material, it must consider the risks from ingestion and inhalation of radioactivity as well as from external radiation. This paper will focus on the derivation and application of slope factors for estimating the age-averaged lifetime excess cancer incidence (including fatal and nonfatal radiogenic cancers) per unit intake or exposure to the radionuclides of concern from these three exposure pathways. This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

CONSIDERATION or JUSTIFICATION/Other

Morgan, M.G., and M. Henrion, 1990. Uncertainty. a Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis. Cambridge University Press, NY.

CONSIDERATION or JUSTIFICATION/Other

Wartenberg, D., and R. Simon. 1995. Comment: Integrating epidemiologic data into risk assessment. American Journal of Public Health. 85(4):491-493. April, 1995.

ECOLOGICAL/Commercial

ASCE. 1989. Proceedings of the 1989 Specialty Conference Austin, TX, USA CD- 1989 Jul 10-12. Publ by ASCE, New York, NY, USA. ASCE, Environmental Engineering Div, USA; Univ of Texas at Austin, Civil Engineering Dep, Austin, TX, USA; ASCE, Texas Sect, Austin, TX, USA; American Acad of Environmental Engineers, USA. Abstract- The volume contains 117 papers presented at the conference. The papers are grouped under general topics that include point-of-entry/point-of-use water treatment devices, activated sludge wastewater treatment, multi-media environmental risk assessment, effluent polishing, radon mitigation in new construction, hazardous waste site cleanup, treatment facility design and operation, sludge management, surface water quality assessment and modeling, mixed waste and low-level radioactive waste disposal.

ECOLOGICAL/Commercial

Paustenbach, D.J. Date: 1988. Title: The Risk Assessment of Environmental and Human Hazards. Corporate Author: . Pub: John Wiley and Sons Inc., New York, NY; 1600 pp. Abstract: A complete handbook for conducting risk assessments for environmental and occupational health hazards. This casebook, the first of its kind, presents 22 case studies, including many of the most important and thorough risk assessments ever conducted. It describes state-of-the-art approaches to assessing the low-dose response, estimating exposure, and evaluating the risks to birds and fish. It also serves as a how-to-text, as well as a reference for developing high-quality environmental and human health risk assessments. Diverse hazards are covered, such as waste sites; contaminated air, soil, and water; consumer products; and indoor air. All assessments are fully documented and referenced.

ECOLOGICAL/DOD

Tate, D.J.; Jones, M.; Schulz, T.; Guo, X.; Fordham, C.L.; Ober, R.; Swalko, M. Date: 1992. Title: Innovative Probabilistic Assessment of Ecological Risk on a Federal Facility. Corporate Author: Ebasco Environmental, Lakewood, CO; Terra Technologies, Golden, CO; U.S. Army, Commerce City, CO; U.S. Army, Aurora, CO. Pub: CONF-9204110; Proceedings of the 1992 Hazardous Materials Control Research Institute Federal Environmental Restoration Conference and Exhibition, Vienna, VA, April 15-17, 1992. Hazardous Materials Control Resources Institute, Greenbelt, MD, 472 pp.; (pp. 147-152) Abstract: This paper presents an overview of an innovative probabilistic approach to ecological risk assessment (ERA) as applied to the onsite area of Rocky Mountain Arsenal (RMA). This 27-square-mile site contains multiple trophic levels in both aquatic and terrestrial ecosystems and is being considered for National Wildlife Refuge status in Congress. Therefore, ecological considerations are of particular importance in the assessment of risk and development of remediation goals at this site. The ERA will provide information for establishment of cleanup goals protective of wildlife on RMA. This ERA approach uses a computerized food web model that is most applicable to bioaccumulative contaminants of concern (COCs). It is tailored to site-specific ecological concerns and builds on the 1989 U.S. Environmental Protection Agency guidance for ERAs. Literature data to develop probabilistic and fixed parameter values provide input to a model that uses Latin Hypercube Sambling to estimate terrestrial and aquatic biomagnification factor (BMF)

distributions. BMF distributions are then calibrated and validated with site-specific contaminant data. At RMA, almost 2000 biota samples representing numerous trophic levels in food webs for five sink species were the basis for calibration and validation of the model. When a BMF distribution is divided into a maximum allowable tissue concentration (developed from literature values), a distribution of probabilistic biota criterion (PBC) is generated. PBCs are then used to quantify risks to biota in the various trophic levels and food webs. Contaminant-specific PBCs are compared to the concentrations of each COC in soil and water to identify exceedances. Finally, exceedances are summed to identify areas where the additive risk for all COCs indicates potential ecological endangerment.

ECOLOGICAL/DOE

Cornaby, B.W.; Daniels, K.L.; Hadden, C.T.; Mitz, S.V.; Rogers, W.J.; Page, D.G. Date: 1992, March. Title: Ecological Risk Assessments and Remedial Investigations of Populations, Communities, and Ecosystems Along East Fork Poplar Creek, Oak Ridge, TN. Corporate Author: Science Applications International Corporation, Oak Ridge, TN; U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN. Pub: CONF-920851 (Vol. 1); Spectrum '92: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Boise, ID, August 23-27, 1992, Vol. 1, 848 pp.; (pp. 815-818) Abstract: Mercury and other contaminants released from the Oak Ridge Y-12 Plant have contaminated nearly 15 miles of the East Fork Poplar Creek (EFPC) system. The creek originates inside the Y-12 Plant boundary and receives runoff and process waters at a rate of approximately 5 million gallons per day. It runs through the city of Oak Ridge and empties into a tributary of the Clinch River, which is part of the Tennessee Valley system of lakes and rivers. Land uses and ecosystems along EFPC include small businesses, residential and agricultural areas, wetlands, forest plantations, and successional forest ecosystems. Contaminants released from the Y-12 plant are predominantly particulate-bound and have therefore accumulated in alluvial deposits downstream from the Y-12 Plant. Contamination is believed to be confined to the floodplain and stream channel. Contamination of the aquatic biota with mercury and polychlorinated biphenyls (PCBs) has been documented since the early 1980s. A remedial investigation assessed the nature and extent of contamination for 188 constituents, including radionuclides, metals, volatile and semivolatile organic compounds, pesticides, and PCBs in surface water, creek sediments, floodplain soils, and

groundwater. The horizontal and vertical distribution of contaminants was determined in soils and sediments at many locations along the creek. Mercury was found to be the major contaminant in all abiotic media. Soils and sediments in ecosystems near the Y-12 Plant have the highest concentrations of mercury (up to 2400 mg kg[E-1]), and contamination decreases with lateral distance from the stream. In 1991, biota were surveyed and/or sampled at one reference site and six locations along EFPC. These seven sites comprise the sampling locations for the ecological risk assessment. Ecological risk assessment is done in accordance with Comprehensive Environmental Response, Compensation and Liability Act regulatory guidance and is incorporated into the U.S. Environmental Protection Agency-approved activities of hazard identification, exposure assessment, effects assessment, and risk characterization. The approach also integrates the requirements for the Natural Resource Damage Assessment and the National Environmental Policy Act. The effects assessment emphasized effects observed in field samples and not merely laboratory dose-response data extrapolated to the field. A weight-of-evidence approach was used, consisting of several parts. There must be a reasonable dose-response relationship between contaminants and the observed effect, contaminants must be spatially and temporally associated with the effect, and the link between the contaminant and the effect must have consistency of association and must be biologically plausible. When these and related weight-of-evidence considerations are all present, and especially when they occur in field-observed sequences of response(s), then the likelihood of occurrence of an ecological effect is high. The weight-of-evidence approach used population patterns, community trophic relationships, and body-burden data for fish, benthos, crayfish, and periphyton in the aquatic system for small mammals, birds, earthworms, arthropods, and vegetation in the terrestrial system. Body-burden data for many metals, polycyclic aromatic hydrocarbons (PAHs), pesticides, and PCBs were obtained for indicator species in the aquatic and terrestrial food webs to measure and estimate exposures to the next trophic level. These data will be used during the feasibility study to help develop and evaluated remedial action levels and cleanup alternatives that are consistent with the protection of populations, communities, and ecosystems, including wetlands and riparian zones, thereby satisfying integrated compliance requirements.

ECOLOGICAL/DOE

Suter II, G.W.; Redfearn, A.; White, R.K.; Shaw, R.A. Date: 1992, July. Title: Approach and Strategy for Performing Ecological Risk Assessments for the Department of Energy Oak Ridge Field Office Environmental Restoration Program. Corporate Author: Oak Ridge National Laboratory, Oak Ridge, TN. Pub: ES/ER/TM-33; 24 pp. Abstract: This document is intended to supplement exiting U.S. Environmental Protection Agency (EPA) guidance for ecological risk assessment at hazardous waste sites by providing guidance that is more specific and more tailored to U.S. Department of Energy sites than the guidance available from the EPA. However, it is a conceptual strategy document and does not include specific guidance on data, assumptions, and models. That detailed guidance is under development and will be presented in subsequent documents. Ecological risk assessments are equal to human health risk assessments in regulatory importance and can use many of the same data and some of the same estimation methods. However, they also have peculiar data needs and methods. Ecological risk assessments begin with an initial scoping phase, termed hazard definition, that characterizes the sources, the potential environment, and the assessment endpoints. In the subsequent measurement and estimation phase, in which data are obtained concerning source of the endpoint biota to the contaminants and the effects of those exposures, assumptions and models are used to relate the data to the desired exposure and effects parameters. Finally, in an integration phase, termed risk characterization, the various exposure and effects estimates are combined to infer the existence, cause, magnitude, and extent of effects of contaminants on the ecological endpoints. This phase is much more complicated for ecological risk assessments than for human health assessments because more types of data are available. Ecological risk assessments estimate effects using laboratory toxicity test results, like human health assessments, but also use results of ambient toxicity tests and biological surveys.

ECOLOGICAL/EPA

Norton, S.B.; Rodier, D.J.; Gentile, J.H.; van der Schalie, W. Date: 1992, October. Title: EPA's Framework for Ecological Risk Assessment. Corporate Author: U.S. Environmental Protection Agency, Washington, DC. Pub: CONF-921029; Waste Management and Environmental Restoration, Proceedings of the Eighth Annual DOE Model Conference, Oak Ridge, TN, October 18-22, 1992, 228 pp.; (6 pp.) Abstract: The U.S. Environmental Protection Agency (EPA) has

an increasing interest in using ecological risk assessments as a basis for environmental decisions. This increased emphasis is illustrated by a recent report by the EPA Science Advisory Board. Among their recommendations, the board suggested that EPA (1) target its environmental protection efforts on the basis of opportunities for the greatest risk reduction; (2) attach as much importance to reducing ecological risk as it does to reducing human health risk; and (3) improve the data and analytical methodologies that support the assessment, comparison, and reduction of different environmental risks. This article summarizes the recently published EPA Framework for Ecological Risk Assessment (1992) that describes the basic elements of ecological risk assessment. In addition, the article discusses several of the scientific issues that have been highlighted through the development of the framework report.

EXAMPLE/Commercial

Bernard, H.; Bixler, B.; Lamont, D.; Masters, H.; Rollo, J.; Sanning, D.; Snyder, H.J., Jr.; Tusa, W.K. Date: 1982. Title: Abandoned Site Risk Assessment Modeling and Sensitivity Analysis. Corporate Author: TRC Environmental Consultants, East Hartford, CT. Pub: Management of Uncontrolled Hazardous Waste Sites, Proceedings of a Conference, Washington, DC, November 29-December 1, 1982; (pp. 396-398).

EXAMPLE/DOD

Bernhardt, D.E. Date: 1992. Title: Depleted Uranium Cleanup Criteria and Associated Risks. Corporate Author: Rogers and Associates Engineering Corporation, Salt Lake City, UT. Pub: CONF-920617; Proceedings of the 37th Annual Meeting of the Health Physics Society, Columbus, OH, June 21-25, 1992; (13 pp.) Abstract: Depleted uranium (DU), a by-product from uranium enrichment, is used extensively for armor-piercing munitions by the military and as a catalyst in industry, and has also been used in various Department of Energy activities. Manufacturing and testing of the DU munitions and use of DU catalysts have resulted in residual contamination at DU facilities. This paper focuses on criteria that have been applied related to private party actions, however it also has application to government actions. Private party cleanup projects have been performed by Rogers and Associates for DU contamination at manufacturing sites in Tennessee and California that were based on criteria accepted under Agreement State licenses. The criteria for these projects were based on site-specific radiological pathways assessments and on the Nuclear