The Geneva Papers on Risk and Insurance, 14 (No 51, April 1989), 149-159

Risk Management Strategies Used in Cleaning up Hazardous Waste Sites

by James M. Seif and
Thomas C. Voltaggio *

1. Defining terms

A meaningful discussion of risk management at hazardous waste sites requires a clear understanding of the terms. Risk management is a process which is part of a chain of activities which is used in formulating government policy. This chain can generally be shown as follows:

Risk Assessment → Risk Management → Risk Communication

Each of these links must be employed to successfully manage governmental programs which deal with hazards.

Risk is defined in Websters as a possibility of a loss or injury. In a regulatory context, such as in EPA, risk is usually the danger of injury to human health, welfare or the environment. This risk is manifested in numerous ways. The mode to be considered in this paper is the risk due to exposure of humans or the environment in general to hazardous substances.

Risk assessment is the method which we use to define the probability of harm coming to an individual or a population as a result of exposure to a substance or a situation. This assessment uses a base of scientific research and is usually quantitative.

Risk management is a public process which is used to decide what to do where risk has been determined to exist. The process must factor in benefits, cost of control and any statutory framework for control.

Risk communication is the process by which we inform the population of the risk, the assessment of that risk and how we intend to manage that risk. An excellent, scientifically valid assessment and a brilliantly derived management process can easily be construed as a failure unless risk information is communicated effectively to the public.

2. Societal factors

Risk management is an extremely volatile issue in today's society. There are several factors which appear to contribute to this phenomena. First, there is a new scientific awareness and public interest in health and fitness. Just count the number of health spas and fitness equipment stores to give an indication of how much this society values its health.

---

* U.S. Environmental Protection Agency, Philadelphia, Pennsylvania

There is a decrease in the faith and confidence that the public puts in science and technology. Examples of catastrophes like the Challenger, Bhopal, Three Mile Island and Chernobyl bring to light the uncertainties in the ability of science to control risk effectively.

Chemical hazards are in the news frequently. This constant repetition of problems or calamities tends to maintain the focus and result in people believing that risks are becoming unmanageable.

There is considerable disagreement among knowledgeable scientists as to the risks of chemical exposure. The public cannot understand the differences among the positions of the "experts" and tends to assume the worst.

These factors tend to decrease the faith that the public puts into the risk management decisions made by government. Effective risk communications require the recognition of these issues.

3. Necessary elements of risk assessment and management

In order to provide meaningful information regarding risk, we must be sure to include the following necessary elements.

First, risk calculations must be expressed as distributions of estimates, not as fixed numbers which can be manipulated without regard to what they really mean. Distributions reflect the uncertainty which is inherent in risk assessment science. Additionally, better tools are needed to explain the meaning of probability distributions to the public.

Second, the public must be informed of the assumptions that underlie the analysis and the management of the particular risk. If we use very conservative assumptions, then this must be communicated so the public understands the differences in probability between the assessment conditions and reality.

Third, we must communicate clearly that risk reduction is our business, not cost-benefit analyses. Cost must be included in any risk management analysis, however the goal of risk management is the balancing of risk against risk by using cost as one factor to decide which risks can be deferred and which must be addressed immediately.

4. Risk Management

There are two major elements in risk management: priority setting and making choices. Priority setting is extremely important for an agency like EPA. We have many statutes with differing requirements and philosophies. We have limited resources and many constituency groups to be responsive to. These competing interests require that the agency set its priorities effectively. The use of risk management allows the priority setting process to be based on the principal of providing for the greatest degree of risk reduction using the available resources.

Making choices is what the agency's mission is. It is, in the final analysis, what we are paid to do. In the hazardous substance cleanup field, it involves the selection of the appropriate remedy to render a site "safe." In the hazardous waste permitting field, it is the conditions of operations that a facility must meet to allow it to operate "safely." In making choices, the agency normally balances the resources available (either to the agency or the permittee in the above examples) with the risk reduction that will result from the action

taken. The risk reduction is a function of the health and non-health benefits that will accrue and the confidence that we have in being assured that the choice made will bring about the results which we anticipate.

Factors which must be considered in all risk management processes are comparability and consistency. Risk management choices for similar problems should exhibit these qualities unless there is a good reason not to. One reason may be a difference in philosophy between problems with similar risks but regulated by different statutes. Some statutes are technology based and others are risk based. Some require both to be factored in. The use of technology or a requirement to be consistent with other relevant statutes will tend to skew a choice from comparability and consistency with similar choices. In these cases, risk communication is necessary to properly explain the seeming dichotomy.

There are several areas in which EPA is concentrating its efforts to improve risk management. These are obtaining better and more consistent information bases, using more varied forms of risk management tools and strengthening the role of communications. In Region III we are using a concept of MERITS. This is a program of managing for environmental results. Apart from the normal agency program initiatives, projects are proposed and prioritized based upon an assessment of risk fund the environment. Resources are identified and used to fund the project.

5. Cleaning up inactive hazardous waste sites - superfund

Cleaning up inactive hazardous waste sites is a portion of the Agency's program of dealing with the hazardous substance problems in the country. There are several major areas. One area is the control of chemical production under the Toxic Substance Control Act. Another is the control of use of chemicals under the pesticides laws or the asbestos programs. Still another is the prevention of chemical exposure from accidents under Community Right-to-Know and Emergency Preparedness law.

The two major laws that deal with hazardous chemicals, however, are the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund"). The major distinction is that RCRA deals with the current handling of hazardous waste by operating facilities and Superfund deals with the cleanup of past mismanagement of the handling of hazardous waste.

The major innovation in the Superfund law is the ability of the government to arrange directly for cleanup using money from a trust fund set up under the law. The current statute provides for $ 8.5 billion for implementation of the program. Enforcement provisions allow for authority to order responsible parties to clean up and also to recoup costs back into the trust fund for money that the EPA spends when it arranges directly for cleanup.

6. Removal program

The Superfund statute provides for a mechanism to clean up acute, short-term, immediate risks to public health or the environment. The mechanism is called a removal response. It is used for transportation accidents, spills or air releases of hazardous substances, acute threats, such as storage of deteriorating and incompatible hazardous substances, etc. A removal response usually involves immediate response to *stabilize and contain*

the hazard; it is not normally a cleanup program. It is meant to reduce the threat sufficiently so that further study can be made prior to any large scale cleanup without posing unacceptable short-term risks.

In keeping with the concept of short-term containment and stabilization, Superfund limits these responses to 12 months or $ 2 million, although exemptions are provided for special circumstances. To facilitate quick response, there are few administrative burdens to overcome prior to activation of trust fund money. Cleanup is carried out by contractors under the supervision of EPA personnel. These contractors have been competitively selected and are available for cleanup for a period of several years on a stand-by basis. When called upon, they are available in a matter of hours. EPA has performed approximately 800 removal actions since the inception of Superfund. This has resulted in significant reduction of risk to human health and the environment.

7. Remedial program

The remedial program provides the framework for an organized response to inactive hazardous waste sites. It consists of several steps. These are discovery and assessment, prioritization, investigation and cleanup. These steps are the same if a responsible party performs the cleanup or if the Superfund trust fund is used.

Discovery and assessment start by organizing an inventory of sites which have the *potential* of environmental or public health risk. The Agency started with a list of 500 potential sites in 1980. This list has mushroomed to over 30,000 in 1988. Sources of these potential sites are citizen complaints, state records of hazardous waste activity, legal notification, etc. Once the inventory is established, it requires a program of assessment to determine the sites which require further review and the sites which can be deferred. This assessment program consists of a two-stage process of document review (called a Preliminary Assessment) and on-site investigation and sampling (called a Site Investigation). The sampling effort is limited and geared to finding if a release of hazardous substances to the environment has occurred or can occur. A further area of investigation is the determination of by what means the hazardous substance can impact human health or the environment. The presence of a large amount of highly toxic chemicals in the middle of the Gobi Desert has a different risk than a smaller amount of less toxic chemicals in a recharge area for a sole source aquifer.

Once the assessment is completed, a prioritization process begins. This process uses a mathematical quasi-risk model called the Hazard Ranking System, or HRS. The HRS builds on the assessment information and factors in such items as waste quantity, toxicity and persistence of the chemical, route that the chemical takes to impact the environment, etc. The result is a numerical score based upon the actual or potential risk to human health and the environment. This will be discussed in detail later in the paper.

Once a site has been scored, it is compared against other sites. If it presents a certain level of risk (currently 28.5 using the HRS), then it is published in the Federal Register on the National Priority List, and work may proceed to fully characterize the site to determine the appropriate cleanup method. At this point, responsible parties are located and asked to perform the work. If they refuse, EPA will perform the work and seek recoupment of the funds expended when the cleanup is completed. In either case, the cleanup process is the same.

The next step is the determination of the scope and degree of contamination at the site. All the sampling up to that point has been to determine if there is a problem or not. The purpose at this point is to fully characterize the situation; the amount of hazardous substances, the extent to which they have or can migrate, the hydrogeological regime and many other factors whichdwill allow the Agency to determine the appropriate cleanup remedy.

Once the site is characterized, a comparison of feasible remedies will be made and will be summarized for public review and comment. At that point, a decision will be made as to the appropriate remedy for the unique circumstances of the site. This remedy decision is a significant risk management decision and will be explained later in this paper.

When the remedy is selected, the responsible parties are again given an opportunity to perform the remedy. As before, if they decline, the agency will perform the cleanup and seek recoupment of those funds. Plans and specifications are then prepared and bids are received for the cleanup. Unlike the removal program, contracts are awarded individually for remedial projects. Because of the greater cost of remedial projects and their lack of the same type of urgency as removal projects, it is believed that fixed cost or unit price contracts are more cost effective.

The remedy is then implemented, followed by an extended operations and maintenance phase. In few situations do we find a remedy completed with no need for continuing activity. Usually, groundwater pumping and treating, extended monitoring, or similar activity will continue for years. This fact is very important to communicate to the public. While the risk is significantly reduced by the cleanup, continued work must continue to ensure the effectiveness of the remedy.

8. Risk Management decisions in Superfund

As one follows the Superfund process outlined above, it becomes apparent that several key risk management decisions occur during the phases of Superfund response. We will outline the following in subsequent sections of the paper:

1 – Removal Prioritization
  A – On-Scene Coordinators
  B – Agency for Toxic Substances & Disease Registry
2 – Removal Cleanup Levels
  A – Action Memoranda
  B – Exemption Request Criteria
3 – Remedial Prioritization
  A – Hazard Ranking System
  B – National Priority List
4 – Remedial Cleanup Levels
  A – Feasibility Studies
  B – Selection of Remedy Process

9. Removal prioritization

Because of the need for quick response in a removal situation, the risk assessment and risk management processes are less formal than in remedial situations. An assessment will

be made by special Agency employees called On-Scene Coordinators (OSC). The OSC is responsible for assessing and directing cleanup work in acute emergency situations. The OSC will sample at the site to determine the existence of a threat and will call upon the health professionals at the Agency for Toxic Substances and Disease Registry (ATSDR) and EPA toxicologists to assist him in determining the sites which must be prioritized. It is usually the judgement of the OSC and his management which determines the prioritization of sites for removal work.

The major factor considered is the immediacy of the threat to human health. Usually this threat is to an individual drinking water supply, or is a threat of fire and explosion or direct contact to toxic chemicals. It is usually ATSDR which provides an expert opinion on the seriousness of these threats.

Most of the sites handled by the removal program are obviously significant threats and little controversy occurs unless resources are stretched too thin to handle all the sites which need immediate attention. Fortunately, this does not happen frequently.

10. Removal cleanup levels

The removal program documentation showing the reasons for the need for response and the explanation of the steps to be taken to clean up is called an Action Memo. This document gives a brief history of the site, the basis for determining that a threat exists, the method of stabilization or containment, the costs and time required to effectuate the action, and the levels of contaminants that the cleanup will reach. This last item is the risk management decision which is made for the action.

As stressed before, the purpose of the removal program is not total site cleanup, rather a containment or stabilization. Of course, if the action is small enough, it may be more cost-effective to complete the cleanup than to leave it to be assessed by the remedial program. This occurs frequently in projects such as transportation accidents or sites where a small number of drums are involved. For many removals, however, contaminants will remain on site to be assessed further.

Generally, the criterion for completing a removal action will be the determination of the level of contamination that will not pose an acute, or short term risk to human health or the environment; therefore, many times, contaminants remain on site which may present long term or chronic health risks. The time frame usually used for short term is 3 - 5 years, since that is a very conservative time frame for a site to be assessed in the remedial program. This issue is usually the most difficult one to communicate to the public at a removal action.

Outside forces play a large role in the risk management process for these actions. The community relations program of EPA requires extensive involvement of the public in all aspects of the removal action, but especially the extent of cleanup. Responsible parties also play a role in commenting on appropriate cleanup levels. Finally, elected officials at the local, state and federal level play active roles in this process. It is usual for EPA to be in the middle with the responsible party on one side, the public on the other and elected officials arrayed at many different points.

At times, removal actions need more than $2 million or 12 months to complete. There are exemption requests which can be approved by our national office. There are two criteria

which may be used to seek an exemption. One criterion is that continued response is immediately required, there is still an immediate risk and assistance would not otherwise be forthcoming. The other is that continued response actions are appropriate and consistent with future remedial actions. The latter criterion is new and policy is still being formulated on its implementation. The risk management process for exemptions balances the need for additional cleanup against the availability of trust fund money and the desire to see larger cleanups being funded under the remedial program with its more cost effective contracting procedures. While multi-million dollar exemptions have been approved, it is a rarity. Most removal actions terminate below $ 1 million and exemptions rarely go over $ 3-4 million.

11. Remedial prioritization

As explained previously, the Hazard Ranking System and the National Priority List are the formal EPA processes for remedial prioritization. The original Superfund law in 1980 required a site to be listed on the National Priority List for remedial construction money to be allowed to be used. Because remedial cleanups can run into the tens of millions of dollars, this insured that the trust fund money would be utilized at the worst sites first. Conversely, if a site does not present sufficient risk to score high enough using the Hazard Ranking System, then the site cannot be listed on the National Priority List and remedial response cannot be conducted. Therefore, the risk management process for remedial prioritization is the Hazard Ranking System and National Priority List process.

As sites have been assessed and investigated, they are scored using the Hazard Ranking System. The analysis of the chemical constituents, hydrogeological and other pertinent data is assembled and a worksheet is prepared. Various weights are given and a raw score is calculated. This is normalized to a 0 - 100 scale and the result is used to determine if a site is eligible for listing on the National Priority List. Currently, a site is eligible if it scores more than 28.5 using the Hazard Ranking System.

A frequent question asked is: "Why 28.5 ??" The original reason was that in the first Superfund statute, EPA was required to generate a list of at least 400 sites for the initial National Priority List. EPA assembled all the HRS evaluations at the time and ranked them from highest to lowest. The 400th site scored around 28.5! Since that time, EPA has evaluated whether or not using other values would result in better risk management. We have failed to find a better alternative.

The Hazard Ranking System considers two types of release mechanisms and three types of pathways to the environment. A release can be actual (or observed), or potential. An actual release is one which is measured by scientific sampling and is at least 3 times above background levels for that chemical in the environment. A potential release is one which could occur depending upon future events. For a potential release to be scored, there must be a pathway from the source to the "target" population, and the target population must be near enough to be impacted. A potential release scores less points than an actual release.

The three pathways for contamination to reach the target population are the groundwater, the surface water and the air. Each of these pathways is evaluated and scores are generated. An additional factor is proximity to a sensitive environment. Rules of thumb for a high score with this model are as follows:

1 – There needs to be a drinking water intake or a number of wells within 1 - 3 miles of the site. Therefore if a site is in an urban environment with city water, then the groundwater pathway will probably not score highly.

2 – The same is true for surface water.

3 – There must be proximity of a target population for an air release to score. No potential air releases are allowed in the model due to the difficulty of assessing such a situation.

4 – The hydrogeology must be clear, especially when aquitards are suspected.

The Hazard Ranking System is undergoing a major revision as a result of a requirement in the latest amendments to the Superfund law. A proposal is expected this year. Changes projected are the addition of an air potential route, more emphasis on environmental effects and the addition of a direct contact route. Outside interests also play a strong role in the risk management decisions of remedial prioritization. The public is involved in the National Priority List process in that the list is an Agency rulemaking action. This means that the list is proposed in the Federal Register. Comment is solicited and a docket is maintained for all to see the comments. A response is prepared and the list is then promulgated by appearing again in the Federal Register, along with a listing of all significant comments and the Agency's response. Considerable interest is also shown by responsible parties and elected officials. Since decisions whether to list or not have significant financial consequences, a great deal of time is expended and effort is made toward communicating the bases of our recommendations. Frequent meetings occur and the community relations program is very active during this stage.

12. Remedial cleanup levels

The determination of remedial cleanup levels is probably the most time-consuming and difficult of the risk management decisions in the Superfund program. Because of the financial consequences, a very rigorous procedure is outlined in the program requirements. The general name for this procedure is the remedial selection of remedy process.

Before the remedy can be selected, a feasibility study is prepared. This study takes all of the data generated in the investigation of the scope and extent of contamination at the site and factors in a number of feasible alternatives which could result in satisfactory levels of cleanup. The cleanup alternatives vary from a no action alternative, to contamination containment options (such as capping the site), to highly complex treatment and destruction options (such as incineration or chemical treatment). The study contains descriptions of technologies, costs, time lines, implementability analyses, legal constraints, technological constraints, and other pertinent factors. The purpose of the feasibility study is to provide the decision maker with all reasonable options from which to choose a remedy. The feasibility study should be neutral in order to allow the decision maker the widest flexibility.

When the feasibility study is completed, the entire project study is provided to the public, elected officials and the responsible parties for their review and comment. Meetings are held and explanations are given. Comments from these reviews are assembled and collated and provided to the decision maker, who in most cases is the EPA Regional Administrator.

The documentation for the remedy selection is provided in a document called the Record of Decision. This is prepared by EPA and includes a summary of remedial studies,

a description of the feasible alternatives, with their costs and time frames, a summary of the comments made by the public and others, and a description of the alternative which has been selected by the decision maker.

Current policy is to base the selection of remedy on the use of nine criteria for analysis. These criteria are:

1 – Overall protection of human health and the environment
2 – Compliance with applicable or relevant and appropriate requirements of other environmental laws (ARARS)
3 – Long term effectiveness and permanence
4 – Reduction of toxicity, mobility or volume
5 – Short term effectiveness
6 – Implementability
7 – Cost
8 – State Acceptance
9 – Community Acceptance

Some of these criteria are explained further below.

Many of these criteria are required by the latest amendments to the Superfund law. The major changes from the original legislation are the requirement for ARARS, long term permanence and reduction of toxicity, mobility or volume.

In the previous legislation, the major criteria were overall protection, implementability, cost and acceptance by the state and community. These criteria tended to make the remedy selection process highly risk based, with the reality check provided by cost and acceptance. For the first several years, remedies tended to contain the waste in place via capping or similar means, or provide for excavation and off-site disposal. Remedies tended to cost an average of $ 5 million and this resulted in a relatively high acceptance rate by states, communities and responsible parties.

When the Superfund amendments arrived with a requirement for ARARS, long term permanence and reduction of toxicity, etc., remedy costs escalated significantly. While not enough time has passed to develop an average remedy cost under the new requirements, many of the remedies are in the $ 10 - 50 million range. Remedies now require treatment of waste in most cases. Incineration, biodegradation and chemical fixation are the leading technologies selected thus far. In many cases, acceptable risk reduction would allow a containment remedy, yet the congressional mandate for permanence and toxicity reduction seems to require more expensive treatment alternatives. Countering that is the need still to be cost effective. One can see the dilemma facing the decision maker.

While the public, responsible parties and elected officials were very active during the public comment period, the selection of remedy process is meant to occur with little outside involvement. The process assumes that the decision maker assembles all the technical information from the feasibility study, the comments from the public, responsible parties and elected officials, the Agency response to the comments received and the nine criteria. He then is expected to select the remedy which best balances all the criteria: surely a formidable task!

Once the remedy is selected, the Agency communicates this decision to the public, along with an explanation of the rationale for the choice. This communication phase is very important to the continued working relationships of the public and other interested groups.

It would be foolish to state that this process works as smoothly in practice as in theory. There is a great deal of involvement by responsible parties, the public, elected officials, national program offices, contractors, auditors, and any other group affected by the remedy selection. It is difficult to keep focus on the program goals while attempting to balance these competing forces. Nevertheless, the process seems to work thanks to dedicated staff and decision makers. The risk management process for selection of remedy is probably the most excruciating that a regional EPA official makes, yet it seems to fulfill that Agency mission to keep risk assessment and risk management procedures the center-piece of decision making.

13. Deletion

A final area of risk management is the decision whether to delete (i.e. remove) the site from the National Priority List after it has been cleaned up. This process requires that a site has had the selected remedy implemented satisfactorily and a decision made that no further fund financed response is necessary. The decision is submitted to the Federal Register as a proposed action and comment is solicited. When the comment period ends, a responsiveness summary is prepared and presented to the decision maker, who in this case is in our national office in Washington. The final decision is promulgated in the Federal Register as a final Agency action. The risk management process for deletion has not been a controversial process due to the similarities of approach with earlier processes in the remedial program.

14. Insurance and responsibility

The responsibility for cleanup of inactive hazardous waste sites lies with the responsible parties. If they are unwilling or unable to perform the cleanup, then the Superfund law provides a mechanism for the government to arrange for cleanup itself using trust fund money. There has been much discussion as to whether a responsible party should agree to clean up itself or wait until the Agency cleans up and presents its bill. In the early days of the program, few cleanups were performed by responsible parties. Over the past three to four years, more and more cleanups have been performed by such parties. This is a promising trend and is expected to continue. Obviously each site cleaned up by a responsible party frees up money to be used to clean up another site which does not have a willing or able responsible party.

There are a great many details which must be arranged for a responsible party to agree to clean up. The Superfund amendments devote much language to the requirements for such agreements. Any agreement must be enforceable, provide for the same general process of risk management as Agency clean-ups and provide for many other legal issues which are not the subject of this paper. A general rule for a responsible party is to take the risk assessment, risk management and risk communication process that the Agency has and adhere as closely as possible to it.

Indemnification of cleanup contractors is a major problem faced in the cleanup of inactive hazardous waste sites. The problem stems from the inability of these firms to obtain insurance and hence the request to the government to indemnify cleanup contractors so work may proceed. The Superfund amendments addressed this issue partially with a provision to provide for indemnification under certain circumstances. These procedures are being developed and will be issued soon. The problem with the Superfund amendments is that it does not allow for indemnification of state liability in strict liability states. This problem is currently under review by the Agency. In the meantime, cleanups are being performed and very few, if any, cleanups have been halted due to this issue.

15. Conclusions

The cleanup of hazardous waste sites under Superfund involves each link of the risk chain: risk assessment, risk management and risk communication. The program was developed as a risk based process and there has not been a need to modify an existing process to incorporate the Agency initiatives in this area. Risk management decisions are incorporated throughout the process at major points, and they reflect the Agency guidance. The risk management process involves heavy reliance on the risk assessments provided in program operation, significant public input throughout the process and feedback of the decisions to affected people. The balancing of the statutory bias for treatment and toxicity reduction against the pure risk factors in remedy selection provides the greatest challenge to the decision maker in the program.

BIBLIOGRAPHY

1. Public Law 96-510, *"Comprehensive Environmental Response, Compensation and Liability Act of 1980"*, 94 STAT.2767-2811, December 11, 1980, and amendments.

2. Environmental Protection Agency, *"National Oil and Hazardous Substances Contingency Plan"*, Federal Register 47(137) Part V, 31180-31243 (July 16, 1982), and amendments.

3. Environmental Protection Agency, *"Risk Assessment and Management: Framework for Decision Making"*, EPA/600/9-85/ /002 (December, 1984).