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1. INTRODUCTION

Durring a nuclear accident it can happen a significant environmentally fission products release. In that case it is not possible to determine precisely the air fission products concentration and, consequently, the estimated doses will be affected by certain errors.

The probability to comme off a nuclear accident, even minor, imposes a creation of a computation method for emergency dosimetric evaluations needed to compare to certain reference levels, previously established. These comparisons will allow a qualified option regarding the necessary actions to diminish the accident effects.

DOZIM code estimate the soil contamination, the irradiation doses produced either by radioactive plume or by soil contamination, either on whole body or on certain organs, as well as internal contamination doses produced by isotops inhalation during radioactive plume crossing. The calculus do not consider neither the internal contamination produced by contaminated food consumption, nor that produced by radioactive depozits resuspention. The code is recomended for doses computation on the wind direction, at distances from 10^2 to $2\cdot10^4$m.

2. THE MODEL

A radioactive material gaussian dispersion was considered /1/, /2/, /3/, and a typical "puff" release. The main atmospheric parameters are the wind speed and direction, and atmospheric stability. Atmospheric stability classes was established with Pasquill method. Radioactive plume dispersion parameters $\sigma_y(x)$ and $\sigma_z(x)$ can be obtained using one of classic methods proposed by: Martin and Tikvart, Briggs and Vogt. We have utilised an unified formula resulted from higher reminded methods:

$$\sigma_{ij} = a_{ij}\cdot x^{b_{ij}}(1+c_{ij})^{d_{ij}}+e_{ij} \qquad (1)$$

where:

i = y or z (horizontal, respectively vertical dispersion)

j = 1 for Martin and Tikvart method

2 for Briggs method

3 for Vogt method (average rugged ground, afforested and in air altitude release of 60m)

4 for Vogt method (great ground rugosity and release altitude of 50m)

5 like 4 but 100m release altitude

x = the distance, on the radioactive plume displacement direction, from the emission point to the interest point

a,b,c,d,e, = constants regarding the method, the stability class, the horizontal or vertical dispersion.

The program take into account the radioactive plume depletion produced by the dry deposition, by the radioactive decay during displacement as well as other parameters like:

- wind speed
- the radioactive plume rise produced either by the heat or by the cold effluents at:
  - high altitude emission
  - small altitude emission
  - to earth surface emission
- adjacent buildings
- emission length
- geometry and dimensions of emissing point

To facilitate the use, the program calculates the decrease of the fission products activity during the interval from the reactor stop to the nuclear accident moment.

Because there are many possible cases of fission products release the total fractions released by a fuel element will be used as input data. It is useful to know previousely these fractions for different security barriers (defective clad, ventilation system, pressure vessel)

To reduce the calculus volume, appropriate dosimetric factors was used for each irradiation case . The isotope "i" time integrated concetration in air is the result of the following formula:

$$\chi_i = \frac{e^{-\frac{1}{2}\left(\frac{H_{ef}}{\sigma_z}\right)^2}\cdot e^{-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2}\cdot e^{-\frac{v_{gi}}{\bar{u}}\sqrt{\frac{2}{\pi}}\int_0^x \frac{e^{-\frac{1}{2}\left(\frac{H_{ef}}{\sigma_z}\right)^2}}{\sigma_z}dx}\cdot e^{-\lambda_i\left(\frac{x}{\bar{u}}+t_r\right)}\cdot Q_i\cdot F_i}{(\pi\sigma_y\sigma_z + C\cdot A)\,\bar{u}} \qquad (2$$

where:

σ_y = horizontal dispersion coefficient (m)

σ_z = vertical dispersion coefficient (m)

A = adjacent buildings surface reached by radioactive plume (normaly disposed on wind displacement direction) (m^2)

c = nondimensional correction coefficient

H_{ef} = effective evacuation highness (altitude) (m)

$\bar{u}$ = wind speed at H_{ef} (m/s)

v_{gi} = the descending speed for "i" isotope (m/s)

Q_i = total activity of "i" isotope, existing in the defective fuel element at the reactor stop moment. (Ci)

λ_i = "i" isotope decay constant. (s^{-1})

x = distance between the emission point and the point of interest disposed on wind direction. (m)

t_r = elapsed time between the reactor stop time and the evacuation moment. (s)

y = normaly on the wind direction distance corresponding to a certain x. (m)

The total irradiation dose due to radioactive plume is:

$$D_1^k = \sum_1^N {}_i\chi_i \cdot F_{1i}^k \quad (\text{rem}), \qquad (\text{Ci}\cdot\text{S/m}^3)\cdot(\text{rem}\cdot\text{m}^3/\text{Ci}\cdot\text{s}) \qquad (3)$$

where:

D_1^k = the dose on "k" organ

F_{1i}^k = dosimetric conversion factor regarding "i" isotope and "k" organ due to in radioactive plume imersion.

N = in air evacuated radioactive isotope number

The irradiation dose on "k" organ due to contaminated soil was accounted as:

$$D_2^k(\text{rem}) = \sum_1^N {}_i\chi_i \cdot v_{gi} \cdot F_{2i}^K \qquad (4)$$

where: F_{2i}^k is the dosimetric factor for "k" organ irradiation produced by "i" isotope existing on the soil surface.

The dose on "k" organ due to contaminated air inhalation is:

$$D_3^k(\text{rem}) = \sum_1^N \chi_i \cdot A \cdot F_{3i}^k \qquad (5)$$

where: F_{3i}^k is inhalation dosimetric factor. (rem/Ci)

A is the breath flow for a standard man. (m^3/s)

The variables signification is consietent. D_j^k includes too the whole body doses.

3. RESULTS

The DOZIM code was utilised for three different cases:

- In air TRIGA-SSR fuel bundle destruction with different input data for fission products fractions released environmentally.
- Czernobil accident doses estimation.
- Intervention areas determination for a hypothetic severe accident at Cernavoda Nuclear Power Station.

The first case input data and results (for a 60m emission highness without iodine retention on active coal filters) are presented in 2 and 3 tables.

4. CONCLUSIONS

The DOZIM code conception allow the doses estimation for any nuclear accident. Fission products inventory, released fractions, emission conditions, atmospharical and geographical parameters are the input data. Dosimetric factors are included in the program.The program is in FORTRAN IV language and is run on CYBER 170/720 computer (CDC).

5. REFERENCES

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2. Reactor Safety Study. WASH - 1400 (NUREG 75/014)
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4. Pour una estimation realiste des emissions radioactives. M. Levenson.

Method	Coef.	σy A	σy B	σy C	σy D	σy E	σy F	σz A	σz B	σz C	σz D	σz E	σz F
1	a	[illegible]	[illegible]	[illegible]	0.1471	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.18
	c	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	[illegible]	[illegible]	0.0	0.0	0.0
	d	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0
	e	0.0	[illegible]	0.0	0.0	0.0	0.0	[illegible]	[illegible]	[illegible]	13.0	[illegible]	[illegible]
2	a	[illegible]	[illegible]	[illegible]	0.08	0.06	0.04	0.2	[illegible]	[illegible]	0.06	[illegible]	0.016
	b	1.0	1.0	1.0	1.0	1.0	1.0	1.0	[illegible]	1.0	1.0	1.0	1.0
	c	[illegible]	[illegible]	[illegible]	[illegible]	0.0001	0.0	0.0	0.0	[illegible]	[illegible]	0.0003	0.0003
	d	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.5	0.0	0.0	[illegible]	0.5	-1.0	-1.0
	e	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0
3	a	[illegible]	[illegible]	[illegible]	[illegible]	1.0819	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.4153
	b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.6115	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.6134
	c	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	d	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0
	e	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	a	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.20	0.16	0.40
	b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.62
	c	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	d	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	e	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	a	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.10	[illegible]	[illegible]	[illegible]	0.16	0.40
	b	[illegible]	[illegible]	[illegible]	0.51	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.61	0.62
	c	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	d	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	e	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$\sigma_{ij} = a_{ij} \cdot x^{b_{ij}} (1 + c_{ij})^{d_{ij}} + e_{ij} \qquad (1)$$

i – y or z · j – used method

TABLE 2

Noble gas and halogen fission products inventory for a TRIGA - SSR bundle.

Isotope	Bundle inventory (Ci)	Release fraction
Kr - 85	280	1.0
Kr - 85m	9650	1.0
Kr - 87	19310	1.0
Kr - 88	27720	1.0
I - 131	22760	0.25
I - 132	34000	0.25
I - 133	51310	0.25
I - 134	60550	0.25
I - 135	47240	0.25
Xe - 133	51240	1.0
Xe - 135	13520	1.0

Wind speed (at 10 m) - either 1 or 3 m/s
Pasquill stability classes - either A or F
Release altitude - 60m
Deposition speed - 0.0 for Noble Gas
- 0.003 for Halogen
Release speed - 4m/s
C constante - oθ
Delay time - 2h
Stack outer diameter - 2.5m
Stack inner diameter - 2.2m
O calcul formula - 3 (Vogt)

TABLE 5

[redacted]e es[redacted]tion [redacted]r T[redacted] - S[redacted]uel [redacted]le destruction

Pasquill stability class	Wind speed (m/s)	Distance (m)	H	D_{Th}	C
A	1	200	3.6	57.8	$2.0 \cdot 10^{-3}$
		300	4.5	72.1	$2.5 \cdot 10^{-3}$
		500	3.0	47.6	$1.6 \cdot 10^{-3}$
		1000	1.1	17.2	$5.8 \cdot 10^{-4}$
		1600	0.5	7.8	$2.6 \cdot 10^{-4}$
		5000	0.06	1.1	$3.2 \cdot 10^{-5}$
		10000	0.02	0.3	$8.3 \cdot 10^{-6}$
	3	200	2.0	32.5	$1.1 \cdot 10^{-3}$
		300	1.9	30.4	$1.0 \cdot 10^{-3}$
		500	1.1	17.4	$6.0 \cdot 10^{-4}$
		1000	0.37	6.0	$2.1 \cdot 10^{-4}$
		1600	0.17	2.69	$9.2 \cdot 10^{-5}$
		5000	0.02	0.36	$1.2 \cdot 10^{-5}$
		10000	0.006	0.10	$3.3 \cdot 10^{-6}$
F	1	200	-	-	-
		300	-	-	$1.7 \cdot 10^{-7}$
		500	0.04	0.64	$2.2 \cdot 10^{-5}$
		1000	0.63	10.20	$3.4 \cdot 10^{-4}$
		1600	1.16	18.80	$6.2 \cdot 10^{-4}$
		5000	0.89	14.71	$4.5 \cdot 10^{-4}$
		10000	0.46	7.73	$2.2 \cdot 10^{-4}$
	3	200	-	-	-
		300	-	-	$4.4 \cdot 10^{-7}$
		500	0.03	0.46	$1.6 \cdot 10^{-5}$
		1000	0.25	4.0	$1.4 \cdot 10^{-4}$
		1600	0.44	7.0	$2.4 \cdot 10^{-4}$
		5000	0.33	5.4	$1.8 \cdot 10^{-4}$
		10000	0.18	2.95	$0.93 \cdot 10^{-5}$

H = effective equivalente dose (rem)

D_{Th} = Thyroide dose (rem)

C = ground deposition from the radioactive plume (Ci/m^2)

DOSIMETRIC DATA PROCESSING IN TRIGA-MR 1 BUILDING

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I. ABSTRACT.

Due to the sources of radiations in the reactor core, in the auxiliary circuits and in the irradiation devices, in the related rooms is a content of gamma radiations and may be a light contamination of the air.

The monitoring of radiations is permanently made by the system of fixed dosimetry.

Data storage and processing is made by the CORAL computer.

This paper gives the details of the works made for storage and processing data with the computer.

II. FIXED DOSIMETRIC SYSTEM AT TRIGA REACTOR.

Fixed dosimetric system may be classified as: technological and health - physics dosimetry. Technological dosimetry is made up by measurement chains whose detection blocks are very close to the nuclear circuits compounds, allowing the immediat detection through measurement of the increasing of dosimetric values (gamma background, radioactive gases and aerosols concentration) of each even damage and generally the exceed of limite and technical conditions which may lead to radioactive releases from closed circuits and systems.

Health physics dosimetry is made up by measurement chains whose detection blocks are placed at work places, where, even in normal operation conditions, dosimetric values may increase, so that in a normal week work period [redacted] (40 hours a week) the absorbed dose by the professionally exposed staff must not exceed the maximum limit value.

We have to mention that technological dosimetry has an important role in the activity of the health physics staff. The aparatus is manufacture by Berthold & G.A. - U.S.A. It is composed from:

- Measurement chains for gamma background.
- Measurement chains for radioactive gases concentration.