THE IMPACT OF ORGANIZATION ON THE ACCEPTANCE OF INNOVATIVE CLEANUP TECHNOLOGY

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ABSTRACT

Application of innovative technology is widely viewed as critical in completing the nation's cleanup agenda. Despite policy, procedures, and programs encouraging innovative technologies, the results to date have been modest in terms of actual innovative technologies selected for remediation at Superfund sites. At DOE and DOD sites, the reason may be partially one of timing. Most federal facility agreements are only a few years old and many of these sites are not yet into the remediation phase. Moreover, some federal facilities pose unique cleanup challenges requiring unique technology that will take time to develop.

Nonetheless, research on the regulatory barriers to innovative technology, including a review of decision documents and a series of interviews with regulators, indicates that one crucially important set of factors affecting the acceptance of innovative technology is organizational. With an emphasis on DOE facilities, this paper explores how organization affects technology acceptance by examining its impact on the information about innovative technology available to decision makers, the extent to which an innovative technology is included among the alternatives available for selection, and the ability of the system to implement innovative technology successfully. It concludes with several recommendations for enhancing the likelihood of innovative technology acceptance.

INTRODUCTION

Application of innovative technology is widely viewed as critical in completing the nation's cleanup agenda. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) mandates the selection of remedies that use permanent solutions and alternative treatment technologies "to the maximum extent practicable." CERCLA also states a preference for remedial actions that permanently and significantly reduce the volume, toxicity, or mobility of hazardous substances. To further these mandates, EPA established the Superfund Innovative Technology Evaluation (SITE) program and the Technology Innovation Office. In 1991, EPA launched a series of procedural initiatives to foster innovative technology in CERCLA decision making (1). Innovative technology appears particularly important to federal facilities, many of which face especially difficult cleanup challenges. In the case of DOE, for example, Assistant Secretary Thomas Grumbly (2) has identified technology development as the factor that will enable DOE to meet its cleanup goals.

In terms of actual innovative technologies selected for remediation at Superfund sites, however, the results to date have been modest. EPA's most recent analysis of Superfund remedial actions (3) indicates that through FY 1992, only 44% used innovative technology. Nearly half of these involved soil vapor extraction, which many observers would not consider innovative. If this technology is excluded, the percentage of innovative remedial actions falls to 26%.

This juxtaposition of policy, procedures, and programs encouraging innovative technologies against the relative paucity of innovative technologies actually in operation, cleaning up Superfund sites, poses an obvious question: why the apparent gap between policy and results? Why are innovative technologies not the linchpin of the Superfund program?

The answer is complex. In the first place, one can be faulted for perceiving the glass as three quarters empty rather than one quarter full: innovative technologies are being used at numerous sites, if not to the extent sought by CERCLA and the EPA initiatives. At DOE and DOD sites, the issue may be one of timing. Most federal facility agreements are only a few years old and these sites have implemented few remedial measures of any sort, innovative or otherwise. Moreover, some federal facilities pose unique cleanup challenges requiring unique technology that will take time to develop. Indeed, DOE has sought extensions of federal facility agreements precisely to allow sufficient time for needed technologies to be made available.

Still, the fact remains that innovative technologies have not become the norm. Federal facilities managers might well ask what factors have impeded the selection of innovative technologies to date and whether federal facilities will be able to address these factors sufficiently to enable the application of innovative technologies to their sites.

One crucially important set of factors is organizational. "Organization matters" because it importantly affects the information about innovative technology available to decision makers, the extent to which an innovative technology is included among the alternatives available for selection, and the ability of the system to implement innovative technology successfully (4).

This paper explores the impact of organization on innovative technology acceptance by first describing the pertinent organizational arrangements, next drawing implications for innovative technology acceptance, and then offering recommendations for enhancing acceptance. The primary focus is on federal facilities, particularly DOE facilities.

ORGANIZATIONAL ARRANGEMENTS

Richard Neustadt's dictum that ours is a government of "separated institutions sharing powers" (5) applies with force to the cleanup arena. This sharing of responsibility is apparent in the structure of the system for developing, selecting, and deploying cleanup technologies, the processes for making remedial decisions, and the diverse perspectives of the participants.

Structure

CERCLA grants sweeping powers to the President, which are allocated to the various federal agencies in accordance with Executive Order 12580. In general, EPA serves as the primary regulatory agency, responsible for assessing federal and non-federal sites for inclusion on the National Priorities List (NPL), adopting and updating the regulations of

National Contingency Plan (NCP), and conducting cleanup actions or requiring responsible parties to undertake them. CERCLA and the NCP also afford the government of the host state the opportunity to assume a substantial role in listing sites on the NPL and in negotiating and overseeing individual cleanups, in either a lead or support capacity. EPA has the additional responsibility of maintaining a field demonstration program for testing innovative treatment technologies, which is met through the SITE program.

While the federal departments have some autonomy as "lead agencies" to address contamination at their own facilities, as a practical matter at the major federal NPL sites DOD and DOE are subject to the same EPA regulatory oversight as private responsible parties. Thus the primary federal facility role is to fulfill CERCLA cleanup obligations as an owner-operator. In addition, the federal departments, particularly DOE, administer extensive cleanup technology development programs. In the DOE system, site cleanup and technology development are executed by facility contractors and the national laboratories.

Processes

CERCLA and the National Contingency Plan require EPA and responsible parties to follow a generally applicable, uniform process for site cleanup. This sequence proceeds from listing of a site on the NPL, to performing a Remedial Investigation (RI) to determine the nature and extent of contamination, to conducting a Feasibility Study (FS) to identify and evaluate alternatives, to identifying a proposed remedy in the form of a Preferred Alternative for public comment, to final selection of the remedy in the ROD, to preparation of a Remedial Design (RD), to construction and operation of the Remedial Action (RA).

The NCP specifies nine criteria for evaluating and selecting among remedial alternatives. The first two are "threshold criteria" that all remedies must meet : overall protection of human health and the environment and compliance with "ARARs" -- federal and state environmental requirements that are either legally applicable or relevant and appropriate. The second five are "balancing criteria" that may be traded off against each other: reduction of toxicity, mobility, or volume through treatment; long-term effectiveness; short-term effectiveness (i.e., construction impacts); implementability; and cost. The final two are state acceptance and community acceptance; these are "modifying criteria" that may be applied to revise the Preferred Alternative based on public comment.

While CERCLA and the NCP establish the overall cleanup process, the detailed sequence for a given DOD or DOE site is generally specified in a federal facility agreement, which is analogous to a consent decree for cleanups led by private parties. The central feature of such agreements is a set of milestones: specific dates by which the responsible parties will take particular actions (e.g., initiate an RI, complete an FS) or face sanctions (such as payment of stipulated penalties).

Several additional processes are specifically relevant to technology development and evaluation.

Through the SITE program, EPA enters into cooperative agreements with technology developers to refine innovative technologies at bench- and pilot-scale and then demonstrate them at sites undergoing cleanup. The results are reported in periodic "technology profile" reports. Other federal agencies have devised their own technology development and demonstration processes. For example, DOE is developing and demonstrating innovative technologies through Integrated Demonstrations (IDs) at a number of its facilities. Through the IDs, technologies for all phases of remediation are demonstrated and evaluated under actual field conditions at a DOE waste site. Successful ID technologies are then made available for deployment at the host site and beyond.

Because there is ordinarily less certainty about the performance of an innovative technology than about baseline technologies, the decision to deploy an innovative technology at a particular site is likely to require a site-specific treatability study, which EPA encourages as a supplement to the remedy selection process (6). EPA contemplates three levels or "tiers" of treatability studies: (a) laboratory screening, which is used to establish the validity of a technology to treat a waste, (b) bench-scale testing, which is used to better estimate the technology's performance on a waste-specific basis for an operable unit, and (c) pilot-scale testing, *which is used to* provide quantitative performance, cost, and design information for remediating an operable unit.

The decision to undertake a treatability study is supposed to be based on balancing the cost and time necessary to perform the test against the risks of proceeding without it. Generally, one would start with laboratory screening and then move to the next tiers if warranted. These efforts could occur as part of the RI/FS (to support the screening of remedial alternatives and the selection of a remedy) or as part of the RD/RA (to verify that the technology can achieve ROD goals).

Participants

At EPA Headquarters, Office of Solid Waste and Emergency Response (OSWER) staff set CERCLA policy, write regulations, and oversee enforcement. OSWER also administers the Technology Innovation program, which encourages government and industry to increase the use of innovative treatment technologies through the removal of regulatory and institutional barriers and the provision of technology and market information. Office of Research and Development staff run the SITE program, in coordination with OSWER.

It is the staff in EPA's ten regional field offices who primarily negotiate and oversee individual cleanups. For a given cleanup, the key decision maker is usually the assigned remedial project manager (RPM). At large and complex sites, including major federal facilities, several different "operable unit managers" may have responsibility for particular geographic areas or contaminant problems. Depending on the particular lead or support functions performed by the host state, staff from the cognizant state agency assume roles similar to those of EPA staff.

In DOE, Office of Environmental Restoration and Waste Management (EM) staff are the main participants in cleanup efforts. Headquarters staff provide management direction to their counterparts in the DOE field offices Cleanup and technology development staff are housed in two separate organizational subunits, EM-40 and EM-50 respectively. This separation of functions is preserved at the field office level, where separate staff in turn oversee the contractors who actually perform cleanup and technology development work.

THE IMPACT OF ORGANIZATION

The NCP process, particularly the preparation of the FS and the ROD, structures remedy selection. In form, the remedy selection process is like a funnel with a series of screens

installed inside. In order to emerge at the bottom of the funnel as the selected remedy, a given technology must 1) be among those alternatives that enter the funnel at the top, 2) must successfully pass through each screen, and 3) must edge out the competing finalists. An individual technology's prospects in each of these respects depends on who participates in the decisions, the information available to them, the incentives they face, and the formal authority and persuasiveness they bring to bear.

Generally the key participants in this process are the RPM or operable unit manager, the responsible party or parties (in the case of a DOE site, EM-40 staff), and the responsible party's contractor. Formally, the decision maker is the RPM, or if there is disagreement, the RPM's management. In practice, the responsible parties and their contractors typically prepare draft documents, which are reviewed by the RPM, and revised in accordance with the RPM's comments.

Technology proponents and developers do not ordinarily have seats at the table when remedies are identified, evaluated, and selected for use at a operable unit. Absent are representatives from the SITE program, EPA's Technology Innovation Office, and in the case of DOE sites, from EM-50 or EM-50 contractors. Unless those who do participate happen to be aware of pertinent innovative technologies or take affirmative steps to consult or involve technology developers or experts, innovative technologies are likely to escape notice at the beginning of the process or be screened out as it proceeds. For a variety of reasons, participants can be reluctant to expand the circle or otherwise give innovative technologies serious consideration.

The RPM's Perspective

In support of DOE's Integrated Demonstration programs, Battelle has investigated how cleanup technology selection works in practice in order to identify implications for technology developers. In one report (7), researchers focused on remedy selection by EPA at Superfund sites, primarily nonfederal facilities. They reviewed FSs and RODs and interviewed EPA staff, including RPMs and others.

This research and the author's previous experience in negotiating private party cleanups suggest that the central figure in remedy selection is the RPM, who typically enjoys substantial autonomy within EPA. While OSWER at EPA Headquarters sets broad policy and sometimes intervenes in difficult situations, decision making for specific cleanups is largely left to the regions. In turn, while OSWER management or its equivalent at the regional level may set strategy and participate in the negotiation of federal facility agreements, and the Regional Administrator may actually sign RODs, it is the RPM or operable unit manager who oversees the remedy selection process on a day-to-day basis. He or she, through reviewing and commenting on the key decision documents (and in the case of the ROD, perhaps drafting it) makes the regulatory decisions that determine which alternatives enter the remedy selection funnel, which pass through the various screens, and which emerges as the selected remedy. Regional EPA management, much less EPA Headquarters management, is generally reluctant to second-guess the RPM's decisions.

RPMs may shy away from innovative technologies for a variety of reasons having to do with incentives or information or a combination. Typically they are "overloaded" with competing demands on their time and attention. Some have limited experience and expertise relative to remedial technologies, particularly innovative technologies. They generally lack resources for a complete and independent analysis of alternatives at the various stages of remedy selection. Thus they must often rely on other EPA staff, Agency "lore," and outside contacts for information. Unless a particular RPM happens to be aware of a particular technology from his or her own experience or as a result of informal contacts with technology experts within EPA or outside, the RPM must necessarily rely on the alternatives as "served up" in the draft decision documents prepared by the responsible parties. If innovative technologies do not appear on these menus, or are described inaccurately or incompletely, they are unlikely to emerge as serious alternatives. On the other hand if the responsible party proposes an innovative technology, the RPM may find it easier to dismiss it out of hand than to take the trouble to understand it. And even if the RPM is attracted by the technology, the prevailing incentives are discouraging. The RPM bears substantial risks if a milestone is missed or has to be renegotiated or the technology unreliable and undergoes down time or worst of all, fails to work altogether. In contrast, the rewards for taking such risks are scant.

Not Invented Here

In the private sector, responsible parties and the consultants who advise them are only serendipitously knowledgeable about or deeply interested in innovative technologies. The same is true at federal facilities. In DOE, as noted, cleanup technologies are developed by EM-50 and deployed by EM-40. EM-40 staff and the contractor personnel on whom they rely are not always aware of or supportive of the potentially applicable innovative technologies being developed outside their organizations. They may view including a demonstration of an innovative technology as part of the remedy selection process as a distraction or as ceding control or funds to others. This fear can be reinforced by RPMs who especially at federal sites, worry about "wasting" money on activities such as technology demonstrations that can be construed as peripheral to getting on with cleanup. In addition, both responsible parties and RPMs may have been burned in the past by technologies that were oversold.

The Dominance of Milestones

For RPMs and responsible parties alike, meeting milestones tends to become a dominating consideration in site cleanup. From the regulatory agencies' standpoint, that is precisely what is intended: achieving cleanup by a specified date is best accomplished by monitoring progress through a series of enforceable steps along the way. The agencies' resolve is reinforced by the public salience of the issue. Missing milestones is portrayed as an embarrassing failure by the agencies and the responsible parties alike. Even negotiated adjustments milestones, for the best of reasons, can be taken as a sign of regulatory weakness. Milestones are adjusted reluctantly, infrequently, and with elaborate explanation or even apology. Responsible parties tend to get this message and themselves emphasize the importance of meeting milestones. This imperative becomes embedded in the organizational routines and of the responsible parties and their contractors -- for example, in the fee incentives of DOE contractors.

The imperative of meeting milestones tends to discourage consideration of innovative technologies, because compared to baseline technologies they require (or may seem to require)

either additional time to develop and demonstrate or more extensive site-specific treatability testing. Missing or adjusting milestones to accommodate an innovative technology may be judged not worth the hassle by responsible parties and their contractors or regulators or both, even though from a long-term perspective the innovative technology may well stand a better chance of achieving ultimate cleanup goals.

Time Perspective and Risk Orientation

Cleanup of groundwater and many of the other complex contaminant streams at DOE sites and other federal facilities is expected to take a long time: 30 years, 40 years, or even longer Yet the incentives operating on responsible parties, their contractors, and regulatory agencies are almost uniformly short-term: milestones, staff development reviews, contract fees, contract terms, even career advancement, emphasize what happens in months or a few years at best. These incentives reinforce the tendency to take the course which appears safest in the short-term, which is often likely to be the familiar technology, no matter how imperfect.

Regulatory Infrastructure

Regulatory agencies may also be discouraged from considering or choosing innovative technologies because of the lack of "infrastructure" for evaluating them. At CERCLA sites, remedies do not require a permit, but they must meet substantive standards, so in the case of a hazardous waste treatment technology, for example, EPA or the state must perform a permit-like review. If the technology does not fall into one of the established categories of RCRA treatment units, it must be reviewed under the open-ended standards of "Subpart X." As a practical matter, this means the reviewer must in effect invent the review standards and process, which may be difficult, time-consuming, and subject to second guessing by the responsible party, interested publics, and others in the agency.

RECOMMENDATIONS

This brief sketch is not intended to be discouraging. It is intended to impart a sense of realism to innovative technology development efforts and to suggest that developing a cost-effective technology is not sufficient to ensure its deployment. To overcome the types of organizational constraints described above, technology developers must make special efforts. Following are some suggestions drawn from the experience of the DOE's Integrated Demonstration for Cleanup of Volatile Organic Compounds at Arid Sites (VOC-Arid ID), which is being conducted at Hanford.

High Quality Data

Technology developers need to develop complete and scientifically sound information on the performance of their technology, through well-planned demonstrations under realistic site conditions. In planning demonstrations, developers should identify and meet data quality objectives that would be required by a skeptical RPM. Demonstration results should be defensible and include an honest appraisal of the technology's weaknesses, limitations, and uncertainties. This data should be communicated in a form that is most useful to busy decision makers -- for example, in terms of the nine CERCLA remedy selection criteria and in comparison with baseline technologies.

Partnerships with Deployers

Technology developers need to bridge the organizational gaps with those who identify and evaluate remedial technologies for deployment -- with RPMs and with responsible parties and their contractors. One of the most useful ways of accomplishing this is to perform field demonstrations as part of the remedial action process, for example as a CERCLA treatability study. This approach has numerous advantages, which include giving deployers hands-on information and a sense of ownership of the technology, providing developers with access to realistic site conditions, and eliminating permit requirements for the demonstration by virtue of the CERCLA permit exemption. However, technology developers must take the initiative to catch the remedial decision process early enough to seek inclusion without being disruptive and be prepared to contribute funds to cover the costs of the demonstration.

Risk Management

Technology developers also need to be creative in helping remedial decision makers minimize the risks associated with choosing innovative technologies. Options include conservatism in matching the technology to the site, especially in initial applications, and development of contingencies such as alternative conventional treatment technologies in the event the innovative technology does not perform as planned. Developing other measures to further manage such risks is an urgent priority if innovative technology is to fulfill its promise.

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