedures, RAMDA was designed to evaluate the worker's annual dose received from radwaste operation in plant or at Lan-Yu. From the analysis, the purpose of dose control program or procedure improvements of radwaste handling in-plant or on storage site could be achieved. Basically, there are seven steps in radwaste operation in plant and two steps at Lan-Yu. A three-dimensional point kernel code QAD-CG/INER is used to generate a data file by simulating each radwaste drum operation step. After some weighting considerations, a set of dose rate conversion factors for each step is performed and built in the RAMDA code. To use RAMDA code, users should input the number of worker of each exposure group and the exposure time for each step, and the annual surface dose rate of radwaste drums. Then the annual operation dose could finally be obtained. A sample problem of RAMDA code to evaluate the personnel exposure of Kuo-Sheng Nuclear Power Plant and at Lan-Yu storage site in 1985 have been achieved. The results reveal that the annual operation dose to workers in plant is 39.40 man-rem and in storage site is 10.95 man-rem. It quite agrees with the measured results of personnel dose.

INTRODUCTION

In Taiwan, there are currently three nuclear power stations (4 BWRS and 2 PWRS) in operation, from which thousands of solidified low level waste drums will be generated per year. These drums will be stored in nuclear power plants carefully until the drum surface dose rate meets the limitation issued by Radwaste Administration of Atomic Energy Council, Republic of China (ROC-AEC) before shipped to Lan-Yu. However, because of the frequency of radwaste-drum manipulation the operation group in plant or in Lan-Yu storage site could not be avoided from the radiation exposure. In order to provide the dose assessment from radwaste-drum manipulation in plant and at Lan-Yu storage site for the purpose of handling improvement to reduce radiation exposure as low as reasonably achievable. Institute of Nuclear Energy Research developed the code RAMDA (Radwaste Manipulation Dose Assessment) to evaluate the dose assessment of radwaste manipulation in Taiwan under a contracted program with ROC-AEC and Taiwan Power Company (TPC). This code can be used to analyze the annual dose of workers received from radwaste manipulation under the operating conditions in Taiwan.

The unit of operators accepted radiological exposure under normal operation of radwaste manipulation is presented in person-mrem/year. This program included radiological evaluation during onsite radwaste transportation & storage and radwaste transportation & storage at Lan-Yu. The operators include fork-lift driver, truck driver, pedestrians, integrity inspector, health physics patrol, inspector, off-container handler, in-container handler, in-trench handler and director.

RAMDA is written in FORTRAN-IV language and has been testified to be operational on the FACOM-M200 computer system successfully since May 1986.

EVALUATION MODEL OF RAMDA CODE

RAMDA is a code developed to analyze the radiological influence for operators and environmental impact of radwaste manipulation during the realistic handling procedures of radwaste drums in Taipower Nuclear Power Plant and at Lan-Yu storage site. The handling procedures can be seperated to seven steps for radwaste operation in plant and two steps at the storage site. The nine steps mentioned previously can also be divided into one to five substeps seperately under the detailed considerations. The operators for each step are met quite similar under the different operation procedures for each step. The simulating procedures for operation steps and operators for each step to be used in RAMDA code analysis are described as follows.

(A) In plant

(1) Radwaste solidified building drums fork-lifting

In this step, there are three substeps: radwaste solidified building drums fork-lifting, radwaste drums transportation between radwaste solidified building and truck, and truck drums remove in. The operators during this step include fork-lift driver, health physics patrol, truck driver, and pedestrians.

(2) Radwaste drums onsite transportation

There is no substep in this step and the operators involve in this step are truck driver and pedestrians.

(3) TSF (Temporary Storage Facility) drums remove in

There are three substeps in this step: truck drums fork-lifting, fork-lift transportation, and TSF drums remove in. The operators during this step involve: fork-lift driver, truck driver, and health physics patrol.

(4) TSF drums remove out

In this step, there are three substeps: TSF drums remove out, fork-lift transportation, and integrity inspection area drums remove in. The fork-lift driver is the only operator during this step.

(5) Drums repainting

There are five substeps in this step: drums inspection, drums fork-lifting, integrity inspection area drums transportation, fork-lift transportation, and conveyance area remove in. The operators during this step include: fork-lift driver, integrity inspector, and health physics patrol. Because of the open drum inspection to be involved during this step, not only the direct radiation exposure is calculated but also the internal exposure is be considered in the evaluation of operators from radiation exposure.

(6) Drums inspection

In this step, there are four substeps: conveyance area fork-lifting, fork-lift transportation, inspection, area drums remove in, and drums inspection The operators during this step involve: fork-lift driver, integrity inspector, health physics patrol, and inspector.

(7) Drums loading in cask

There are five substeps in this step: inspection area fork-lifting, fork-lift transportation, drums remove in, drums fork-lifting, and drums loading in cask. The operators during this step involve: fork-lift driver, pedestrians, health physics patrol, off-container handler, and in-container handler.

(B) At Lan-Yu

(8) Radwaste drums transportation in site

There is no substep in this step and the operators during this step involve: fork-lift driver and pedestrians.

(9) Drums loading in trench

In this step, there are three substeps: drums locking, drums fork-lifting, and drums setting. The exposure groups during this step involve : health physics patrol, in-container handler, in-trench handler, and director.

Figure 1 shows the flow diagram of RAMDA code which describes the procedures to analyze the operation dose. The flow diagram will be described as follows:

1. Refer to the radwaste-drum manipulation procedures to generate the analysis model in details for each operation step.
2. Use a three-dimensional point kernel code QAD-CG/INER to generate the geometrical simulation model for each step, add the measured data, and then go to the actual evaluation of each radwaste-drum operation step as mentioned before.
3. After some weighting considerations for the variation of volume source and detector points, a set of dose rate conversion factors for each step are performed and built in RAMDA code.
4. Input numbers of each exposure group and exposure time for each step into RAMDA code.
5. Input long term average annual surface dose rate

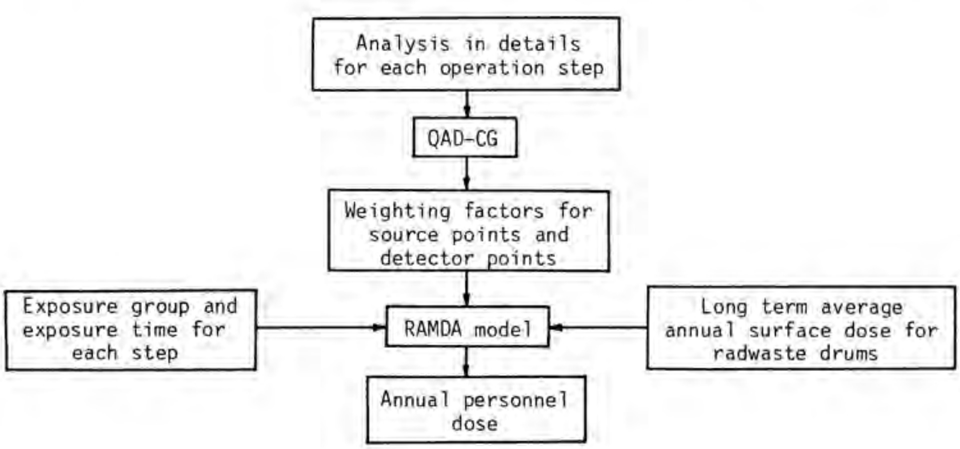

Fig. 1. Operation Flow Diagram of RAMDA Code.

for radwaste drums into RAMDA code.

6. After the procedures as shown above, the annual personnel dose for each exposure group and the total annual dose of workers could finally be obtained.

The surface dose rate of radwaste drums have laid between a large-range for each plant under a long-term consideration, therefore, the operation dose evaluated by RAMDA should also be an average viewpoint during a period of long time. The input of surface dose rate for radwaste drums in RAMDA has two options. The first is that the surface dose rate for each radwaste drum can be input directly into RAMDA. After averaging treatment of the data use in RAMDA, an average surface dose rate could be obtained and used to evaluate the annual dose for each exposure group. The other option is to assume that the surface dose rate for radwaste drums can be seperated into six categories by different considerations and these six categories can be input seperately by users.

The input of RAMDA code includes two parts. The first one is to input radwaste drums surface dose rate, and the other one is to input the data of handling procedures by NAMELIST format. In addition to the input data, the BLOCK DATA in RAMDA code is generated before analysis, and users could change these data if necessary.

Use RAMDA code to analyze the dose assessment of radwaste manipulation, the following assumptions are also important:

(1) The radiation exposure analysis model and dose assessment data are generated by three-dimensional point kernel code QAD-CG/INER.

(2) The nuclide in the radwaste drums is assumed to be Co-60 and its activity is assumed to be 1 Ci/drum.

(3) The material of radwaste drum is assumed to be ordinary concrete (type OR-04) with density of 1.4g/cm**3. The shielding wall material is also assumed to be ordinary concrete but with density of 2.35g/cm**3.

(4) The densities of other shielding material by using RAMDA are assumed as follows: The density of lead is 11.4g/cm**3, and stainless steel 8.0g/cm**3.

Except the above considerations, using RAMDA code to evaluate the dose assessment of radwaste manipulation, the input parameters of transport index, shipping cask type, truck transport distance, truck velocity and curie per integrity inspection are important parameters. Besides, number of operators, time interval of each operation step, package per shipment and shipment per year are also important parameters during the consideration of annual exposure by using RAMDA code.

RAMDA APPLICATION IN TAIWAN

Based on the actual conditions of the annual production of 6664 radwaste drums and 19 shipments in 1985, the radwaste manipulation in Kuo-Sheng Nuclear Power Plant of TPC and at Lan-Yu storage site has been evaluated by using RAMDA code. Table I shows the results of dose calculations with the aid of RAMDA code. From these results, it has been found that the annual operation dose to workers in plant is 39.40 man-rem and in Lan-Yu storage site is 10.95 man-rem. These computed data will quite agree with the measured results of personnel dose: ranging 30—45 man-rem during the workers in plant and ranging 5—15 man-rem at storage site. As shown in Table I, we know that the exposure to workers in plant is maximum during their inspection and painting of the storage drums.

This paper reveals that the annual dose computed from RAMDA code may be considered as an excellent reference for the dose assessment of radwaste manipulation in Taiwan. The extension of our present work in progress is to reload RAMDA code on a personal computer. Besides, a code named RADSHIP-3 which simulatesthe radwaste transportation radiological impact assessment in Taiwan has been achieved. The final target of our whole project is to achieve a linkage of RAMDA and RADSHIP-3 to evaluate the radiological impact during the radwaste transportation in Taiwan.

REFERENCES

1. F.D. Chang and M.F. Su,"RADSHIP-2: A Computer Code to Analyze the Radiological Impact from Radwaste Transportation," Institute of Nuclear Energy Research, ROC, May, 1985.

2. S.C. Yang and M.F. Su, "A User's Manual for NUCLYD, Beta and Gamma Spectrum Calculation from a given Set of Isotopes, " Institute of Nuclear Energy Research, ROC, August,1980.

3. Cain, V.R., "QAD-CG: The Combinatorial Geometry Version of The QAD-P5A Point Kernel Shielding Code, "ccc-307, Oak Ridge National Laboratory, 1977.

4. B.J. Chang,"A User's Manual for RAMDA," RS14-C40-01 , Institute of Nuclear Energy Research, May 1986. (In Chinese).

5. C.L. Shih, "Technical Report I," RS14-F20-01, Institute of Nuclear Energy Research, April 1986. (In Chinese).

6. C.L. Shih,"Technical Report II," RS14-F20-02, Institute of Nuclear Energy Research, June 1986. (In Chinese).

TABLE I

Results of RAMDA Code (man-mrem/yr)

	Fort-Lift Driver	Truck Driver	Pedestrian	Integrity Inspector	Health Physics Patrol	Inspector	Off-Container Handler	In-Container Handler	In-Trench Handler	Director
Radwaste Solidified Building Drums Fork-Lifting	1.65 +2	1.07 +2	1.60 +1		1.07 +2					
Radwaste Drums Onsite Transportation		3.08 -2	2.03 +1							
TSF Drums Remove In	1.51 +3	9.29 +2			9.29 +2					
TSF Drums Remove Out	3.18 +2									
Drums Repainting	2.26 +1			1.88 +4	4.82 +0					
Drums Inspection	2.11 +1			7.87 +3	2.61 +3	5.22 +3				
Drume Loading in Cask	5.22 +0		8.26 +1		8.26 +1		2.01 +2	3.88 +2		
Radwaste Drums Transportation		1.68 +1	5.16 -2							
Drums Loading in Trench					3.25 +1			1.26 +3	8.45 +3	1.19 +3