ESTABLISHING SITE-SPECIFIC PERFORMANCE STANDARDS: THE KEY TO MATCHING INNOVATIVE TECHNOLOGIES TO SUPERFUND SITES

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ABSTRACT

The level to which a Superfund site is restored is determined by performance standards. Performance standards derive from two sources: 1) technology and regulatory standards (often referred to as Applicable, or Relevant and Appropriate Requirement's, or ARAR's), and 2) standards based on risk assessment or resource management analyses. ARAR's are advantageous to providers of innovative technologies in that they are both relatively unambiguous and regional or national in scope. Risk-based standards are advantageous to site owners in that they are more likely to facilitate the specification of a cost-effective response. The acceptability of performance standards is a function of the compliance points selected for the site, the test methods specified to confirm compliance, and the analytical procedures (models) used to relate test data to performance standards at the compliance points.

The provider of an innovative technology must demonstrate that its product fulfills requirements imposed by both types of performance standards. A technology which addresses all standards is likely to succeed; one that attempts to force-fit performance standards to its capabilities and limitations is likely to fail.

DISCUSSION

An innovative technology constitutes a suitable remedial measure whenever the performance standards established for the site fulfill both regulatory requirements and public expectations. Analytical procedures (defined as models) relate test data to performance standards at the compliance points. Two of the important federal laws which regulate hazardous wastes are the Resource Conservation and Recovery Act of 1976 (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund). Each places special emphasis on permanent solutions to waste management problems.

RCRA discusses permanence as follows:

> Sec. 1003(a). The objectives of this Act are to promote the protection of health and the environment and to conserve valuable material and energy resources by-

4. assuring that hazardous waste management practices are conducted in a manner which protects human health and the environment;
5. requiring that hazardous waste be properly managed in the first instance thereby reducing the need for corrective action at a future date;

> Sec. 3004(d)(1). ...... the land disposal of the hazardous waste .... is prohibited unless the Administrator determines the prohibition on one or more methods of land disposal of such waste is not required in order to protect human health and the environment for as long as the waste remains hazardous, taking into account-

A. the long-term uncertainties associated with land disposal,

B. the goal of managing hazardous waste in an appropriate manner in the first instance, and,

C. the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous wastes and their hazardous constituents.

Superfund is implemented, in part, through the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)(1). Superfund discusses permanence as follows:

> Sec. 121(b)(1). Remedial actions in which treatment which permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element, are to be preferred over remedial actions not involving such treatment.

The NCP provides additional guidance:

> 40CFR300.430(a)(1)(i). The national goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste.

Thus, a suitable remedy for a site, and one which technology providers must strive for, is a permanent remedial measure.

Performance standards are associated with defined compliance points. Test protocols are specified at the compliance points. Performance standards, compliance points, test methods are independent factors. Because there is considerable latitude in the site-specific specification of these factors, an opportunity exists at any site to propose different remedial actions. This provides both flexibility and uncertainty. Flexibility increases the probability that site owners, regulators, and the interested public can agree on a permanent remedy. Providers of innovative technologies have an increased opportunity to adapt their product to the needs of the individual site. Uncertainty increases the probability that site principals will hold different ideas as to what the permanent remedy entails. An example of these concepts applied to the specific remedial technology of stabilization/solidification is provided by Barich and Mason(2). Flexibility is exploited while uncertainty is avoided if performance standards, compliance points, test methods, analytical models, and the total remedial design concept are defined precisely early in the life of a waste management project.

Performance Standards

Performance standards derive from the well-documented risk assessment process and the identification and analysis of regulatory requirements(3,4). In the federal Superfund program in the United States, the Applicable or Relevant and Appropriate Requirements (ARAR's) process documents regulatory requirements(5,6).

ARAR's include all requirements in federal or State law that have direct applicability at a site. "Applicable" means that an element of law or regulation applies at a site, regardless of whether it is regulated by Superfund. A "relevant and appropriate requirement" is a requirement that, although not required by law, addresses directly remediation needs at the site. They include requirements which are similar enough to the elements of the remedial measure to be considered as "relevant and appropriate." ARAR's are conveniently categorized as location-specific, chemical-specific, and action-specific. They can be numerous. There is, however, a procedure to simplify the translation of ARAR's into performance standards.

Federal and State requirements often address the same concerns. A drinking water requirement, for example, might be similar in its federal and State form. All candidate performance standards which derive from ARAR's are evaluated for overlap (commonly between governmental jurisdictions). "Non-overlapping performance standards" constitute the smallest set of performance standards for which there is no overlap. Given the propensity in federal environmental law to establish minimal standards and to encourage States to assume responsibility for environmental programs, non-overlapping performance standards are often State standards.

Non-overlapping performance standards are analyzed for instances where by meeting one performance standard, another will be met. This situation occurs most frequently in sites with multiple contaminants. If by controlling one heavy metal out of several confirmed at a site, for example, all will be controlled, then the performance standard associated with the first metal is a "design-controlling performance standard."

The desired set of performance standards which derive from ARAR's is the set of non-overlapping, design-controlling performance standards. The complexities of managing hazardous waste sites are such that considerable effort should be allocated to simplifying the performance standards by defining exactly the non-overlapping, design-controlling set.

Each non-overlapping, design-controlling ARAR is analyzed further to quantify the ARAR as a performance standard. Three cases are possible. First, the ARAR may itself be a well-defined, unambiguous performance standard. An example is the waste listing threshold that soils exceeding 5 mg/l of chromium by the Toxicity Characteristic Leaching Procedure (TCLP) are hazardous. The test method and the meaning of the test result are known; alternative interpretations and site-specific applications are neither desired nor permitted. The only question for the waste management professionals what constitutes a valid waste sample.

Second, the ARAR may contain a well-defined endpoint, but alternative methods of specifying the endpoint at a site may exist. An example is a water quality criterion for the protection of aquatic resources (copper less than 2.9 ug/l to be protective of marine aquatic resources from acute toxicity). Although the endpoint is well-defined, the relationship to the treated waste form is not. How much copper will be released from the waste to the water protected by the acute toxicity ARAR? Will a zone of mixing be permitted? How large is the zone of mixing? Although answers to these questions are obtained without reference to the treatment technology, they are critical to the determination of the performance to be achieved by the treated waste form. The questions include both management and technical concerns. How large a zone of mixing is primarily a resource and environmental management issue. The configuration of the zone of mixing is more a technical issue.

Third, both the endpoint and the method of application to the site may be subject to interpretation. An example is a performance standard which derives from natural resource or health risk assessments. The natural resource assessment or risk assessment may require a study as involved as any associated with the site. Once these assessments are available, the acceptable flux of contaminants is determined. Natural resource and health risk assessments are conducted without reference to the waste management technology. They, too, are primary determinants of performance to be achieved.

An innovative technology is suitable as a permanent remedy if it fulfills all performance standards established for the site. Establishing performance standards is an involved process which can result in different standards for the same site. The regulator is in no position to approve a technological solution as suitable until the performance standards are complete. The technology provider is unable to propose seriously a technology product until the performance standards are agreed upon.

Compliance Points

Many performance standards are evaluated at compliance points. Compliance points are locations where and frequencies when monitoring occurs. When remedial decisions are completed for Superfund sites in the United States, compliance points must be identified. The requirement states: "Performance shall be measured at appropriate locations in the ground water, surface water, soils, air, and other affected environmental media. Measurement relating to the performance of the treatment processes and the engineering controls may also be identified ....(7)." Just as there is flexibility in the identification of performance standards, there is flexibility in the identification of compliance points.

Compliance points exhibit the following properties: location, frequency of testing, method of sampling, and test methods. Each must be specified precisely before a valid compliance point exists.

The location of a compliance point can be established within the waste form, adjacent to the waste form, at a property line or other legally defined boundary (such as a site boundary), at a discharge point, or at a point of use. Multiple compliance points can be specified, for example, at the edge of the waste form and at the property line. The closer the compliance point to the waste form, the more direct is the measure of waste behavior, but the less direct is the relationship of compliance point monitoring data to performance standards derived from natural resource and risk assessments. Conversely, the closer the compliance point to the point of use, the more direct is the relationship of compliance point monitoring data to performance standards, but the less direct is the measure of waste behavior.

At each compliance point a frequency of testing is specified. The shorter the frequency with respect to anticipated changes in the treated waste, the smaller will be the expected changes in the performance standard parameters, and the more difficult the task of confirming that real changes are occurring. Shorter frequencies improve the chances that failures can be detected before they become severe. Longer frequencies may simplify the task of confirming that real changes are occurring. Failures, however, may be more advanced and more difficult to correct.

Performance standards are expressed whenever possible as quantitative characteristics; test methods transform samples acquired at the compliance points into results which are related through models to the quantitative characteristics. Leaching is an example of a characteristic of a waste form. Leaching of a coupon by the Toxicity Characteristic Leaching Procedure (TCLP) is an example of a test method.

Test Methods and Models

There are often several test methods addressing a performance characteristic which have either regulatory status or are fully peer reviewed and approved. Whenever these are specified for use at a compliance point, the user need only defend the selection of the method and the interpretation of the data. The requirement to defend only method selection and data interpretation can be an advantageous in a regulatory or litigation setting. The peer review process, or the administrative procedures which precede the adoption of a regulatory test, provide the primary defense for approved methods.

Whenever non-standard or non-peer reviewed test methods are specified, the methods themselves must be defended. This is in addition to the defense of the application and the interpretation of data. A non-standard or non-peer reviewed method may meet the engineering requirements of the site better than the approved test methods. The user must decide whether the improvement is sufficient to justify the additional requirement to defend the method.

Data acquired at compliance points are not the same as the performance standards. Data are related to performance standards through the use of models. Models range from elementary (e.g., multiplication of test results by unity) to complex (e.g., those which allow numerous complex phenomena to act on the test results).

CONCLUSION

The question of whether a waste management technology is an appropriate permanent remedy for a hazardous waste site is answered by confirming the regulatory and public acceptance of the performance standards established for the site. There is considerable flexibility in establishing performance standards. Performance standards are evaluated at compliance points. There is also flexibility in establishing compliance points. Finally, compliance point data is related through models to the performance standards. Once again, there is flexibility in the selection and application of models.

Flexibility increases the likelihood that regulators, technology providers, site owners, and interested publics, can agree on an appropriate permanent remedy. However, flexibility increases the potential for mis-communication.

Flexibility is exploited while mis-communication is avoided if the performance standards, compliance points, and analytical models are agreed upon early in the life of a project. These items require regulatory agreement, whenever possible, prior to selection and implementation of an innovative waste management technology.

REFERENCES

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