CRESP UPDATE *Hanford*

THE CONSORTIUM FOR RISK EVALUATION WITH STAKEHOLDER PARTICIPATION IS FUNDED BY THE U.S. DEPARTMENT OF ENERGY TO PROVIDE RESEARCH AND DEVELOPMENT OF RISK-BASED DECISION-MAKING TOOLS FOR USE IN THE CLEAN-UP OF THE NATION'S NUCLEAR WEAPONS COMPLEX. SPRING 1998

This first issue features research and project highlights from each CRESP/UW Task Group. Contact Task Group Leaders for more information on these projects and others not highlighted here.

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Consortium for Risk Evaluation with Stakeholder Participation

HEALTH HAZARD IDENTIFICATION

Task Group Leader: Elaine Faustman, (206) 685-2269

Screening for Beryllium Sensitization at Hanford

Beryllium has been used by DOE since the 1950s. Human exposure to beryllium can result in chronic beryllium disease (CBD), an immune system-mediated ailment. Although OSHA has set exposure standards, CBD cases have been documented at exposures below the current OSHA eight hour, time-weighted, average of two milligrams per cubic meter. Currently, medical monitoring relies on an assessment of beryllium sensitization based on the lymphocyte proliferation test (LPT), which is used to assess the growth of white blood cells involved in the immune response to beryllium exposure.

CRESP researchers have investigated factors that could heighten sensitivity by influencing the response of peripheral blood lymphocytes to beryllium. Our goal is to improve the sensitivity and specificity of the LPT. We have developed an alternative testing method, based on flow cytometry, that allows the evaluation of cell cycle changes during as many as three successive cell division cycles and can provide cellular and molecular clues to the mechanisms underlying beryllium sensitization. The versatility of this method should advance understanding of the causes of CBD, refine clinical assays for identifying beryllium-affected workers at DOE, and improve the assessment of industrial hygiene and disease prevention programs.

REMEDIATION TECHNOLOGY

Task Group Leader: David Stensel, (206) 543-9358

New CT Treatment May Be 25% Less Costly

Carbon tetrachloride (CT), considered a toxic and carcinogenic compound, has been found in many DOE and Department of Defense (DOD) hazardous waste sites. A common site remediation method is to remove CT from the vadose zone (the area beneath the ground's surface but above the water table) by soil vapor extraction (SVE) and treat the SVE gases by granular activated carbon adsorption. CRESP researchers have developed an alternative biological treatment process using a gas contactor and a bioregeneration reactor. The SVE gas is sparged through fine bubble diffusers and the CT is transferred from the gas to a suspension of powdered activated carbon (PAC). Next, liquid, biomass, and PAC is continuously recycled to a bioregeneration reactor, where the CT is degraded under anaerobic conditions. An organic substrate is fed to the anaerobic reactor to support the growth of CT-degrading culture.

CRESP researchers studied CT degrading culture grown with acetate dextrose and propylene glycol and found that the propylene glycol culture had the highest CT degradation rate and was also the most cost-effective substrate. Researchers created a design model and used it to develop an optimal economic design, which was found to be 25% less costly than activated carbon treatment with off-site carbon regeneration.

Ecological Health

Task Group Leader: James Karr, (206) 685-4784

Adapting the Index of Biological Integrity
Many states and federal agencies have adopted multimetric biological indexes to describe and evaluate the biological condition of a place. Our work involves the adaptation of the Index of Biological Integrity (IBI), which was first developed for fish and aquatic invertebrates, to terrestrial systems by examining plants and insects at the Hanford site. Few studies have attempted to examine assemblages of terrestrial species across a range of physical, chemical and biological disturbances. Our study examined the responses of terrestrial plants and insects at Hanford to anthropogenic disturbance at 13 and 19 sites in the springs of 1997 and 1998, respectively. The patterns of biological change observed among the sites provide leads for identifying reliable metrics for use in a terrestrial IBI for Hanford. By choosing attributes that provide clear signals of the effects of human actions (dose-response curves), we can detect and understand the biological effects of diverse human actions.

Can Science and Risk Analysis Eclipse Legacies?
Protecting ecological health requires a comprehensive and accurate way to assess ecological condition plus a deeper understanding of ecological risk. CRESP is committed to advancing these areas, but advances in science and risk analysis will not be enough. Success depends on our ability to overcome legacies that trap us in the past, such as our disciplinary boxes, our institutions, and our political processes. When these legacies control decision making, scientific advances and risk analysis become secondary. Albert Einstein recognized this problem when he said, "Serious problems cannot be dealt with at the level of thinking that created them." How can we best present our analyses to counteract the power of the past? This project explores the dimensions of those legacies and the extent to which they inhibit effective risk assessment and the implementation of management programs defined by risk assessment to reduce ecological and other risks.

Social, Land Use, Demographic, Geographic and Economic

Task Group Leader: Tom Leschine, (206) 543-0117

Several projects from this task group are relevant to the Tank Waste Remediation System (TWRS) at the Hanford Site. **Tank Waste at Hanford: Status Report and Identification of Issues** describes key technical, regulatory, and institutional issues related to the management of high-level radioactive wastes at Hanford. Identification of these issues provides a background for other task group projects. This project is nearly complete.

Many uncertainties remain in the expected performance of technologies critical to tank waste disposition at Hanford, and *c*ritical technology choices have yet to be made. **The Role of Technology Development in Hanford High Level Waste Clean-Up** proposes to use standard policy analytic methods, built around the technology assessment literature, to examine key technology development issues together with an assessment of DOE's decision making approaches. Retrospective case studies will be conducted to identify "lessons learned" that can be applied to current activities.

Three projects are relevant to stakeholder participation in DOE clean up efforts: **Citizen Involvement in the Cleanup of Hanford: Explaining the Success of Advisory Board Activities; Understanding How Consideration of Risk Contributes to Consensus on Cleanup Decisions at DOE Sites;** and **What's Fair in Peace and War?**, a survey of citizen attitudes toward fairness at Cold War weapons facilities.

Modeling and Land-Use Issues for Hanford Future Development Scenarios is relevant to demographic and economic topics. This project examines potential changes in components of regional economies around the Hanford site and proposes to compare standard econometric models in their predicted outcomes for the region.

The Value of Information
Dr. Elaine Faustman, CRESP
Management Board

One of the most frustrating aspects of being a scientist or engineer working in the field of environmental remediation is the apparent lack of use of new scientific and technological advances in the remediation and risk management process. In fact, a continual disconnect exists between the state of the science approaches and the current situation where application of outdated, inefficient and in some cases misleading or inappropriate techniques and approaches persist.

Why do these disconnects exist? It is the purpose of this brief article to highlight several of these reasons and to provide some examples of techniques that assist the scientist and risk managers to bridge this gap.

In 1983, the Natural Academy of Science published a framework for identifying and characterizing risks to emphasize risk assessment as the scientific association between exposure and an adverse health effect (the "Red Book," [NRC, 1983]). Risk *management* was defined as a distinct process that developed public policies to address the hazards identified and characterized by the risk assessment process. This conceptual separation of science and policy is one of the contributors to the dichotomy between science and its application in risk management.

In 1994, a subsequent National Academy of Sciences report entitled *Science and Judgment in Risk Assessment* highlighted the problems of getting good, current science into risk assessment. Because of these disconnects, scientific research progressed without a strong incentive to address critical data needs or key areas of uncertainty that "drive" either the qualitative or quantitative risk assessment process. Without improving such decisions, many research dollars, time, and resources were spent with minimal impact on improving the risk assessment process. Upper bound estimates of risk did not challenge the scientists to revise the scientific basis for risk assessment, and mechanistic studies challenging the risk assessment defaults were ignored as the risk assessment framework as originally applied did not readily demonstrate how such new information would be used. Subsequent reports by the NAS (*Understanding Risk*, 1996) and the President's Risk Commission Report have called for alternative approaches where the context for risk assessment is defined and all current science is used in an iterative process to develop improved risk assessments as an integrated part of risk management.

It is in this context that we would like to encourage the expanded use of newly developed *value of information* (VOI) approaches. Value of Information are approaches that build on decision analysis methods where the "value" of scientific information is determined in the context of "policy" decisions. Such techniques have been available in economic analysis, engineering analysis and clinical management; however its application in risk assessment has lagged.

Numerous methods for valuing potential outcomes can be used and can include: economic impact; health impacts such as increased number of lives saved or improvement in quality of life, potential days of illness prevented, earlier detection of preventable disease; mixed impacts such as lives saved per unit of money spent; and decision impacts such as magnitude of change in risk estimates (e.g., ten-fold decrease in predicted cancer risks, or change in exposure estimates, e.g., decrease in populations at risk of disease).

These approaches are often used in combination with scientific models to predict the impact of collecting new data in order to inform decisions about the type and amount of data to collect. When the risks are well characterized, VOI calculations are accomplished by calculating the risks expected for a risk management program based on new information and comparing the new risks to the old risks. Some of the decrease in risk is converted to a financial value so that it can be compared with the cost of collecting the new information and implementing the new risk management program. When risks are poorly characterized, which is more often the case, uncertainty distributions are used to represent risk, and the new information is evaluated by its ability to decrease the width of the distribution, which reflects decreasing uncertainty about the true risk. Bayesian techniques are one type of statistical approach available for conducting this latter type of analysis. Bayesian approaches offer a structured approach for immediately incorporating new data into existing risk models.

Numerous CRESP investigators are using value of information approaches whether formally or informally. We encourage the interested reader to see examples of the use of these techniques to evaluate economic impacts at USDOE sites (Greenberg et al), site exposure estimates (Burger et al and Sanga et al), environmental monitoring and remediation strategies (Massman et al and Stensel et al), biomarker effectiveness (Bartell et al), and assessment of carcinogenicity (Omenn et al and Lee et al).

Decision analytic approaches such as multiattribute utility functions have had a tortured history in DOE. Many examples of this history are illustrated in *Ranking Hazardous Waste Sites*, (NRC, 1994); Tenni et al 1995. Key problems with these techniques include single point estimates as outputs, lack of stakeholder input when valuation of social parameters is determined, and lack of transparency of assumptions and uncertainties. Note that may of these same issues are shared with conventional risk assessment practices.

Worker Safety and Health

Task Group Leader: Scott Barnhart, (206) 731-3388

Structure and Function of Occupational Health Services at Ten DOE Sites

This study evaluates and compares the structure and function of occupational health and safety services (OH&S) at selected DOE facilities including 1) the primary hazards and risks associated with site activities; 2) OH&S structure, including service providers and programs in place; and 3) OH&S service delivery functions. This study uses written surveys and telephone interviews. The survey provided a broad overview of hazards, service providers, programs, and some policies. The interviews will provide a detailed description of programs in terms of structure, function, and financing. This analysis will assist USDOE as it examines how the health and safety systems for the ten largest sites respond to worker health and safety requirements, such as the recent guidance on beryllium standards.

Key findings include: 1) Remediation and cleanup activities at these facilities are accompanied by an enormous potential for occupational exposure to an array of hazards; 2) While radiation and explosives were identified as the most dangerous hazards, physical hazards were described as the most common; 3) There is an urgent need to ensure that workers are protected; 4) Direct health service providers (physicians, nurses and IHs) make up a small proportion of all identified health and safety personnel; 5) An occupational health and safety infrastructure is in place, but the effectiveness of this structure has not been adequately evaluated. Recommendations will be based on these findings.

CBD Prevalence at Hanford

Beryllium is known to cause an acute pneumonitis as a result of high exposure concentrations as well as a chronic immunologically-mediated granulomatous

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Exposure Assessment

Task Group Leader: John Kissel, (206) 543-5111

Assessment Of Dermal Exposure To Soils

Protocols used in the U.S. to assess human exposure to chemicals in soils at contaminated sites usually include a dermal pathway. Use of default exposure factors found in U.S. Environmental Protection Agency (USEPA) guidance can lead to dermal route risk projections that appear to warrant remedial action. Because those default parameters are typically highly uncertain, risk estimates based on them inspire little confidence. Allocation of clean-up resources on the basis of such estimates is problematical. However, failure to use the results of a risk assessment opens the process to criticism that the assessment is merely a means for post hoc rationalization of preordained conclusions. Better estimates of soil/dermal pathway risk are therefore needed to fully integrate the risk assessment paradigm into the site remediation decision process. Toward that goal, a series of efforts funded by USEPA and the USDOE have been conducted at the University of Washington to improve the empirical grounding of relevant exposure factors. These efforts include field measurement of dermal soil loadings resulting from a variety of activities, phone surveys of behavioral patterns likely to lead to or prolong soil contact, pilot studies of soil contact using soil amended with a fluorescent marker, and laboratory studies of the effect of soil properties on adherence.

Results from those studies are currently being integrated to produce a distribution of estimated dermal exposures to soil in residential settings. A residential scenario was selected on the basis of availability of information and pertinence to clean-up decisions.

Evaluation Of The Predictive Capability Of Models Of Exposure To Soil Contaminants

Clean-up decisions regarding contaminated

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Outreach and Communication

Task Group Leader: Deirdre Grace, (206) 616-7378

The Hanford Openness Workshops (HOW) are a collaborative effort among DOE's Richland Operations Office (DOE-RL), the Washington State Department of Ecology, and regional Tribal and citizen representatives. CRESP Outreach and Communication convenes and facilitates the workshops, provides technical consultation, and prepares fact sheets and reports. The HOW's mission is to resolve issues impeding the availability of any information important to public understanding and decision-making at the Hanford site, while protecting national security or privacy information. The HOW represent the first such forum at a DOE site. Four workshops were conducted from October '97–May '98. A report will be presented to DOE-RL in late 1998.

The Risk Roundtable: Evaluating Risk from a Tribal Perspective was held January 1998 in Pendleton, Oregon to discuss how American Indian tribes can use tribally appropriate risk tools and methods. Twenty-three tribes and tribal organizations were represented, along with 14 federal and state agency representatives. The Confederated Tribes of the Umatilla Indian Reservation hosted and co-sponsored the event. CRESP was the other co-sponsor, with a diverse group of program supporters. A forthcoming report will outline the major discussion points and lessons learned from the Roundtable. It will be available from the Roundtable web site, <http://cresp.sphcm.washington.edu/roundtable/>.

Improving the Quality of Health Risk Information in the DOE-EM Budget Process

Indepedent reviews have indicated problems in the quality of health risk data generated in the DOE planning and management process. This study, conducted with the Worker Safety and Health Task Group, explores the feasibility of integrating two management systems used at Hanford to improve the quality and transparency of the data.

Data Characterization, Analysis and Statistics

Task Group Leader: Gerald van Belle, (206) 543-6991

Strontium-90 Radiation Standards for Environmental Cleanup

The health effects of soluble Sr-90, although not studied in human populations, are inferred to be bone cancers and leukemia, based on studies of other types of radiation exposures. The current evidence on bone cancer suggests that the standard should be changed. The scientific evidence for leukemia suggests the standards do not need to be modified for this effect–the leukemia risks extrapolated using a linear-quadratic doseresponse from studies of the atomic bomb survivors are appropriate. The standard for Sr-90 would increase by 56% based on this change.

Developing a Theoretical Framework for Collaborative Risk Evaluation Using Geographic Information Systems

This project focuses on synthesizing several theoretical frameworks related to collaborative risk evaluation into a single, more complete approach. The frameworks considered include those for risk characterization, analytic deliberative process, use of GIS for collaborative decision making, a normative model for public participation, and post-normal science. An integrated framework is being developed based on CRESP's *Improving DOE/EM Risk Information: Content and Format.*

This work is a component of the stakeholder-driven Risk Information Project (RIP) led by Dr. John A. Moore. Phases 1 and 2 of RIP examine how risk is used in DOE/EM decisions and provide a cross-case analysis of risk information understanding and use at DOE. Phase 3 provides an opportunity to design and conduct empirical research–i.e., where actors are behaving in context. Many stakeholders are calling for participation in environmental remediation decisions. However, little advice is offered to decision makers for managing complicated risk information in a participatory decision setting.

(Worker S&H, continued from page 4)

lung disorder at lower exposures in susceptible individuals. Workers at Hanford have been exposed to unknown concentrations of beryllium as a result of fuel fabrication, research and clean up processes. Future remediation workers will also be exposed and DOE has now mandated a beryllium worker protection program (BWPP), including medical surveillance of these workers and minimization of exposure.

The purpose of this pilot study is to investigate the prevalence of beryllium sensitization and chronic beryllium disease (CBD) in an effort to determine the extent of exposure at Hanford and to support appropriate medical surveillance programs for former workers and future remediation workers at the site. The target population includes all individuals who worked in buildings where beryllium was known or suspected to have been used. Questionnaires have been used to elicit occupational and medical histories. Blood samples were collected for lymphocyte transformation and proliferation testing (LPT) by two different methods. The prevalence of beryllium sensitivity to date is low (one out of 60). Sensitized individuals are referred for follow-up. The prevalence of CBD will also be calculated along with the relative contribution of the LPT, chest x-ray, and other clinical data used to establish the diagnosis.

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soils are typically based on rudimentary exposure assessments. In the U.S., these have historically employed simple deterministic models of potential pathways. Concern over the cost of clean-ups has fostered criticism of regulatory models as excessively cautious. In particular, inclusion of high-end estimates of multiple exposure factors may lead to compounded conservatism. The primary remedy for this problem involves use of distributed parameters and characterization of uncertainty and variability in expected exposures. While stochastic description of exposure factors is intellectually much more appealing than traditional deterministic methods, implementation is hindered by the same lack of information that led to the use of conservative point estimates in the past. Validation of probabilistic models is therefore appropriate, but has seldom been attempted.

Our approach is to develop case studies for which sufficient environmental and biomonitoring data exist to permit evaluation of regulatory model perfomance. Findings from the cases reflect the inherent difficulty of predicting exposures that are heavily dependent upon human behavior. Caution is warranted in assuming that distributions of exposure factors that are applicable across temporal, geographical, and social boundaries can be obtained.

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address correction requested

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Research and project updates from each CRESP/ UW Task Group.