DEPARTMENT OF ENERGY INITIATIVES TO MEET THE WASTE MANAGEMENT CHALLENGES OF THE 1990s

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ABSTRACT

This paper discusses the approach the Department of Energy (DOE) proposes to take as it redefines and accelerates its environmental cleanup and waste management activities. The Department's response to meeting its environmental responsibilities is intended to have a long-term positive impact on this country's approach to waste management.

INTRODUCTION

The simple fact is that waste management is bottom-line economics, bottom-line health protection, and the "eye of the needle" for a future nuclear option in this country. In the past, waste management was thought of simply as a service -- somebody generates waste and somebody else takes it away. Economics was never a consideration. Today the question is, "What is this waste? How many times do we have to handle it? How can we stop its generation in the first place?" That is significant to the evolution of waste management.

Currently, health and safety safeguards are often "patchworked" because they have been added, one layer at a time, to an already existing system. In some cases, DOE generates wastes for which an approved treatment or disposal method has yet to be established. DOE and its contractors are having to deal with these issues amid the growing concern of criminal enforcement of this country's environmental laws.

DOE has responded to increased and justified public scrutiny by lifting the "veil of secrecy" and opening its defense facilities to State regulators. The Department is underwriting a significant portion of the costs associated with State monitoring of DOE's environmental compliance. The Department has involved the public and others long-considered adversarial to DOE's weapons production mission in the development of near-term plans for environmental cleanup, compliance, and waste management. This long-overdue change is welcome, and is viewed as a key element to regaining public confidence in the Department's ability to operate these nuclear facilities safely.

PUBLIC PERCEPTIONS OF RISK

Another management challenge DOE faces deals with public perceptions. It is amazing the people cannot come to grips with the concept of risk.

Radioactive material is of higher concern to the public than hazardous wastes. Why, when 275 million tons of hazardous waste is generated each year in this country, is radioactive waste of such concern? The unasked question is "Do the benefits that we derive from the industries that process and utilize these materials, or that create them as a byproduct, exceed the risks associated with their existence?"

The true nature of these substances should be placed into proper context so that the American people can make risk-based judgments.

Products like chlorine, acids, propane, and gasoline are far more accessible to the general public than nuclear waste and pose a far greater risk in our daily lives than nuclear material.

Why has the scientific community allowed this myth to continue to the point where it elicits such a visceral negative reaction? Where did the nuclear and scientific communities go wrong?

In 1985, 1.7 million people were evacuated from the path of Hurricane Elena--the largest peacetime mobilization ever. As a result of last year's earthquake in California, 12,000 were displaced. Hurricane Hugo has resulted in over 255,000 people applying to the Federal Government for disaster relief. A gas pipeline explosion earlier this year in the Soviet Union killed almost 650 people when a passing train ignited leaking gas.

Compare these statistics to the nuclear industry. Zero for evacuation as a result of a transportation-related incident involving radioactive material. In 1979, Pennsylvania Governor Thornburgh recommended the precautionary

evacuation of pregnant women and preschool-aged children from a 5-mile radius of Three Mile Island. Others joined this group and left the immediate area. Yet, the public still resists nuclear technology.

The public perceives that there is no apparent solution to the broad spectrum of wastes that are being generated, and that's affecting their ability to support nuclear technology. Every article that is printed today on the Department's struggle to characterize Yucca Mountain -- note- just to characterize, not to ship or store radioactive waste -- will invariably highlight the fact that it will take hundreds of thousands of years for these wastes to decay safely. At the same time, the public thinks nothing of industrial pollutants and contaminants like lead, arsenic, and mercury -- contaminants that don't have a half-life and remain hazardous to humans forever -- which are often found in surface impoundments or below-grade disposal. There is no "equity of concern" in areas that pose as great or a greater threat to public health than nuclear wastes. Where is the credibility of science? Where is the credibility of industry and why is it that this message has not gotten across to the public?

DOE has worked hard since Admiral Watkins' confirmation to develop plans that demonstrate the commitment to managing nuclear wastes and restoring the environment. These plans include the research needed to develop and demonstrate new technology and to fix these problems permanently, not postpone them further for future generations. The nuclear community needs credibility; it needs a national ombudsman to deal impartially with controversial issues. The Department does not envision a single person who would serve as this country's nuclear ombudsman; rather, there will be a body of respected individuals from government, academia, the law, medicine, scientific organizations, and industry who could testify before Congress, give the public both sides of an issue, and represent the scientific consensus of the Nation. YOU ARE THESE PEOPLE!

Scientists, engineers and policy makers are just beginning to better understand the economic and environmental effects of fossil fuel combustion -- particularly in the East and in its effect on our Canadian neighbors -- yet there are those who still continue to perpetuate the misconception that this country is unable to treat, transport, and dispose of hazardous and radioactive wastes. The absence of credibility and a perceived absence of a sound final solution to waste disposal adversely affects public confidence in DOE's ability to operate its nuclear facilities safely.

MOVING INTO THE 1990's

The public must be put on notice that this is changing. The "science" of environmental restoration is evolving. The public must be a participant in guiding this evolution. The Department believes that the key challenge lies in the ability to successfully restore the environment and deal with these wastes in a manner that the public can *understand* and *accept*. This is fundamental to the nuclear industry and to science in general.

The evolution and future of the Department's waste management program is best characterized in its two Five-Year Plans. Last March, the Secretary promised Congress that he would deliver a comprehensive plan that outlines specific actions DOE intends to undertake over the next 5 years to achieve compliance with this Nation's environmental laws and to begin to clean up and restore those sites that we have contaminated over the past 40 years. This was a nearly impossible schedule for such an important document, but the Secretary recognized the need to immediately take charge of the Department's problems.

Published last August, the Department's *Environmental Restoration and Waste Management Five-Year Plan* contains the framework for DOE to characterize, prioritize, and consolidate cleanup activities at every site. Immediate problems will be confined and corrected. The priorities of a 30-year cleanup effort will be based on credible science and technology and, hopefully, on new national standards that finally resolve the dilemma facing the Country today regarding "How clean is clean?" The Department is already hard at work with States and EPA. This process will help to re-establish DOE's credibility with Congress, the American public, and regulatory bodies at both the Federal and state levels.

Last November, DOE issued a separate chapter to the Five-Year Plan, the "Applied Research, Development Demonstration, Testing and Evaluation Plan". The R&D Plan is a real attempt to get results from research and technology demonstrations within a timetable that is driven by a "hard" assessment of *need* and *risk*. The term "needs-driven" means that the basic need is to solve a problem, not relocate it. Decisions will be made on the basis of performance and return on the dollar spent, even for basic research decisions in the molecular sciences to enable us to address waste problems *in-situ*. The Department will build a methodology that applies tough cost/benefit criteria to all waste-related R&D. The Department will use industry and peer academic input to determine what's really useful and achievable, time won't be wasted on evaluating competing proposals that have limited value. In parallel with in-situ waste treatment, the Depaartment will pursue two other goals in the R&D program --waste minimization and human resource development. These initiatives will be discussed in more detail in a few moments.

The Department's plans for performing cleanup and compliance work will steadily evolve as new or better information is gained from release sites across the country and as new technology is brought to bear on these activities.

DOE's two Five-Year Plans -- and the site implementation plans that are being prepared now by each major

DOE field office -- will provide the initial steps toward credibility, although, of course, performance will be the ultimate measurement. The Five-Year Plan is the near-term focus of a 30-year national program. DOE is going out of its way to solicit and incorporate the views of outside groups -- State and Tribal officials, EPA, and the National Academy of Science -- into its program planning. The Department's discussing the merits of expanding this group further to better assure a true national consensus. This remarkable change will help focus attention and money towards finally solving the many environmental cleanup and waste management problems currently faced, both in this country and abroad.

The Secretary has consolidated all environmental restoration and waste management activities into a single office headed by Leo P. Duffy. The clear, focussed direction provided by these Plans and by this Office provides a framework from which DOE can finally begin to approach its environmental responsibilities in a rational, systematic manner.

The Department recognized in developing its overall approach that several key issues would have to be resolved within the next 1 to 2 years, in parallel with its efforts to implement near-term activities. Many key elements of the Department's R&D effort will focus on near-term technology development and application. Here the emphasis will be on *creativity*. The R&D program will serve as a catalyst for applying today's technology to unresolved cleanup and waste management problems in ways never before considered, as well as for the development and demonstration of new and innovative technologies.

A key to DOE's environmental stewardship is waste minimization. DOE is committed to preventing the generation of waste, and recycling where possible to minimize the volume and toxicity of waste which is unavoidably generated. Just a partial listing of current research efforts in waste minimization that have "high" value to DOE -- meaning, the Department could use new technology right now -- include the evaluation of alternative materials, cleaning processes, cleaning equipment, vapor containing equipment, and recycling to eliminate CHCs and CFCs or to substitute for these compounds in the production process; demonstration processes to purify contaminated lead and silver for recycling; development of new paint formulations that meet specification requirements and enable DOE to comply with volatile organic compound emission standards; and development of a replacement process for thermal denitration to eliminate nitrous oxide emissions. Some innovative concepts under consideration that lack the same degree of definition as others. These type of projects include the development of substitutes for chromium; liquid CO_2 cleaning; aqueous fluid bed degreasing; magnesium and fluorine recovery; and carbon tetrachloride substitution.

That's not to say we haven't had some successes along the way. In-situ biodegradation of nitrate in soils, sludges, and the vadose zone is technically feasible. For example, the Department applied biological denitrification to remediate lagoons at the Y-12 Plant in Tennessee. It's now a near-commercial technology and further selected demonstration should accelerate its commercialization potential.

Another challenge the Department faces is development of technology to minimize the environmental impact of waste already introduced into the environment. In the near-term, the cleanup of waste disposal sites may provide no economic return or, in some cases, may not even be technically possible. In such instances, the development of in-situ containment technology could provide the time needed to develop a new and innovative technology that addresses presently unapproachable problems. In-situ mining and enhanced oil recovery technology, for example, can serve as the genesis for development of new containment technology. Although DOE faces additional problems caused by the extensive use of organic solvents in its nuclear operations, waste technology development within DOE and within the domestic mining industry are similar. Advanced separation, containment, and concentration technology are the fundamental elements of a technology base that must be significantly extended.

Improving the efficiency and the extent of metal recovery processes in its nuclear operations will be necessary to avoid future environmental contamination. The recovery of metals from high volume dilute solutions, for example, is a waste technology that will find application throughout the materials cycle. Presently, the "method of choice" for removing metals from dilute solution is lime precipitation. Lime precipitation is effective in the removal of metals at the low parts-per-million range, but leaves a large amount of residue for disposal. Increasingly stringent water discharge standards and the increasing cost of disposing hazardous metal-bearing lime precipitates are prompting the need for the development of more effective technology.

Nor is this only a DOE problem. The Defense Department is having to deal with sites and facilities where depleted uranium, as an example, has been used in artillery projectiles. It has cleanup problems at the Aberdeen Proving Ground in Maryland, at its firing range near Yuma, Arizona, as well as in Europe. In fact, the Defense Department has over 8,000 sites in need of restoration. The EPA Superfund program is at 1,300 sites and some have estimated that this number could increase five-fold before the program is completed. DOE is looking at about 3,000 locations, including spill sites, that require restoration. The

Defense Department has just begun to prepare a strategic planning document similar to DOE's Five-Year Plan to improve its understanding of the problems it faces at military installations across the country, as well as to dramatically improve performance in the environmental and waste management area.

DOE is just beginning its 30-year effort to cleanup and improve waste management. In many cases, the Department does not have the required technology in-hand; in others, appropriate standards or restoration techniques must be developed. For example, one major hurdle facing biological waste treatment involves the regulatory process. Will EPA allow the injection of biological material or nutrients in-situ? The Department's developing a strategy that will enable DOE to pass a tough regulatory test -- containing biological material and nutrients while not producing other toxics -- and DOE's R&D program will assist in this process.

Biotechnology is just one broad research area that holds tremendous application potential to address DOE's needs. Environmental biotechnology is a rapidly advancing area which holds great potential for cost-effective remediation of existing DOE waste sites and for the implementation of environmentally-sound waste management practices. Promising applications of this technology can be divided into five general areas.

The first involves the biodegradation of organic contaminants. Microorganisms may be used to treat a variety of media -- soils, subsoils, groundwater -- and to degrade a wide range of organic fuel/solvent compounds.

A second promising application involves the microbial removal of metals. Organisms can interact with metals to change their mobility in the environment by any of several biochemical mechanisms -- oxidation/reduction, absorption/uptake/chelation, and alkylation.

Denitrification is a third promising application. Many nuclear processing operations generate waste streams containing high concentrations of nitrate which is a serious inorganic contaminant of ground and surface water. Nitrate can be eliminated by microorganisms that convert it to nitrogen gas.

A fourth general application that shows potential involves site stabilization by engineered biological systems. Although most biotechnological processes utilize microorganisms -- bacteria, algae, fungus, and yeast, to name a few --processes that utilize higher plants may prove beneficial for site stabilization.

Environmental monitoring with biosensors is the fifth and last broad category. Real-time sampling and monitoring techniques will help assure the success of DOE's environmental restoration activities, with special relevance to in-situ remediation. In addition to their sensitivity and selectivity, biosensors may offer significant cost savings in sampling.

Environmental biotechnology yields millions of dollars in product per year. Biological sewage treatment represents one of the largest -- if not the largest -- throughput *industries* in the country. By fostering environmental biotechnology research, DOE believes that the true potential of the technology can be realized and directly applied to the cleanup of severely contaminated waste sites.

Yet, it would be virtually impossible to train a biohydrometallurgist in today's educational system. The challenges associated with environmental restoration and waste management will require contributions from all "classical" science and engineering disciplines, as well as persons trained in the law, regulatory compliance, and economics. As part of its 5-year planning initiative, DOE will be working with universities to create new technical curricula that emphasize the physical sciences for application to the country's waste management problems. Emphasis will extend from the development of new associate-level degree programs for "practitioners" to financially supporting graduate-level research and internships in support of post-doctoral research. This improved application of human resources to DOE's problems will reduce the cost of site remediation programs while improving environmental protection.

CONCLUSION

DOE is entering a new era whereby we intend to clean up sites that have been contaminated by radioactive and hazardous wastes over that past 30 years. The cost of this undertaking is staggering, and the Department expects to diminish these costs by supporting a well-focused, needs-driven, and results-oriented applied research and development program that extends today's technology base.

In preparing its 5-year plan for R&D, DOE has identified the expertise present in the system; identified current areas of research; identified its research needs; and is in the process of integrating these components into its R&D portion of an agency-wide Five-Year Plan for environmental cleanup and waste management.

This effort will have many synergistic benefits that will help to effectively deal with a number of environmental problems associated with the metal finishing industry, ash and slag from coal-fired electric powerplants, acid mine drainage, irrigation wastes, uranium mill tailings, municipal solid waste landfills, municipal water supplies, defense logistic centers, and defense production facilities.

Technology exists today to remove metals from low-concentration, low-volume solutions -- examples of this technology include renal dialysis and isotope separation. Hydrometallurgical technologies exist to recover metals from high-concentration, high-volume solutions. Economic technologies do not exist, however, for the removal of metals

from low-concentration, high-volume waste solutions, and fostering the development of this technology will be one early focus of the R&D program we institute as part of the Five-Year Plan. At the same time, the Department must develop a comprehensive strategy that permits the in-situ injection of biological material and nutrients by Federal and State environmental regulators.

Scientifically-trained individuals who can devote their efforts to this task will be at a premium, but those who are now working to extend the biotechnology base for application to the mining industry -- for example -- will find tremendous synergy with the problems faced by DOE in its efforts to find lower-cost and more effective solutions to its waste cleanup effort. DOE can, and will, help to meet this challenge by supporting the scientific community as it develops this needed technology.

The United States has been recognized historically for its leadership in many areas, including the development of vital energy technology. Through implementation of the *Environmental Restoration and Waste Management Five-Year Plan*, DOE's goal is to become a world leader in the development of innovative waste management technologies.