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To: The CRESP Management Board

From: John F. Ahearne, Melvin W. Carter, Charles Fairhurst, Milton Russell, and Arthur C. Upton, members of the CRESP Peer Review Committee

Subject: Research Needs on Issues Relating to Stewardship

This is in response to your request for an independent evaluation of the most important questions that CRESP should address in its research to assist the Department of Energy (DOE) in developing and implementing plans for the long-term stewardship of contaminated sites in the nuclear weapons complex. Pursuant to your request, we have listed below the relevant research needs that we judge to be the most important and most appropriate for CRESP scientists to address in their research.

As you will note, the research needs that are identified below fall into two broad categories: those which are concerned primarily with the technical assessment and control of risks to human health and the environment at contaminated sites, and those which are concerned with the associated institutional, socio-economic, and political ramifications. We have made no attempt to rank the research needs in order of their relative importance.

1. Risk Assessment. The capacity for an independent, objective, transparent, and scientifically sound assessment of the risks to human health and the environment that may exist at a given site, now and in the future, is critical to the success of DOE's stewardship efforts. It is important, therefore, that the methodology for such assessments be developed more adequately and its applicability validated at a minimum of two major sites. To do so will require the coordinated efforts of scientists of many disciplines, systematically addressing unresolved issues in each of the various elements of the risk assessment paradigm; i.e.,

a. hazard identification: i.e., identification and location of the hazardous (and potentially hazardous) physical and chemical agents that are present in each area of a given site, determination of the quantities (including concentrations) of each agent, and determination of how the concentration may vary in space and time under the influence of natural processes (physical decay, hydrological dispersion, microbiological degradation, etc.) and man-made actions (containment, failure of containment, breach of containment, removal of contaminants, etc.);

b. dose response evaluation: i.e., evaluation of the types of effects in human and ecological receptors that may result from exposure to one or more of the

hazardous agents at a given site, taking into account the levels of exposure that may occur, the susceptibilities of the receptors that may be exposed (based on species, age, sex, physiological state, and other variables), and the relevant dose-effect relationships for each of the agents or combination of agents in question;

c. exposure assessment: i.e., analysis of the extent to which sensitive targets in human or ecological receptors may be exposed to one or more of the agents at a given site, now or in the future, taking into account the concentration of the agent(s) in situ, the environmental transport of the agent(s), the relevant behavioral, physiological, and pharmacokinetic pathways, and other pertinent variables;

d. risk characterization: i.e., calculation of the probability and consequences of harm to individual human or ecological receptors as a result of exposure to any of the hazardous agents at a given site; calculation of the numbers of such receptors that may be affected; and calculation of the associated socio-economic, ecological, and cultural impacts. Because of the long-term nature of stewardship and hence of the effect of decisions taken for the purpose, it is critical that the risk characterization include bounding estimates of these factors at generational intervals (e.g., 30-year intervals) into the future. At some sites, for example, the hazard will gradually diminish, while the probability of containment failure may increase.

e. comparative risk; i.e., the magnitude of the risk from contaminants at a given site needs to be measured in relation to the magnitudes of risks posed by other socio-industrial hazards, in order to place the risk in proper perspective.

To enable management decisions to be adequately informed in years to come, given the advances in science and technology that can be envisioned, the need for ongoing assessment of the potential impacts on workers, other human populations, and ecological receptors from contaminants that are present at, or being transported from, a given site may be expected to continue indefinitely into the future.

2. Containment. The adequacy of isolation and containment measures for preventing undue exposure of human and environmental receptors to harmful agents at DOE sites needs to be evaluated and established, along with the methodology for assuring stakeholders and regulators that the necessary remedial actions will be (and are) taken in the event of any containment failures.

3. High-Level Nuclear Waste. Acceptable processes for the long-term management of high-level nuclear waste remain to be fully developed. The remaining issues need to be resolved and the adequacy of the resulting management processes demonstrated.

4. Transportation. Activities involved in the management of hazardous wastes, decontamination of sites, and decommissioning of facilities will generate increased requirements for the development and validation of systems that can be used safely for transportation of the hazardous materials in question.

5. Accidents. In the course of time, the aforementioned activities will inevitably involve incidents and accidents that occur in the public domain. Hence there is a need to develop appropriate resources for coping with such events, including trained personnel and programs to protect potentially affected populations.

6. Cost-Effectiveness of Management Actions. Isolation, containment, and remedial measures need to be evaluated for their cost-benefit relationships, in order to enable the corresponding waste management decisions to be adequately informed.

7. Institutional Stability and Capability. In order to maintain the desired levels of containment and to deal adequately with any failures of containment that may occur at a given site in the future, appropriate control, surveillance, and remediation capabilities must be developed and maintained, which, in turn, will require the development and assurance of the institutional stability, capability, political will, and financial ability to perform the desired functions. To this end, CRESP could play a useful role in:

a. "working through" with stakeholders and regulators relevant institutional and financial approaches, with the goal of determining which, if any, would provide acceptable levels of assurance; some such potential approaches have been identified by others (e.g., Bauer, C. and Probst, K.N., "Long-Term Stewardship of Contaminated Sites", Resources for the Future, Washington, D.C., 2000);

b. evaluating each such approach to determine its limitations and whether it would require regulatory action;

c. determining what administrative, legal, and/or regulatory actions would be required to implement such approaches, and helping to provide a path forward that could be used in pursuing them.

7. Cleanup Standards. A national standard for end-states needs to be developed, which would define the levels of cleanup and/or containment for which the federal government could be held responsible at any particular site. Given the establishment of such a standard, the justification (and funding) for any tighter standard that might be desired by a local group would be the responsibility of that group's state or local government.

8. Stakeholder Involvement. A method is needed for providing assurance to concerned citizens that their well-being will be adequately protected with respect to stewardship sites. One promising method of doing so is to involve stakeholders in the monitoring and assessment activities of stewardship in ways that enable them to be confident over the

long term that their health and environment are being adequately protected. To this end, CRESP could work effectively with stakeholders and regulators to:

a. assist DOE in developing local community "agents" who could assume responsibility for the oversight and, if necessary, further action on closed sites and/or sites where stewardship was in progress;

b. develop a model action plan for such "agents" to assist them in fulfilling their responsibilities;

c. explore methods for selecting and organizing such "agents" for the desired purpose, with the goal of providing effective representation to all groups (including those representing the collective national interest) in the decision making; and

d. determine what statutory changes, if any, would be required to transfer authority, funding, and responsibility to such "agents" from DOE.

9.Stewardship Time Horizon. There is a need to develop site-specific measures of how the stewardship task that is required at a given site will vary as a function of the time profile of the potential risks from contaminants that are left in place at the site, taking into account the various processes that will gradually reduce the potential for exposure to such agents (e.g., radioactive decay, chemical degradation, dilution, adsorption, immobilization, etc.). There is also a need to develop location-specific time profiles for the likelihood of containment failure and migration of contaminants to points where exposure could occur. At a large site, moreover, the "footprint" over time in the level of restriction that is called for will vary for different areas of the site.

Such measures will be essential for determining the requirements for successful stewardship over time and for defining the challenges to be faced by the institutions that will be responsible for protecting human health and safety and for maintaining ecological security. Such challenges have been overestimated in some cases because of failure to take the time-dependent changes into account and to recognize that long-term restrictions are likely to be required on relatively few sites, most of which are permanent repositories. Conversely, however, inadequate consideration has been given in many instances to the potential for containment failure and for land use changes in future years.

10. Perceived Risks and Consequences of Containment Failures. The methods for assessing the probability and potential consequences of containment failures and for sharing such information adequately with stakeholders need to be improved if society is to make sound decisions on the use of disposal on site rather than contaminant removal or destruction. To this end, CRESP could play a valuable role in exploring such questions as the following:

a. How do stakeholders and regulators currently perceive the risks and potential consequences of containment failures?

b. What are the factors and values that have shaped such views?

c. What evidence or process, if any, would lead stakeholders and/or regulators to correct any misperceptions they may have?

d. By what methods can such evidence best be gathered and presented to stakeholders and regulators?

11. Acceptability of the Stewardship Option. There is a need to develop cost-benefit measures for estimating or benchmarking the contribution to the national well-being that could be obtained by leaving contaminants in place and instituting stewardship at a given site, as opposed to other options, such as cleanup, removal of contaminants, or greater reliance on engineered containment. The measures to be considered include, for example, the avoided cost of removal or further containment of waste, and the value to the community (and/or tax base) of the land and facilities that may be at stake. Through its involvement with stakeholders, CRESP could contribute significantly to the process by helping to evaluate:

a. the information gaps that limit the acceptability of the stewardship option to affected communities, and the research that is needed to fill such gaps;

b. the kinds of information that will be required in the future to allow mid-course corrections when stewardship procedures fail or when changes in land values or other determining values require changes in the ways contaminants are handled;

c. the processes by which society can be adequately assured that the information needed for successful stewardship will available over a sufficiently long term period, which extends indefinitely into the future for contaminants at some sites; and

d. the methods by which an affected community can best be assured of the fairness, utility, effectiveness, and acceptability of the stewardship option, which includes, but is not limited to, compensation of the community for the services it supplies to, and the costs it absorbs for, the nation by retaining the wastes in its locality.

The research needs listed above comprise those which we consider to be most important and most appropriate for CRESP scientists to address. We respectfully submit them to you herewith, in the hope that you will find them to be useful and that you will not hesitate to call on us if we or other members of the CRESP Peer Review Committee can do anything further to be of help to you.

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