LONG-TERM STEWARDSHIP OF THE DOE WORKFORCE: INTEGRATING SAFETY AND HEALTH INTO THE DESIGN AND DEVELOPMENT OF DOE CLEAN-UP TECHNOLOGIES

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ABSTRACT

The International Union of Operating Engineers (IUOE) has been involved with work at Department of Energy (DOE) sites since the Manhattan Project. A 1995 EPA/NIEHS Labor Market Study showed Operating Engineers to be the main labor force on environmental clean-up jobs throughout the country. Therefore, the IUOE with its intensive hands-on clean-up work force is often impacted by risk decisions such as clean-up vs. leave in place. This has resulted in a vested interest in understanding risk to the workers and their families. A cooperative agreement with the Department of Energy in 1995 has allowed the IUOE to work with the DOE to conduct safety and health assessments of new environmental technologies and has produced several products that are providing far-reaching impact for protecting workers during current clean-up activities and for the future, after workers retire and enjoy the long-term stewardship of their lives.

Several of the current initiatives such as the Technology Safety Data Sheet (TSDS) and the consideration of the costs of complying with safety and health regulations are discussed here. Also discussed is the steps DOE, in particular EM-OST, are taking for the continuing consideration of occupational safety and health in the technology development program.

INTRODUCTION

Under the auspices of the Manhattan Project, the United States was able to design and build an atomic bomb in less than four years at a cost of approximately $2 billion (1). Over the years, the nuclear weapons complex grew into more than 11 million square meters of buildings and 92 thousand square kilometers of land – an area larger than Delaware, Rhode Island, and the District of Columbia combined. The Department of Energy (DOE), in particular the Office of Environmental Management (EM) which was created in 1989, is the agency responsible for the enormous task of cleaning up the legacy of radioactive, chemical, and other hazardous waste left after 50 years of U.S. production of nuclear weapons. This includes an estimated 5.5 trillion liters of contaminated ground water and 40 million cubic meters of contaminated soil and debris, as well as the storage and guarding of 18 metric tons of weapons-usable plutonium. The responsibility for storage, treatment, and disposal of radioactive and hazardous waste also belongs to EM. This includes over 34 thousand cubic meters of high-level waste stored at Hanford, Idaho, and Savannah River sites, and for deactivation and decommissioning of about 4 thousand facilities that are no longer needed to support the DOE's mission (2). The DOE has estimated the costs of this clean-up to be $250 -$350 billion over the next 75 years (3).

In addition to the DOE legacy and cleanup mortgage, other agencies such as the Department of Defense (DoD) have massive clean-up work. The DoD has identified 10,000 contaminated sites and spends $2.1 billion annually for environmental remediation. They spend another $2 billion annually on operations and maintenance related to pollution prevention and $170 million on environmental research and development (4).

To expedite and make environmental cleanup more efficient, the federal government has been increasingly funding environmental technology research, development, and demonstration (RD&D) programs during the last decade. In July 1995, the Congressional Office of Science and Technology (OTA) issued a report that examined such programs within five departments and three agencies (5). The report estimates that during FY 94, $2.5-$3.5 billion was devoted to environmental technology RD&D. The largest agencies involved were the Environmental Protection Agency (EPA), DoD, and DOE. The DOE had, by far, the largest program reflecting the unique and demanding nature of the DOE-EM program, a point noted in the OTA report.

Traditionally, worker health and safety considerations, specific to the technologies developed through this RD&D effort, have not been included in the mainstream of the continuum. The DOE became the first agency to begin addressing these safety and health issues in 1995 with a cooperative agreement with the International Union of Operating Engineers (IUOE) International Environmental Technology and Training Center (IETTC) for the Human Factors Assessment of Environmental Technologies (6). Several of the products that have resulted from these evaluations and this program promise to have far-reaching impact for protecting workers during current clean-up activities and to allow them to maintain their quality of life as they move through their careers.

The primary mission of the EM program is to reduce threats to health and safey posed by contamination and waste at DOE sites including those associated with the nuclear weapons complex (7). EM's Office of Science and Technology (OST) supports the development of new technologies that will result in faster, safer, and more effective environmental remediation. EM's Office of Safety, Health, and Security (OSHS) provides corporate leadership to OST and DOE/EM field components on all aspects of ensuring and monitoring worker safety and health. In addition, DOE's Assistant Secretary Carolyn Huntoon has stated: "First and foremost, we must protect workers, the public, and the environment. 'Safety First' is more than just a slogan – it must be at the heart of everything we do. I want to focus on safety to become the norm at all of our sites and with all of our employees – contractors or Federal (8)." The partnership between the DOE-EM organization and the IUOE has produced several important initiatives for protecting workers who will operate innovative technologies on DOE sites through 2006 and beyond.

ENVIRONMENTAL MANAGEMENT ADVISORY BOARD

The Environmental Management Advisory Board (EMAB) was established in accordance with the Federal Advisory Committee Act (FACA) and is charged with providing advice and recommendations to the DOE's Assistant Secretary for Environmental Management. The Board is comprised of representatives from Tribal nations, state and local governments, environmental and citizen activist groups, labor organizations, industry, and the scientific and academic communities. On April 17, 2000, the EMAB transmitted to Assistant Secretary Carolyn Huntoon a "Resolution on the Consideration of Occupational Safety and Health in the EM-OST Technology Development Program (9)." The EMAB report found that "the OST Program addresses occupational safety and health more comprehensively than other federal agencies with development programs in the remediation technology sector." However, the EMAB made eight suggestions to further improve the steps taken to address safety and health for OST-developed technologies. These eight recommendations included:

- Provide safety and health guidelines/checklists to the DOE developer community;
- Provide guidance for consideration of safety and health matters in the American Society of Mechanical Engineers (ASME) peer review process;
- Develop more detailed guidelines for the consideration of safety and health in the Stage-Gate procedure;
- Require a Technology Safety Data Sheet (TSDS) for every technology at mid-stage review;
- Consider approaches to including occupational safety and health compliance costs in technology cost-performance data;
- Encourage the identification of "safer" technologies and dissemination of that information;
- Initiate a Heat Stress Management Development Program; and
- Develop specific contract language that promotes use and/or implementation of new technologies.

While DOE-EM is working to address all of these resolutions, this paper will specifically address numbers four and five.

HUMAN FACTORS ASSESSMENT OF ENVIRONMENTAL TECHNOLOGIES

A cooperative agreement between the DOE and the IUOE (6) has created the IETTC to evaluate technologies DOE has chosen to be sufficiently effective and robust to provide a real service to the DOE clean-up effort and possibly the commercial market. The mission of the Human Factors Assessment (HFA) Program is to conduct formal safety and health assessments to help mitigate/eliminate hazards prior to demonstration and/or deployment of a technology. One goal of the HFA Program is to work with the technology developer throughout the research and development continuum to identify safety and health hazards as early as possible to allow them to be designed out as opposed to costly retrofits.

The program uses a team approach, assembling each team to provide the expertise required for each technology. However, the one area of expertise that remains throughout all teams is the worker. 'Field experienced' hazmat workers are members of virtually all technology assessment teams. Workers are the people most in contact with the potential safety and health hazards and they have a vested interest in the safety and health hazards related to the equipment they must use to perform their jobs. The workers have been some of the most valuable problem solvers on the team and almost always find hazards that others on the team miss.

The HFA Program also encompasses DOE's Integrated Safety Management (ISM) principles. The objective of ISM is to incorporate safety into management and work practices at all levels, addressing all types of work and all types of hazards to ensure safety for the workers, the public, and the environment. The HFA has the same objective but on the level of specific technologies. Workers who participate in the HFA receive training on hazard assessment techniques and tools which builds a level of comfort for the worker to apply his/her expertise in an objective manner. Preliminary results from a survey being conducted by the IUOE showed that that nearly 60% of the workers felt they would benefit from further hazard assessment training (see figure 1).

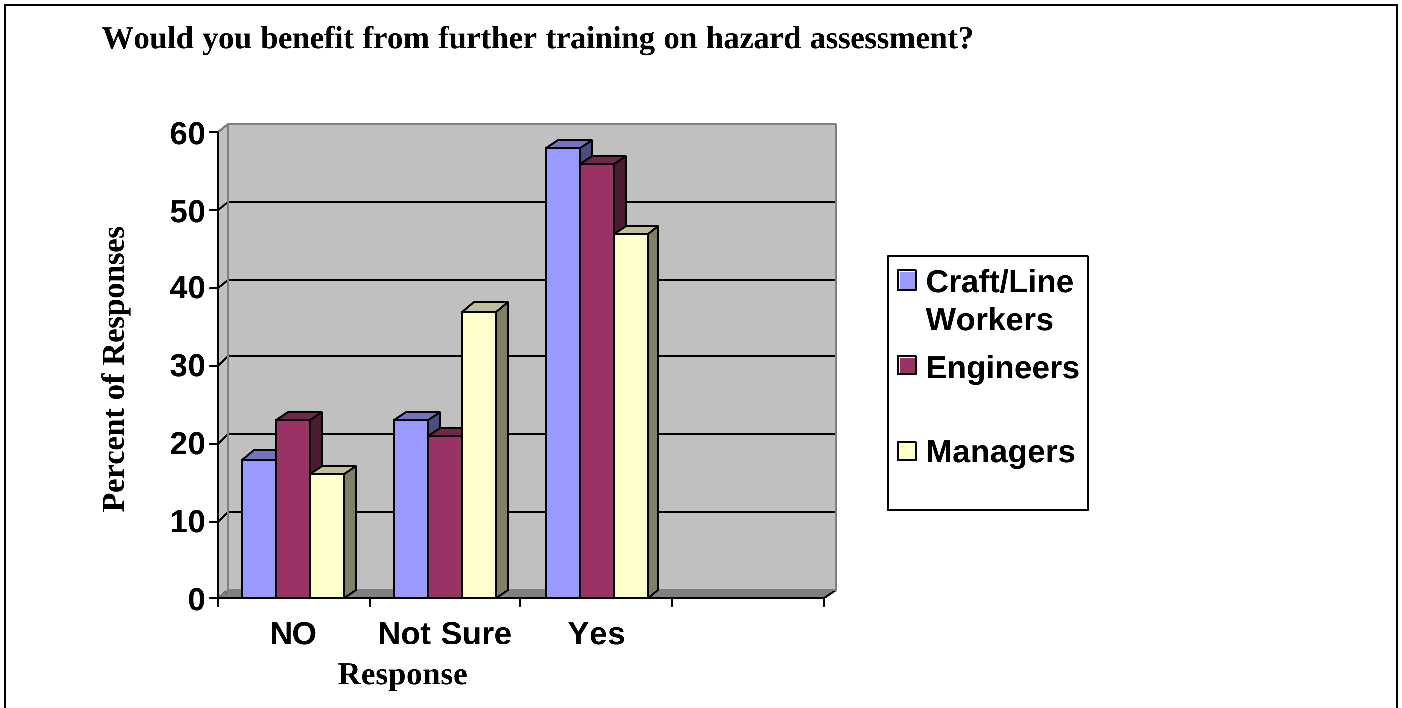

Fig. 1. Training Response

To date, the IUOE has conducted over 50 human factors assessments. Some of the findings for innovative and commercially available technologies are:

- The noise levels were extremely high for nearly all of the technologies that remove the upper surface of contaminated floors and painted metal structures, with an average level of 182% of the Occupational Health and Safety

Administration's (OSHA) allowable dose for an 8-hour day for a sampling period of less than half of a workday. The results of measurements taken outdoors varied widely with a coefficient of variation of 152.5% for 37 readings. When the technologies were used to remove surfaces from metal, the values were usually in excess of ten fold of OSHA's allowable dose, again measured outdoors.

- From 37 nuisance dust samples collected during concrete surface removal tests of 12 technologies, the average result was 375 mg/m^3, compared against the OSHA standard of 15 mg/m^3 (OSHA 1997). The results varied widely depending on the technology producing a coefficient of variation of 206%. These tests were conducted on surfaces that were not contaminated, but the technologies are designed to clean-up concrete contaminated with toxic chemicals and radioactive materials (10).

In addition to the human factors assessments that are conducted to identify safety and health hazards, the HFA Program has developed a guidance document to present protocols for organizations developing hazardous waste remediation technologies that can help them consider safety and health dimensions throughout the development cycle. The guidance document, "New Environmental Remediation Technologies: Guidance Criteria for Occupational Safety and Health" was developed during a National Technical Workshop held October 14-16, 1998 (11).

An example of the importance of looking at all aspects for the possibility of hazards can be seen by a report finding that looked at worker contamination in relation to the personal protective equipment (PPE) being used (12). The authors found that the workers were being contaminated with radiation because they were sweating in their anti-C clothing and the contamination was migrating through perspiration-soaked areas.

A recent accident at the Portsmouth Gaseous Diffusion Plant and the findings of the accident investigation (13) also illustrate the need for hazard analysis and programs such as the HFA Program and ISM that address safety and health issues of technologies. On August 22, 2000, a laborer working with an in-ground treatment to treat hazardous chemicals combined two incompatible chemicals in a bucket. This resulted in a violent chemical reaction that ignited his clothing and seriously burned him. The resulting investigation found:

- Developers and the site contractor "failed to analyze the hazards for all field activities. This failure resulted in inadequate development and implementation of control measures for and knowledge of the potential hazards."

- The developers, as well as the site contractor, "failed to implement the hazard controls that were stated in the project documents."

- The developers, the site contractor, and the DOE office did not establish clear roles and responsibilities for planning, execution, and oversight of the project.

- The DOE office, the site contractor, and the developers "did not establish or ensure a safety culture that implements integrated safety management and encourages personnel to stop and re-enter the analysis phase when a change or unexpected condition arises."

TECHNOLOGY SAFETY DATA SHEET

Background

The TSDS is a technology-specific document designed to provide, among other information, the identity and relative risk of safety and health hazards associated with the technology. It can be used as a tool to manage safety throughout the technology development and implementation process and provide developers with a method to collect and report hazard information in a form that is understood by the user community. It was developed in a consensus national technical workshop (14) and was intended to be the technology version of the now familiar Material Safety Data Sheet (MSDS).

Description

There is currently no regulatory mandate for a TSDS to be developed nor for the format to be used if one is developed. Guidelines from a consensus document developed through a national technical workshop (14) recommends that the following elements are, at a minimum, contained in the TSDS:

- Section 1: Technology Identity
- Section 2: Process Description
- Section 3: Process Diagram or Photograph
- Section 4: Contaminants and the Medium
- Section 5: Associated Safety Hazards
- Section 6: Associated Health Hazards
- Section 7: Phase Analysis
- Section 8: Health and Safety Plan Required Elements
- Section 9: Comments and Special Considerations
- Section 10: Case Studies

This workshop also provided a consensus that the TSDS would be a valuable tool to technology developers, users (management), users (labor), funders, federal and state regulators, and the community. Given that the technologies are intended for cleaning up hazardous waste sites, the TSDS can be valuable in complying with regulatory requirements. For instance, the TSDS can be incorporated into a site's required Hazard Communication or Hazardous Waste Operations and Emergency Response (HAZWOPER) informational program. The TSDS can be used to inform safety and health professionals of potential hazards and to enhance the site-specific elements of required HAZWOPER training. The TSDS should always be available to the worker using the technology and should be kept where it is readily accessible to the worker.

Preparation of the TSDS

The basis for preparing a TSDS is the hazard analysis. This can be accomplished in many ways using many different proven methods or "tools". Some of the common methods used for hazard analysis include what-if/checklist, Hazards and Operability Study (HAZOP), Failure Mode and Effects Analysis (FMEA), and Fault Tree Analysis (FTA). "Tools" for conducting these and other types of hazard analysis are readily available.

The recommended sections of the TSDS should contain the following information:

Section 1: Technology Identity

This section should identify the technology and list any alternative names that the technology is known by, as well as the manufacturer's name and address. Key information and emergency contacts should be included. The name and address of the originator of the TSDS needs to be included because as additional information becomes available, it needs to be relayed to the originator for inclusion in the next revision of the TSDS.

Section 2: Process Description

This serves as an introduction to the technology to familiarize the user with the technology.

Section 3: Process Diagram or Photograph

The process diagram provides an overview of the entire system. Photographs and drawings may prove more understandable than diagrams and therefore, should also be included.

Section 4: Contaminants and Medium

Environmental technologies are designed to handle specific contaminants such as petroleum products or radioactive wastes. The hazards associated with those contaminants need to be clearly described in the TSDS. The medium that is being cleaned should also be described. The following questions should be answered. Does the technology clean up soils or groundwater? Does it operate in the medium such as an in situ groundwater cleaning unit or does the contaminant have to be brought to the technology? What happens to residues generated by the process?

Section 5: Associated Safety Hazards

All safety hazards associated with the technology should be listed and ranked in terms of relative risk and severity. A rating of one indicates that a hazard may be present but is not expected to be above a background level. For instance, electrical hazards may be present but pose no particular hazard linked to the technology. A rating of two indicates some level of hazard above background. A rating of three indicates a high hazard potential, and four indicates the potential for imminent danger to life and health.

Section 6: Associated Health Hazards

All health hazards associated with the technology should be listed and ranked in terms of relative risk and severity. The same rating system as described above for safety hazards is used for health hazards.

Section 7: Phase Analysis

A hazardous waste site is similar to a construction site in that it is constantly changing, moving from initial characterization, through remediation and ultimately to closure. Each phase of a remediation technology at a site imposes its own hazards, and therefore, must be taken into consideration. Transporting the equipment to the site exposes workers to hazards that are very different from those of constructing the unit. Maintenance, particularly emergency repairs pose particularly high risks. The developer should consider each phase of the use of the technology and identify hazards.

Section 8: Health and Safety Plan Required Elements

This section identifies specific regulatory requirements that need to be addressed and information that must be included in the site Health and Safety Plan.

Section 9: Comments and Special Considerations

This section is for communicating special information not adequately covered in the previous sections.

Section 10: Case Studies

This section is used to document any case studies of accidents or off-normal events with the technology. This section may not be applicable to all technologies since previous use may not have occurred.

As discussed earlier, one of the EMAB resolutions presented to DOE Assistant Secretary Carolyn Huntoon was to require a TSDS for every technology at mid-stage review. A pilot conducted to assess the appropriateness of this resolution found that mid-stage or

Stage Gate 3 (Advanced Development) based on the DOE Gate Model (15) was too early for complete TSDS development and Gate 4 (Engineering Development) was more appropriate (16). During the pilot, it was virtually impossible to obtain enough information and produce anything worthwhile on the TSDS when the technology was at Gate 3. At Gate 4, enough information was available to begin producing some valuable information for a TSDS which can then be added to and further developed as the technology moves into Gate 5, Demonstration. At the end of Gate 5 the TSDS should be complete but all TSDS development before this stage should have the word "DRAFT" to indicate it is not yet a completed product. At Gate 6, Deployment, the information from the TSDS can be used for the site-specific Health and Safety Plan which must be developed. The TSDS is not and was never meant to be site-specific but was meant to inform site safety and health professionals of potential hazards and to enhance the site-specific elements of the Safety and Health Plan and required Hazardous Waste Operations and Emergency Response (HAZWOPER) training.

It was reported that even though Gates 0-3 are too early to begin developing a TSDS, it is never too early for the technology developer to start considering safety and health in the R&D process. The goal is to get the researchers and developers to begin using a "thought process for hazard avoidance, elimination, or control" and to use "tools" provided to them to start addressing safety and health at the front end of development (17).

Currently, there is not an agreed upon format for the TSDS. In addition to the format being used by the DOE through the IUOE cooperative agreement, OSHA and the Navy have been considering different formats for the TSDS. The EPA/Labor Superfund Task Force, an ad hoc group comprised of key federal agencies responsible for hazardous waste clean-up and the labor unions responsible for conducting the work, has been considering the value of TSDSs and how the federal agencies can support the development and use of these documents. The first step has been to try to create a generic format that incorporates the best aspects of the existing TSDS templates.

A National Technical Workshop sponsored by DOE in October 2000 (18) advanced the generic format by coming to consensus on the following points:

- The document should be created primarily for workers;
- TSDSs can assist in hazard assessments but should not take the place of more formal assessments;
- All hazards should be identified and rated as either low, medium, or high risk;
- TSDSs should identify hazards in each phase of the technology from construction, through operation and maintenance, to final decontamination and dismantling;
- TSDSs should be kept in close proximity to the technology for easy access by workers;
- TSDSs should be used as tools for training workers; and
- Creating a TSDS can help a technology developer comply with the European requirements for a CE Mark, as well as the new ANSI recommendations for machine tools found in B11.TR3:2000.

THE COST OF SAFETY AND HEALTH HAZARDS

EMAB resolution number five as presented to Assistant Secretary Carolyn Huntoon was to consider approaches to include occupational safety and health compliance costs in technology cost-performance data. The board felt that the inclusion of the costs to the user to comply with safety and health standards as a consequence of hazards associated with a technology is a factor that is not now considered and that this hinders the development of truly innovative 'safer' technologies and presents a barrier to marketing a new technology in addition to continuing to put workers at risk (9). A recent study has shown "there is ample evidence that OST technology deployments make a substantial contribution to improved worker safety and health (2). There is however little work that has been done to show how the mitigation/elimination of hazards contributes to the cost effectiveness of a technology.

A National Technical Workshop (18) was held October 23-25, 2000 to begin addressing these issues. The workshop participants were asked to focus on the consideration of the costs to employers for occupational safety and health standards compliance activities associated with hazards present in technologies which are procured and employed by the enterprise. The premise being that until such time as the user of new technologies is able to include the cost of safety and health compliance in the over-all cost-performance and/or life-cycle cost considerations associated with technology procurement decisions, little attention will be paid by the developers or development-funding organizations to eliminating hazards during the development process. If the market demands inherently safe new technologies, the development community will respond. This is seen in the European approach which required developers to incorporate risk assessment into their design (19).

The workshop report is currently being written and the overall consensus of the participants will be available early next year. However, during the breakout group on 'cost compliance' consensus was reached on the goals of a cost estimating system. These included:

- As simple as possible;
- Consistent among users;
- Explicitly recognizes its own weakness;
- Comparable to baseline technology use; and
- Useful for analysis.

NEXT STEPS

EM-OST is aggressively taking steps to integrate occupational safety and health throughout the technology process with the aim of being practical and cost-effective. An action plan is currently being drafted to address what they are doing, when it will be done, and how success will be measured. A policy paper to address why safety and health are being emphasized and how the technology development program will implement occupational safety and health is also being drafted.

Some of the initial considerations for an action plan include:

- Assist developers to address occupational safety and health early in the technology development process;
- Require clear lines of responsibility throughout the process, through procurement vehicles;
- Address occupational safety and health in all reviews – in both content and reviewer expertise;
- Require a TSDS as early in the development as feasible;
- Provide users more safety and health information – including on 'inherently safer' technologies;
- Assess the occupational safety and health compliance costs issue;
- Look into needs for a heat stress program.

Some of the initial considerations of guiding principles for occupational safety and health in science and technology include:

- Taking responsibility for making technologies as safe as possible for those who develop and use them;
- Assist decision makers in selecting safer technologies;
- Aim to increase safety and value while minimizing bureaucracy;
- Assist developers in practical ways to optimize occupational safety and health;
- Partner with worker organizations to achieve practical occupational safety and health protection;
- Foster development of 'inherently safer' technologies; and
- Continuously improve our occupational safety and health practices.

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