REALISTIC ENVIRONMENTAL EXPOSURE CALCULATION FOR A MULTI-SOURCE FACILITY

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The annual radiation exposure caused by a nuclear facility usually is calculated from the measured release volumes of the individual nuclides and the so-called long-time diffusion factor, which results from the meteorological statistics of the site. This procedure is performed to make two assumptions: firstly, the release rates of the radioactive substances are quasi-continuous, and secondly, the superposed short-time diffusion factors of the changing weather conditions during the time of interest are comparable with the long-time diffusion factor. Because of their operational condition, these assumptions cannot be fullfilled by all nuclear installations.

Therefore we have designed a model and a computer code to calculate the radiation exposure under changing weather conditions and instantaneous release rates. This model is a multi-source model, i.e. the exposure due to the single installations will be superposed to the real location within the nuclear facility.

MODEL AND METHODS

The short-time diffusion factors are calculated by the hourly measured release volumes, the wind direction, the diffusion category and the mean wind velocity in emission height. The calculation method used herein is the Gaussian plume model, the parameters of which were measured by us for two emission heights (1). These short--time diffusion factors are superposed due to the real location of the sources to receive the environmental concentration distribution of each nuclide. Within this method quasi-continuous release rates can be described as well as instantaneous release volumes.

In order to calculate the radiation exposure of the total body and the other organs the following exposure pathways are considered: gamma-submersion, beta-submersion, soil radiation, inhalation and ingestion. In the case of the first four pathways the usual calculation methods are taken into account. The ingestion model is modified because of the instantaneous character of the diffusion calculation. The uptake from soil is derived from releases

throughout the whole year. In this term long-lived nuclides released in former years are also regarded. In our model the direct foliar deposition is derived only from really released volumes during the vegetation period. Based on a statistic time-dependance of the individual releases during the growing season of the different relevant foods, this term of our model includes the usual ingestion model in the case of uniform release rates (2).

EXAMPLE

As an example we present the annual radiation exposure of the Juelich Nuclear Research Centre in the year 1978. The Research Centre comprises several individual sources of emission. Depending on their operational condition, these individual installations release radioactive substances in one part in a quasi-contineous manner, and in another part as single emissions. The composition of the airborne radioactive substances differs very much. The main sources are listed in table 1.

Table 1. The airborne radioactive releases of the main installations of the Juelich Nuclear Research Centre in the year 1978

installation	nuclides	release in 1978 (Ci/a)	
reactor FRJ-1	AR 41	140^{+}	
	J 131	$1.1\ 10^{-4+}$	$2.5\ 10^{-5++}$
	HG 203	$1.8\ 10^{-2+}$	
reactor FRJ-2	AR 41	130^{+}	
	H 3	199^{+}	
	J 131	$1.6\ 10^{-4+}$	$5.6\ 10^{-6++}$
reactor AVR	H 3	399^{+}	
hot cells	KR 85	2.6^{+}	
	J 131	$3.5\ 10^{-3+}$	
fuel cells lab.	KR 85	1.6^{+}	
	J 131	$1.7\ 10^{-3+}$	
chemic lab.	J131	$4.2\ 10^{-3+}$	$3.1\ 10^{-4++}$

\+ release volumes during the whole year
++ release volumes only during the vegetation period from 1.4.1978 til 31.10.1978

During that year the release rates of the reactors FRJ-1 and FRJ-2 were in the main quasi-continueously, whereas the hot cells, the fuel cells lab. and the chemic lab. had irregular emission volumes. The main part of the tritium emission of the reactor AVR took place during an incident.

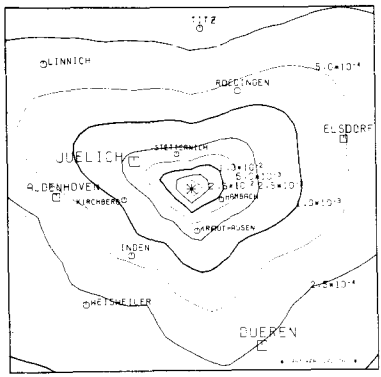

Figure 1

Annual dose of the total body from gamma-submersion

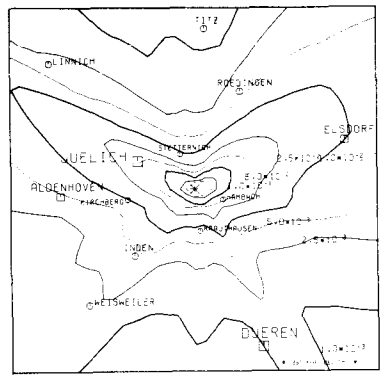

Figure 2

Annual dose of the total body as the sum of all relevant exposure pathways

Figure 1 shows the annual total body dose from gamma-submersion only, whereas figure 2 describes the annual total body dose as a sum of all relevant exposure pathways. The plotted isodoses of this last figure reflects the tritium incident of the reactor AVR and the predominant two weather conditions at that time. The curves are marked with the corresponding dose values in mrem per year. The asterisk describes the Nuclear Research Centre. The area of the map is 26 km by 26 km.

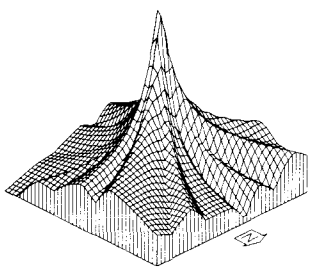

Figure 3

Relief-plot of the thyroid ingestion dose of the infant by J 131

Figure 3 shows the thyroid ingestion dose of infants by J131 only. The shape of the short-time diffusion factors are seen due to some few single emissions.

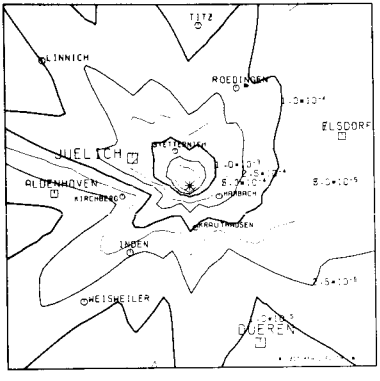

Figure 4

Inhalation dose of the thyroid of the infant by J 131

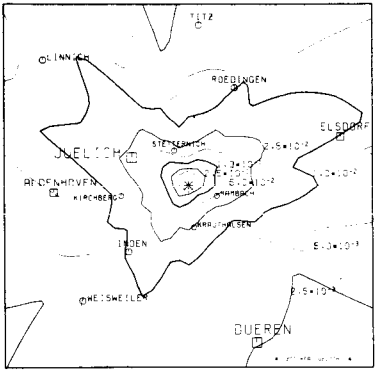

Figure 5

Ingestion dose of the thyroid of the infant by J 131

The figures 4 and 5 show the thyroid inhalation dose and the thyroid ingestion dose of infants by J 131. The inhalation dose in figure 4 includes also the main release volumes of J 131 during the winter period (see table 1). Because of the short life time of J 131 these release volumes had not to be taken into account for the ingestion dose calculation seen in figure 5. These two figures demonstrate very clearly the use of our model and that it is impossible to calculate the doses with the long-time diffusion factor.

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