

## **The Benefits of Probabilistic Exposure Assessment: Three Case Studies Involving Contaminated Air, Water, and Soil<sup>1</sup>**

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Probabilistic risk assessments are enjoying increasing popularity as a tool to characterize the health hazards associated with exposure to chemicals in the environment. Because probabilistic analyses provide much more information to the risk manager than standard "point" risk estimates, this approach has generally been heralded as one which could significantly improve the conduct of health risk assessments. The primary obstacles to replacing point estimates with probabilistic techniques include a general lack of familiarity with the approach and a lack of regulatory policy and guidance. This paper discusses some of the advantages and disadvantages of the point estimate vs. probabilistic approach. Three case studies are presented which contrast and compare the results of each. The first addresses the risks associated with household exposure to volatile chemicals in tapwater. The second evaluates airborne dioxin emissions which can enter the food-chain. The third illustrates how to derive health-based cleanup levels for dioxin in soil. It is shown that, based on the results of Monte Carlo analyses of probability density functions (PDFs), the point estimate approach required by most regulatory agencies will nearly always overpredict the risk for the 95<sup>th</sup> percentile person by a factor of up to 5. When the assessment requires consideration of 10 or more exposure variables, the point estimate approach will often predict risks representative of the 99.9<sup>th</sup> percentile person rather than the 50<sup>th</sup> or 95<sup>th</sup> percentile person. This paper recommends a number of data distributions for various exposure variables that we believe are now sufficiently well understood to be used with confidence in most exposure assessments. A list of exposure variables that may require additional research before adequate data distributions can be developed are also discussed.

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**KEY WORDS:** Risk assessment; probabilistic analyses; air pollutant; water pollutant; contaminated soil