INFLUENCE OF THE MOST IMPORTANT DATA ON THE CALCULATION OF THE MAXIMUM RADIATION EXPOSURE IN THE VICINITY OF NUCLEAR FACILITIES

Schmidtlein, P., Bonka, H., Hesel, D., Horn, H.-G.

Lehrstuhl für Reaktortechnik, RWTH Aachen, F.R.G.

The Radiation Protection Ordinance in the F.R.G. demands that the radiation exposure resulting from the operation of a nuclear facility is kept as low as possible, taking into account the state of science and technology. In (1) the methods for the calculation of the maximum radiation exposure are determined.

RELEVANT RADIONUCLIDES

When analysing the radiation exposure due to radionuclides released from nuclear facilities in more detail, one can see that only a few nuclides deliver relevant contributions to the radiation exposure. Fig. 1 and 2 show the contributions of the most important nuclides in the vicinity of a pressurized water reactor via the air and water pathway (2).

In the case of the air pathway especially the noble gases and C 14, as well as I 131 for the thyroid, are decisive for the dose. The dose via the water pathway is determined by H 3, Cs 134 and Cs 137.

The dose in the vicinity of a reprocessing plant is governed by a few nuclides as well (2). Due to the long cooling time between the unloading of the reactor and the reprocessing of the fuel elements the relevant nuclides like H 3, Kr 85, Sr 9o, Ru 1o6, I 129 and some transuranium isotopes are all long lived.

INFLUENCE OF THE MOST IMPORTANT DATA

The calculation of a radiation exposure has to consider the distribution of radionuclides in the atmosphere and the hydrosphere, the transfer into the foodstuffs and the transfer into the various organs after inhalation and ingestion.

Basing on this contamination of the environment, the maximum doses can only be calculated exactly for external submersion and, when using the specific activity model, for H 3 and C 14 (3).

The inhalation dose can also be calculated sufficiently exact, if the input parameters are known. Here the influence of the aerosol size distibution is only important for extreme aerosol sizes (very large or very small diameters). If the dose conversion factors are weighted over

This work was sponsored by the Federal Minister of the Interior of the F.R.G. under the number St.Sch. 675

the size spectrum of the natural aerosols 1 μm can be deducted as a median diameter (4). Fig. 3 shows the inhalation doses for various particle diameters of a Sr 9o aerosol standardized on the dose for 1 μm.

The calculation of the ingestion dose is highly sensitive to the deposition behaviour of the airborne radioactive material, as well as the transfer and concentration factors in the food chains. When considering the size spectrum of the aerosols in the calculation of the deposition velocity for fallout and washout, it shows, that the present calculation procedure results in an overestimation of the deposition velocity by a factor of 5.

The transfer data for the most important nuclides Sr 9o, Cs 137 and I 131 have been determined after atomic bomb tests. As the values laid down in (1) are still being discussed, the importance for the dose calculation was examined.

Fig. 4 and 5 show the influence of the plant-, milk- and meat transfer factors on the ingestion dose. The dose calculation was simplified corresponding to the formulae stated in fig. 4 and 5, where $\bar{\chi}$ is the long time dispersion factor, N is the precipitation, x is the distance, $\bar{u}$ is the mean wind velocity and ν is the food pathway (plants milk, meat, fish). Mostly for Sr 9o an increase of the transfer ground-plant has a considerable influence on the dose. This influence, however, decreases when the loss of radionuclides into deeper soil layers and due to harvest is considered (5,6).

For the water pathway the accumulation factors in fish and most of all the high consumption rate (39 kg/yr) are very important (fig. 6 and 7).

The variation of ground concentration due to loss of radionuclides via washing out into lower soil layers and harvest is shown in fig. 8 and 9.

It can, however, be assumed that the maximum possible doses for those nuclides which are of greatest importance for the dose, can be calculated sufficiently conservative.

REFERENCES

1. Bundesminister des Innern: Gemeinsames Ministerialblatt, ISSN o341-1435, 1979
2. Hesel, D. et al.: 12. Jahrestagung, Fachverband für Strahlenschutz 1978, S.753
3. Bonka, H.: Wissenschaftl. Symposium des Institutes für Strahlenhygiene des Bundesgesundheitsamtes. Berlin 14-16 Nov. 1979
4. Hesel, D.: Detailed publication in preparation
5. Schmidtlein, P.: 12. Jahrestagung, Fachverband für Strahlenschutz 1978, S. 434
6. Schmidtlein, P.: Detailed publication in preparation

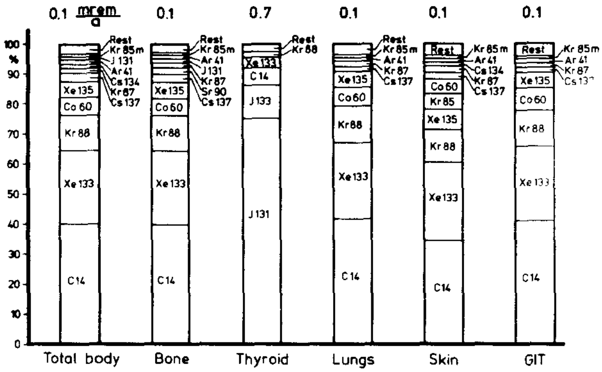

Fig. 1: Contribution of relevant radionuclides to the radiation exposure of an adult via the air pathway at the point of maximum exposure (Pressurized Water Reactor 1000 MW_e, H=100m)

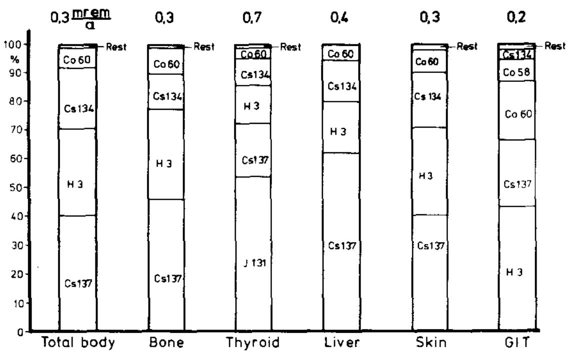

Fig. 2: Contribution of relevant radionuclides to the radiation exposure of an adult via the water pathway. (Pressurized Water Reactor, Q = 100 m^3/s)

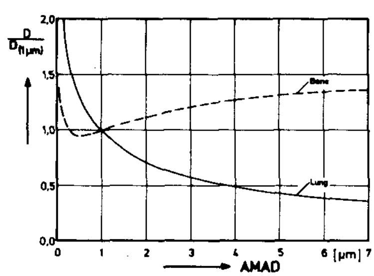

Fig. 3: Doses to lung and bone due to inhalation of Sr90 aerosols with various particle diameters, normalized on the dose for 1μm AMAD

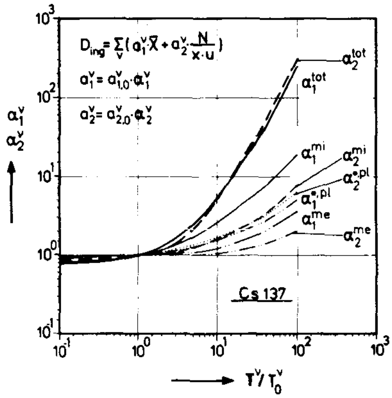

Fig 4: Change of α_1^v and α_2^v due to variation of transfer data.
*: with loss of radionuclides

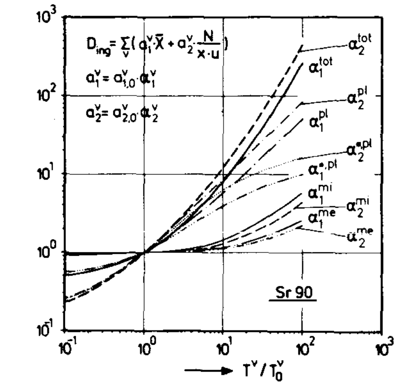

Fig 5: Change of α_1^v and α_2^v due to variation of transfer data.
*: with loss of radionuclides

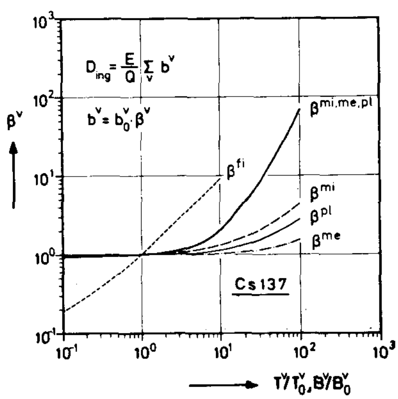

Fig 6: Change of β^v due to variation of transfer data and concentration factor in fish.

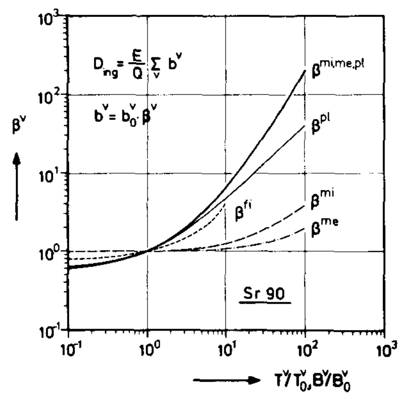

Fig 7: Change of β^v due to variation of transfer data and concentration factor in fish.

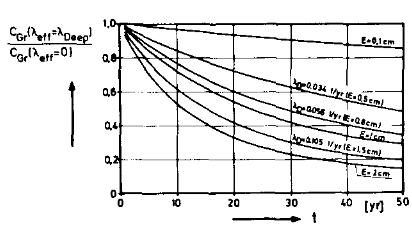

Fig.8: Relation of the ground concentration with and without loss of radionuclides due to transfer into lower soil layers E = Sinking velocity

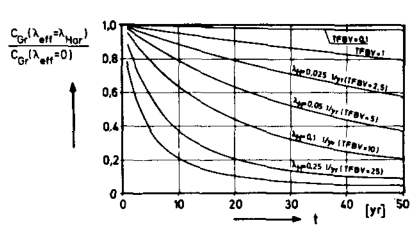

Fig.9: Relation of the ground concentration with and without loss of radionuclides due to harvest
TFBV = Transfer factor soil-vegetation