UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

EPA-SAB-RAC-COM-93-006

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Re: Quantitative Uncertainty Analysis for Radiological Assessments

Dear Ms. Browner:

During its history, the Radiation Advisory Committee (RAC) has on numerous occasions expressed its strongly held view that the EPA should incorporate uncertainty analysis as a routine part of its scientific work. Incorporating uncertainty analysis in its scientific work is a necessary element of the scientific support for policy actions undertaken by the EPA. The EPA has recently made a significant advance in adopting this practice through the analysis of uncertainties in its assessment of the risks of radon in drinking water. This joint effort was conducted by staff of the Office of Groundwater and Drinking Water, the Office of Radiation and Indoor Air, and the Office of Policy and Program Evaluation. This analysis was recently reviewed by the RAC and was the subject of a separate report to you (EPA-SAB-RAC-93-014). This letter is to provide a commentary on uncertainty analysis and urge its widespread use.

Quantitative uncertainty analysis should be an integral part of performing human health and ecological risk assessments for toxic chemicals, radionuclides, physical stressors, and biotic stressors. Uncertainties associated with both exposure and effects must be accounted for in risk asssessments and subsequent risk management decisions and communications. Approaches developed and used by the offices identified above in their analysis of quantitative uncertainties associated with radon risks have application to risk assessment activities in a variety of EPA program offices.

Quantitative uncertainty analysis is relatively straightforward when there is reasonable confidence that the data are of acceptable quality, when crucial relevant risk factors have not been omitted, and when there is a reasonably well-accepted body of literature on the parameter values that would be used to define the uncertainties. The tools needed to accomplish such analysis are readily available.

In other cases, uncertainty analysis is more difficult. That is the case when data are seriously deficient in quality, when they simply do not exist, or when important risks have not been studied. A formal uncertainty analysis must be preceded by an understanding of these factors. For instance, if source terms are of poor quality, and if the uncertainty in these estimates cannot be readily determined, then a quantitative uncertainty analysis that only takes the usual factors such as uncertainties in radiation risk per unit dose or in stochastic measures arising from instrumentation will, by itself, be inadequate to describe the uncertainties and must be complemented by further careful investigation and discussion.

An evaluation of the integrity of the data and the sources of information being used to make both central estimates and uncertainty bounds should be done as a part of the analysis. When there are unquantified risks (such as synergisms which can reasonably be expected but have not been studied), then these should be qualitatively discussed as a complement to the quantitative uncertainty analysis.

We highlight a few elements that we believe will aid the EPA to perform the quantitative aspects of uncertainty analysis.

Databases exist for many parameters needed for exposure assessments. The Agency should consider review of distributions of important parameters in criteria and guidance documents to determine if the information needed to perform formal uncertainty analyses for particular assessments is present. For example, the documents dealing with radionuclides in drinking water contain much of the information needed to perform formal uncertainty analyses for those assessments.

Bounds on parameter values and the specified shape of the distribution of plausible values are used in the analysis of uncertainty. Sensitivity analysis will reveal any important dependence upon the form of the distribution. The absence of data does not mean that uncertainty analysis cannot be performed. In the absence of data, quantitative estimates of parameter uncertainties can be obtained by consulting with an appropriately diverse group of experts. However, in some cases, the resulting analysis may be controversial externally, especially if the range of expert opinion is not wide enough.

Computer software is available for quantitative uncertainty analysis, both for mainframe and personal computers. As part of the development of probabalistic risk assessment for power reactors that began in the 1970s, Sandia National Laboratory has developed a software shell that permits implementation of uncertainty analysis for existing computer codes. An example of its use is the recent implementation of uncertainty analysis for a large radionuclide transport and dose assessment code (GENII).

Inexpensive uncertainty analysis software has been developed for either Macintosh or IBM-type computers. Many assessment models can be implemented in spreadsheet format. Quantitative uncertainty analyses are easily performed using products like Crystal Ball©, @Risk, or Demos. An Agency-generated capability for Monte Carlo analyses was described by A.J. Klee in "the MOUSE Manual (U.S. Environmental Protection Agency, Cincinnati, OH 1986). Of course, whenever using any piece of software, efforts should be undertaken to benchmark and verify the calculations to ensure that the software is not producing erroneous results. Efforts should also be made to ensure that the algorithms in the software are appropriate to the specific environmental problem at hand.

General guides to quantitative uncertainty analysis that are applicable to exposure, dose, and risk assessment are "Evaluation of the Reliability of Predictions Made Using Environmental Transfer Models" (IAEA Safety Series No. 100; International Atomic Energy Agency, Vienna, 1989) and "Uncertainty: A Guide for Dealing with Quantitative Risk and Policy Analysis" by Morgan and Henrion (1990).

The SAB strongly encourages the increased use of uncertainty analysis as exemplified by its recent use in analyzing the cancer risks of radon in drinking water. We strongly urge that the EPA incorporate the results of this anlaysis in its overall drinking water risk assessment. Additionally, we urge that such ues of uncertainty analysis be expanded across EPA programs. In approximately one year the Science Advisory Board would like to receive an update on how uncertainty analysis has been used by the Agency across its programs.

Sincerely,

Raymond C. Loehr, Chair
Executive Committee
Science Advisory Board

Genevieve M. Matanoski, Chair
Radiation Advisory Committee
Science Advisory Board

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