ASSESSMENT OF RADIOLOGICAL IMPACT OF VENT RELEASE OF THE CYCLOTRON CENTER IN BRATISLAVA.

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INTRODUCTION

The aim of this paper is to present assessment of radiological impact of vent release of the Cyclotron Centre of the Slovak Republic (CC SR) in Bratislava. Radioactive gases and aerosols, which occur in the course of operation of CC SR complex, are emitted into the atmosphere from vent systems or vent stacks. By vent release we understand release of radioactive pollution from permanent untightness and/or open windows of building. For calculation needs we have used: (1) source term data (emission rate of radioactive gases and aerosols from the CC SR during its operation period), (2) meteorological data from location of the CC SR (data in half-hour intervals in 11 month period), and (3) calculation system RTARC, which was adapted for assessment needs of radiological impact from CC SR emission.

The system RTARC was adjusted thus, that it is possible to calculate summary radiological impact for numerous of half-hour emissions under meteorological conditions, which are defined for each particular emission.

MODEL DESCRIPTION

RTARC 4.5 (Real Time Accident Release Consequence) is a computer code developed at VÚJE Trnava, Inc. – Engineering, Design and Research Organization, Slovak Republic to calculate and predict off-site radiological consequences in the event of nuclear accident or radiological emergency during the early phase (Štubňa, M. 1988).

The exposure pathways considered in the program package are those that are the most important ones during the early phase of an accident: (1) external exposure by the passing radioactive plume; (2) external exposure by radioactivity deposited on the ground; and (3) internal exposure by inhaled radioactivity.

System RTARC is used for the 30-40 km distances from the dispersion of radioactive materials point of view. Gaussian dispersion model including dry and wet deposition of the aerosols and iodine forms as well as complex terrain influence on the dispersion of the radioactive materials in the atmosphere are modeled in the system. The plume rise and building wake effect are taken into account in dependence on the source characteristics.

INPUT DATA

The yearly stack release [GBq/year] to the atmosphere was used for calculations. Taking into account the fact, that meteorological data from the CC locality were available for the half an hour intervals, the yearly release of radioactive materials was recalculated according the following equation:

$$1/2\ \mathit{hour\ release}\left[Bq\right] = \frac{\mathit{1\ year\ release}\left[Bq\right]}{\mathit{250\ working\ days} \cdot \mathit{10\ hour} \cdot 2} \tag{1}$$

The half an hour releases of individual radionuclides for the block I, block J and for both blocks of CC are summarized in Table 1. It was supposed that the radioactivity release from vent systems or vent stacks lasted 10 hours (from 6 a.m. up to 4 p.m.) each day. The meteorological data were used for corresponding half an hour intervals of release in day of release. The available meteorological data covered the period from beginning of July 2000 up to the end of May 2001, i.e. the data from 11 months of year.

The calculated doses represent the sum of impact due to release of 6436 half an hours partial releases, what is equivalent to 3218 working hours of CC. Taking into account that working year consists of 250 working days, that means 2500 hours under the assumption of 10 hours working day, the results of calculation characterize the radiological impact for more than one CC working year.

Table 1. Half an hour activity releases [Bq] from vent systems or stacks of CC Bratislava.

Isotope	Block „ I “	Block „ J “	Suma I + J
^{18}F	5.00E+06	1.00E+05	5.10E+06
^{15}O	5.00E+06	1.80E+05	5.18E+06
^{67}Ga	6.00E+03	0.00E+00	6.00E+03
^{111}In	3.00E+03	0.00E+00	3.00E+03
^{123}I	2.00E+06	1.00E+06	3.00E+06
^{201}Tl	2.00E+03	0.00E+00	2.00E+03
^{99m}Tc	9.00E+06	6.40E+05	9.64E+06
^{41}Ar	1.20E+06	3.22E+07	3.34E+07
^{81}Rb	0.00E+00	8.00E+04	8.00E+04
^{13}N	0.00E+00	7.80E+05	7.80E+05

The rectangular system of coordinates where positive axis Y was in north direction and positive axis X was in east direction was used. The geometrical centre of „I“ block of CC was established as a centre of coordination system. Two buildings were modelled for the analyses purposes: block I and block J. The parameters of the system of coordinates as well as parameters of the modelled buildings are summarized in the Table 2.

Two release points were modelled (blocks I and J) with radioactive pollution into the atmosphere by two ways: from vent systems of blocks and/or from vent stacks of blocks. It was supposed that thermal energy and mechanical speed of release from vent systems and from vent stacks are negligible, i.e. that there is no thermal and mechanical plume rise. This assumption leads to the conservative overestimation of calculated values of concentrations and doses.

In case of vent systems release the pathway via the windows, permanent untightness and others was supposed. Because of the mixing of radionuclides in wake of building during the release, the results are less sensitive on the release height which is less than the building height.

In case of vent stacks release it was supposed, that orifice of stacks are in 21.5 m height above the terrain. Taking into account that block J is under construction, the values, indicated in table 2 are approximate.

Dose factors for internal exposure by inhalation were used from the Decree No.12/2001 of Ministry of Health of Slovak Republic, based on Basic Safety Standards, Safety Series No. 115. For the calculation of exposure by inhaled isotopes ^{13}N and ^{15}O the dose factors as for ^{11}C were used. The dose factors for children were used for age category 7-12 years. Dose factors for external exposure from cloud and deposition were used from Federal Guidance Report (EPA, 1993).

Table 2. Geometric centre of blocks in system of coordinate, building proportions and stack heights using as input data for system RTARC.

Objects	Coordinates of object centre		Building height	Release height	Building width
Block I	X = 0.0 m	Y = 0.0 m	H_v = 15.0 m	H_b = 18.0 m	W_b = 65.7 m
Block J	X = -76.9 m	Y = 0.0 m	H_v = 15.0 m	H_b = 18.0 m	W_b = 65.7 m
Stack I	X = -15.0 m	Y = -26.3 m	H_k = 21.5 m	H_b = 18.0 m	W_b = 65.7 m
Stack J	X = -76.9 m	Y = 0.0 m	H_k = 21.5 m	H_b = 18.0 m	W_b = 65.7 m

Half an hour averaged values measured at the stationary meteorological station in the locality of CC SR used in calculations are following: (1) wind speed on the height 10 meters, (2) wind direction on the height 10 meters, (3) radiation balance, and (4) rainfall amount. The Pasquill's atmospheric stability class were estimated with using the values of radiation balance and values of wind speed.

RESULTS

All calculated values of doses represented radiological impact for period from moment of external or internal exposure to period of 1 year. Table 3 represents summary review of maximum values of the effective doses for adults in defined calculation grid. Graphical presentation of effective dose fields [nSv] for the radioactive releases in one year from the vent system of the block „I“ is on the Figure 1.

Table 3. Maximum values of effective doses for adults from individual types of release and coordinates of maximum values in the defined calculation grid.

Maximum from all exposure pathway			
Type and location of release	Coordinate of maximum X [m]	Y [m]	Maximal value [nSv]
Block I	-50	0	794.0
Block J	-100	0	952.0
Both blocks	-50	0	1727.0
Stack I	0	-50	492.0
Stack J	100	-100	356.0
Both stacks	0	-50	844.0

The contribution from individual exposure pathways to the maximum value of effective dose for adult due to simultaneous release from vent systems of both blocks are presented in Table 4.

Table 4. The contribution from individual exposure pathways to the maximum value of effective dose for adult due to simultaneous release from vent systems of both blocks.

Maximum from all exposure pathway [nSv]	External exposure from cloud [nSv]	External exposure from contaminated area [nSv]	Internal exposure by inhalation from cloud [nSv]	Internal exposure by inhalation of resuspended isotopes [nSv]
1726.595	650.0	905.0	171.0	0.595

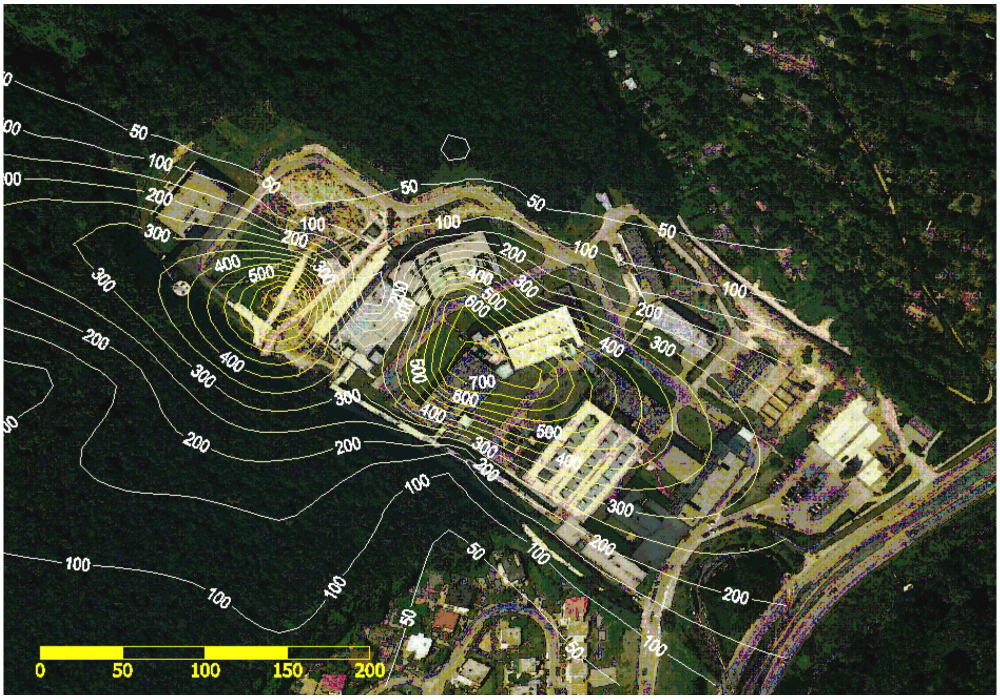

Figure 1. Effective dose fields [nSv] for adults from all exposure pathway for the radioactive releases in one year from the vent system of the block „I“

Ratio between the effective dose from operation of CC SR and effective dose from natural background is very small. The effective dose from the operation CC SR is more than 1000 times less in comparison to the effective dose from natural background (for dwelling house is effective dose equal 2.3 mSv/year) in the dwelling-houses near the CC SR area. The general conclusion based on analyses performed is that radiological impact to the population living in near range to the CC SR is negligible.

REFERENCES

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