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TOPICAL SESSIONS
Reports of Co-Chairmen for Highlight Sessions

T-19(1 and 2): Environmental Dose Assessment: Methods, Results and Problems

Thursday, 18 May 2000

Chair and Keynote: A. Bouville Co-Chair: E. Wirth

In the ***keynote, Andre Bouville*** pointed out the differences between prospective and retrospective dose assessment. Prospective assessments are usually done for critical groups with more or less conservative assumptions. The aim of retrospective dose assessment is to estimate the dose as realistic as possible. Great importance is also attached to the evaluation of the uncertainties, as they play a role in the estimation of the risk associated to the exposure. Examples of the methodologies used in the reconstruction of doses resulting from substantial environmental releases were presented, along with a discussion of the uncertainties attached to the results. Of special interest is the short lived radionuclide iodine 131 because it often contributes significantly to the dose but corresponding measurements are rare. The dose due to Sr90 and Cs137 can estimated be estimated more easily, because measurements are already possible.

In another presentation, Balonov and Bouville illustrated the general methodology on internal dose reconstruction with results based on experimental data. When radiological data of different types that can be used for dose reconstruction are available, the hierarchy of their use should be based on the degree of reliability that they provide in the dose estimates. The content of radionuclides in the body is most closely connected with the internal dose, and, therefore, it should be used for internal dose reconstruction as *the first priorit*y. The results of local food products analyses for radionuclide content jointly with data on food consumption and a model of radionuclide intake with contaminated food should be considered as *the second priority* for internal dose reconstruction. Radioecological and dosimetry modelling should be applied as *the third priority* for internal dose reconstruction when site-specific experimental data are not available. Due to model conservatism, methods based on both food contamination data and radioecological modelling may lead to significant internal dose overestimation. Correction of the systematic inaccuracies of the intake model should be provided through validation procedures based on the comparison of modelling results with sample measurement data both of radionuclide content in food and human body.

This hierarchy of internal dose reconstruction methods was successfully implemented for the reconstruction of internal doses received since 1949 by residents near the Techa river and since 1986 by inhabitants of areas

contaminated as a result of the Chernobyl accident as further presentation indicated.

Golikov and coworkers presented a model of external exposure of population living in the areas contaminated after the Chernobyl accident and its validation. The model consists of four sub-models for the following issues:

- absorbed dose rate in air at a reference site in the settlement;
- absorbed dose rate in air at various types of rural or urban locations relative to the reference site;
- occupancy times of different population groups at various types of locations; and
- conversion factor from absorbed dose rate in air to effective dose rate.

A detailed verification of the model calculations have been performed with measurement data of the absorbed dose rate in air and of individual doses obtained with the method of TL dosimetry. The results of the deterministic and the stochastic versions of the model satisfactorily agreed with observed data. The average dose in inhabitants of a rural settlement predicted by the model is within the range 0.69 to 1.55 of the measured values at a confidence level of 95*%.* This model has become a useful tool for the federal and regional authorities in the contaminated areas.

Another dose reconstruction concerned Population of the Techa River by ***Dr. Degteva*** and co-authors. The specific aim of this project was to develop the Techa River Dosimetry System (TRDS) for the reconstruction of external and internal radiation doses for approximately 30,000 individuals in the extended Techa River area. Individual doses were reconstructed on the basis of

- derivation of an historical source term and a simple river model to simulate the transport of radionuclides downstream and their retention on sediments;
- systematic measurements of gamma-exposure rate along the banks of the river and the typical life-style patterns of the inhabitants of the riverside villages; and
- an age-dependent strontium biokinetic model validated by measurements of Sr90 in bones, teeth and the whole body of the members of the cohort. The code of dosimetry system permits the calculation of organ specific age-dependent cumulative internal and external doses for each of the cohort members on the basis of individual history of residence on the contaminated Techa River.

The results show, that the doses vary in a wide range. The dose decreases with the distance to Mayak. In one place the difference between the maximum and the mean dose can be more than a factor of 20 for individuals. Dose assessments for member of the public are also done for present routine effluents. Some papers have been introduced which deal with the releases and the dose estimations in vicinity of the European reprocessing plants La Hague and Sellafield. The dose estimations are based on environmental measurements.

Within this frame ***Dr. Depres*** and Mansoux introduced The advantage and limitations of dose assessments to the member of the public based on environmental monitoring. Their paper presents the results of an methodological approach used to assess doses received by the public on the basis of

environmental measurements in the vicinity of the Marcoule reprocessing plant, with a particular emphasis on :

- the methodological difficulties raised by the assessment of the dose to the most exposed group of population (the reference group) due to plant discharges, when the environmental measurements are used ;
- the exhaustiveness of the impact evaluated according to this approach, by comparing the results obtained with the results of an assessment based on the modelling of environmental transfers ;
- the improvements required to perform more realistic public dose assessments.

Based on the environment data they calculated a dose of about 0,9mSv/a but the contribution from discharges of the plant of marcoule was only about between 0,05 and 0,02 mSv/a.

Two papers were presented which use released radionuclides as tracer for model verification. A radioactivity diffusion model in global ocean has been developing in order to assess the long-term behavior of radioactive materials discharged from nuclear facility. The model was verified by ***Dr. Nakano*** and co-authors by using the fallout data from atmospheric nuclear tests. Yearly and latitudinal fallout data was adopted from the UNSCEAR reports. The results were compared with the observation data that includes total amount and vertical profile of Cs137, Sr90 and Pu 239/240 in the North Pacific. As for horizontal distribution, the result of the verification agreed with the general knowledge qualitatively. As for vertical profile, Cs137 and Sr90 could be accurately calculated except the surface layer. On the other hand, the observation peak of Pu 239/240 existed deeper than the calculation peak. It suggested that adding the scavenging process to the diffusion model was necessary to calculate the element existed as particulate phase.

The reprocessing plant Thorp in Sellafield releases a significant amount of Kr85 during normal operation . This releases has been used by ***Dr. Parker*** and co-authors to verify long term dispersion factor. A series of Kr85 measurement in the vicinity of the plant, has been required to demonstrate that the dispersion behaviour of aerial discharges, from Sellafield, is adequately represented in their dose assessment models. These measurements were completed by detailed wind tunnel simulations and classical mathematical models.

These experiments demonstrated that the current aerial dispersion model , used for critical group dose prediction, is conservative for both short term and long term discharges. The current dose assessment model overestimates the beta component of critical group dose by approximately a factor of three. It is reasonable to conclude therefore that total dose (including gamma) is also overestimated. Variation of the Air Kerma Rate from Natural Radionuclides in the Ground Due to the Change of Source Configurations was investigated by ***Mr. Saito***. The kerma rate in air from natural radionuclides of U238 series, Th232 series, and K40 changes according to the source configurations in the environment.

In a variety of Monte Carlo simulations he indicated that the kerma rate from natural radionuclides is almost proportional to the solid angle subtended by the soil, but

the change in kerma rate due to source configuration is generally smaller than that expected from the solid angle. This is explained by the difference in absorption properties for photons between air and soil. Soil absorbs photons at a higher rate than air. Therefore, the increment of soil in the environment leads to the decrement in the scattered gamma-ray component in the kerma rate: the increment of air leads to the opposite tendency. As a result, the normalized kerma rate never exceeds two even ..... source geometry. One a river, the kerma rate decreases as the position gets close to the middle, but the decreasing tendency is much slower than the decrease of the solid angle for source since the contribution rate of scattered gamma-ray to the kerma rate increases largely.

The behavior and fate of particle bound radionuclides like Pu or radiocesium will be closely related to the movement of soil sediment. ***Borghuis*** and co-worker uses the GIS and remote sensing technique to detect changes of a river bed due to sedimentation and erosion. For these investigations they chose the Yenisey River. In the pilot study it became clear that the preparation of the raw satellite images is an important but time consuming process. The resolution and accuracy of the georeferenced images is satisfactory.

The first results show that the interpretation of images aided by the GIS enable the observation and presentation of processes in the Yenisey that are relevant from a radioecological point of view. However, a sound radioecological assessment is at the moment of writing not yet possible. The study lacks crucial field information and river hydrological data such as water discharge, water levels, and suspended sediment concentrations.

As French mines are progressively ceasing operation, COGEMA has developed an extensive remediation programme. The contribution by ***Daroussin*** and Benhard describes the kind of remediation and point out the success of this emphasis with respect to dose reduction. An extensive network of monitoring air water and food has been installed. The results of several years of monitoring show a direct influence of the cover on the tailings for stations located on site. The impact due to gamma exposure or radon is rapidly decreasing and the total impact to the public is limited.

Dr. Wirth asked the question How Can the Reliability of Radioecological Assessment Models Be Improved? He pointed out that a Radioecological models consist of three components - the model structure or number compartments, - the radioecological parameters, and the assumptions on the living habits of man and agricultural practices.

The degree of conservativity should be taken into account by the assumptions for the living habit and agricultural practices. Modelling is the endeavour to optimise the structure of radioecological models on the basis of the available knowledge on the behaviour of radionuclides in the environment. Therefore, modelling should be an integrating experimental and theoretical process. If possible, model calculations should be accompanied by measurements to verify model's results. Monitoring programmes and the design of radioecological models should be harmonised in a way that the results of measurements can serve as new input parameters, i.e. models should be flexible with respect to input parameters.