IMMOBILIZATION AS TREATMENT

Section 121(b) of CERCLA mandates the EPA to select remedies that "utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable" and to prefer remedial actions in which treatment "permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, and contaminants as a principal element." Immobilization is one such treatment technology which may find application at Superfund sites to meet the CERCLA mandate for treatment. Since immobilization is not generally considered a destructive or removal treatment technology for which treatment effectiveness can most easily be defined, it is important that the Agency establish clear guidelines as to when and under what conditions immobilization satisfies the CERLA mandate.

The purpose of this guide is to provide guidance on the conditions under which immobilization is an appropriate treatment technology under the Superfund program. This guide provides: a definition of immobilization, the current Agency policy on the use of immobilization for Superfund applications, the status of the immobilization as it relates to the RCRA Land Disposal Restrictions, and ROD documentation requirements.

DEFINITION OF IMMOBILIZATION

The term "immobilization" is used to mean any of the technologies which limit the solubility or mobility of contaminants. The term "fixation" has also been used as a synonym for immobilization. Technology types which fall within the realm of immobilization include:

Stabilization
Solidification/Stabilization
Sorbent Solidification

The various immobilization technologies limit solubility or mobility with or without a change in physical characteristics of the matrix. Immobilization may involve physical/chemical processes that do more than simply entrap the contaminants.
Solidification alone is not included as a treatment technology under the Superfund definition of immobilization because it does not satisfy the statutory preference for treatment to reduce the toxicity, mobility, or volume (TMV) under Superfund. The term "solidification" implies a treatment technology which is intended to produce a monolith for purposes of structural integrity. Since the principal purpose of solidification is structural integrity, it does not qualify as treatment under Superfund for purposes of reduction of TMV. Solidification performed in conjunction with stabilization (i.e., solidification/stabilization), however, would satisfy the preference for treatment under Superfund and falls within the Superfund program's definition of immobilization.

IMMOBILIZATION AS A TREATMENT ALTERNATIVE

Concerns have been raised regarding the types of immobilization that provide for adequate protection. The principal reason for these concerns rest on the fact that immobilization is not generally considered a destructive technique but rather prohibits or impedes the mobility of contaminants.

Although experts are in general agreement regarding the effectiveness of immobilization for most inorganics and metals, the effectiveness of immobilization for organics cannot be predicted without testing. Furthermore, the testing methods available (i.e., leachability tests) provide different types of information on the mobility of contaminants depending on the test. For these reasons, Superfund has developed general guidelines for evaluating and selecting immobilization taking into consideration the testing methods currently available, scientific understanding to date, and the NCP expectations regarding treatment.

The preamble to the NCP (55 FR Page 8701, March 8, 1990) provides the following guidance regarding treatment effectiveness:

"...The Superfund program also uses as a guideline for effective treatment the range 90 to 99 percent reduction in the concentration or mobility of contaminants of concern....EPA believes that, in general, treatment technologies or treatment trains that cannot achieve this level of performance on a consistent basis are not sufficiently effective and generally will not be appropriate."

The use of any treatment technology, including immobilization, needs to be weighed against this policy and current knowledge regarding the technology application.
SUPERFUND POLICY ON USE OF IMMobilIZATION

This guide provides Agency policy on the use of immobilization for treatment in view of concerns that have been raised regarding technology performance primarily for organics. The Superfund policy is as follows:

Immobilization is generally appropriate as a treatment alternative only for material containing inorganics, semi-volatile and/or non-volatile organics. Based on present information, the Agency does not believe that immobilization is an appropriate treatment alternative for volatile organics. Selection of immobilization of semi-volatile and non-volatile organics generally requires the performance of a site-specific treatability study or non-site-specific treatability study data generated on waste which is very similar (in terms of type of contaminant, concentration, and waste matrix) to that to be treated and that demonstrates, through Total Waste Analysis (TWA), a significant reduction (i.e., a 90-99 percent reduction) in the concentration of chemical constituents of concern.

The need for treatability study data and the importance of conducting appropriate leachability tests as part of the study, are important parts of this policy statement. Treatability studies to demonstrate the effectiveness of treatment of organics is needed since we do not believe that we can predict the degree of performance which may be provided without such testing. Although immobilization has a long history of application for inorganics, treatability testing may also be advisable for site specific cases for both inorganics and organics constituents where we have insufficient data.

EPA believes that given the uncertainty associated with immobilization of organics, the most stringent leachability test available (i.e., TWA) should be used to demonstrated the effectiveness of the technology. A successful demonstration using TWA provides a measure of assurance regarding the leachability of the organics. TWA does not mirror environmental conditions, however, and does not provide information on the protectiveness under specific management scenarios for the immobilized product. One or more other leachability tests may

1 The 90-99 percent reduction in contaminant concentration is a general guidance and may be varied within a reasonable range considering the effectiveness of the technology and the clean-up goals for the site. Although this policy represents EPA's strong belief that TWA should be used to demonstrate effectiveness of immobilization, other leachability tests may also be appropriate in addition to TWA to evaluate the protectiveness under a specific management scenario.
also be used in conjunction with TWA to ensure that the remedy is protective and can meet the remediation levels for the site-specific conditions.

Immobilization is not currently viewed as an effective treatment method for volatile organics since these compounds will be released during treatment as well as following treatment. Alternative treatment methods should be evaluated to destroy or remove the volatile organics to remediation levels either prior to or concurrently with immobilization. A treatability study will be needed to demonstrate the effectiveness of the destruction or removal treatment technology through measurement of emissions.

The Superfund policy on immobilization is based on current knowledge with regards to immobilization effectiveness. This policy may change in the future as we gain knowledge on the use of immobilization and leachability testing.

POLICY ANALYSIS

The immobilization policy focuses principally on the appropriate use of the technology as a treatment alternative. The performance of the technology against site specific remediation goals also needs to be considered in the evaluation of the treatment technology.

The policy is broken down into various components to clarify when immobilization will and will not be considered to constitute treatment to reduce TMV under Superfund:

Immobilization generally constitutes treatment of wastes to reduce TMV in the following circumstances:

- Immobilization of inorganics.
- Immobilization of semi-volatile and non-volatile organics contaminants of concern where a treatability study was performed during the RI/FS or is planned during the RD/RA, and the performance achieved or performance goal is generally 90 percent reduction or greater of the contaminant concentration or mobility using TWA before and after treatment.

Treatability tests for immobilization of inorganic wastes may be appropriate in situations where insufficient data is available to support remedy selection or implementation.
Immobilization of semi-volatile and non-volatile organics where non-site-specific data (treatability or full scale operational data) are available for similar wastes (in terms of contaminants, concentration, and waste matrix), and the performance achieved was generally 90 percent reduction or greater in the concentration or mobility of contaminants of concern using a TWA before and after treatment. The reference for the treatability study report and a discussion of the data applicability at this site was provided.

Immobilization is not deemed to constitute treatment to reduce TMD in the following circumstances:

- Immobilization of volatile organics.  

- Immobilization of semi-volatile and non-volatile organics where a treatability study producing data meeting the above criteria is not performed, planned and/or referenced.

ANTICIPATED APPLICATIONS OF IMMOBILIZATION

Immobilization is most commonly accepted as an appropriate remedy for wastes which contain only inorganics or high levels of inorganics in combination with semi- and/or non-volatile organics which would not in themselves result in a waste being deemed a principal threat. For example, a waste may contain elevated levels of lead and a low-level concentration of a relatively immobile organic (e.g. PCBs). In such a case one could immobilize the waste for the metal but the organic might not be targeted for treatment since it is at levels at which engineering controls would be more appropriate. A treatability study for the organics would not be needed unless we were attempting to achieve a significant degree of treatment (e.g., 90 percent or greater reduction in mobility) for purposes of protectiveness. A treatability study would need to be conducted, if the organics were of concern and immobilization was being used to treat those constituents. A treatability study would also be needed for the inorganics if insufficient information is available to support the remedy decision for these constituents.

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This general statement does not apply to carbon adsorption of volatile emissions which is followed by carbon regeneration or treatment. Carbon adsorption has found wide acceptance for volatile organic control from air emission sources and waste water treatment facilities.
Although treatment of high levels of organics may be achievable with immobilization, the Agency is recommending that alternative treatment technologies be evaluated in addition to immobilization, or that treatment trains (which combine pre-treatment or concurrent treatment to destroy or remove the organics together with immobilization) be evaluated. Treatment technologies which have found application to organic wastes include destructive or removal technologies such as thermal destruction, thermal desorption, solvent extraction, etc. If pre-treatment or concurrent treatment is evaluated to address the organics, the technology should generally be able to achieve a significant reduction of the organics constituents (i.e., 90 percent reduction or greater or a level that is deemed protective under the reasonably expected use scenarios).

Since immobilization is not currently considered a viable treatment alternative for volatile organic materials, an alternative treatment method to immobilization (i.e., use of a pre-treatment or concurrent treatment method) should be used to remove or destroy the volatile organics to remediation levels. Treatability study data are required to demonstrate the destruction or removal of the volatile organics to these levels.

**EXAMPLES**

**Examples of immobilization which constitute treatment:**

- The waste matrix contains inorganics at concentrations that represent a principal threat and high molecular weight organics that are low-level threat wastes since they are near above unrestricted use levels and are relatively non-mobile under the current and future environmental conditions. The disposal of the treatment product would generally require engineering controls since the organics would generally be above levels of concern. Selection of immobilization would constitute treatment to reduce TMV for the inorganic if it met the remediation goals for the inorganics since the waste warrants treatment solely due to the presence of inorganics.

- The waste matrix contains mobile semi- and non-volatile organics at concentrations that represent a principal threat. A treatability study is conducted that shows that the concentration or mobility of the organics is reduced 90 percent or greater by using TWA before and after immobilization. The treatability study is documented in the ROD. Immobilization of the organics constitutes treatment to reduce TMV since a treatability study verified its probable performance which was documented in the ROD.
The waste matrix contains inorganics at levels deemed appropriate for treatment (i.e., principal threat) and semi- and non-volatile organic contaminants at levels deemed appropriate for containment (i.e., low-level threat). Treatment of the both types of wastes is selected based on economies of scale (cost effectiveness) and treatability study data which demonstrate a 90 percent reduction in the concentration or mobility for both inorganics and organics of concern. Immobilization of the organics and inorganics constitutes treatment to reduce TMV because a treatability study was conducted and documented showing effective treatment of the organics.

Examples of immobilizations which generally do not constitute treatment to reduce TMV:

- The waste matrix contains inorganics that due to mobility and concentration result in the waste matrix being deemed a principal threat and volatile organics which result in emissions above levels that are protective. Immobilization would generally count as treatment to reduce TMV for the inorganics but not for the volatile organics which would volatilize during the immobilization process and may continue to volatilize after completion of the remedy. Pre-treatment to remove or destroy the volatile organics to remediation levels established in the ROD is generally required.

- The waste matrix contains mobile semi- and non-volatile organics at levels which constitute a principal threat. A treatability study was not conducted, treatability study data of similar waste was not documented in the ROD, and a treatability study is not planned post-ROD. Immobilization would generally not constitute treatment to reduce TMV in this situation since the waste warrants treatment due to the presence of the organics and a treatability study was not performed, planned, or documented.

RCRA LAND DISPOSAL RESTRICTIONS

CERCLA remedial actions must comply with the requirements of the Resource Conservation and Recovery Act (RCRA) when they are determined to be applicable or relevant and appropriate requirements (ARARs) unless a waiver is justified. Potential ARARs for CERCLA responses include the RCRA land disposal restrictions (LDRs) established under the Hazardous and Solid Waste Amendments (HSWA). The LDRs prohibit the land disposal of restricted RCRA hazardous wastes unless these wastes meet...
treatment standards specified in 40 CFR Part 268, meet the minimum technology requirements during a national treatment capacity extension, or satisfy the requirements of one of the other available compliance options (i.e., treatability variance, equivalent treatment method, no migration demonstration, or delisting).

While immobilization may be treatment to reduce TMV, it may not be able to comply with the LDRs, which are based on best demonstrated available technology (BDAT). In setting BDAT, the Agency can decide that BDAT involves destroying or recovering the hazardous constituents, or that decreasing the mobility represents BDAT. To date, immobilization has been selected as BDAT only for metals. Immobilization is not generally appropriate for compliance with existing BDAT standards for organics (40 CFR Part 268.43) because it serves to dilute the waste, lower the effectiveness of the analytical method, and not significantly lower the amount of hazardous constituents present.

Immobilization of organics does have a role in the treatability variance process for contaminated soil and debris. The fact sheet entitled: Superfund LDR Guide #6A (2nd Edition) Obtaining a Soil and Debris Treatability Variance for Remedial Actions, Superfund Publication 9347.1-06FS, September 1990 should be consulted for guidance on applying this variance.

The evaluation method specified in Superfund LDR Guide #6A for the immobilization of organic waste (first foot-note on page two) has changed since the issuance of the guidance. The September 1990 guidance specified the "TCLP method" but should read TWA. The revised foot-note should read:

"TWA should be used when evaluating wastes with relatively low levels of organics that have been treated through immobilization."

As stated previously, TWA is believed to provide a more stringent test of the immobilization and the potential degree of chemical interaction which may have occurred.

The treatability variance guidance for soil and debris (as modified above) will apply on a case-by-case basis until final LDR soil and debris standards are issued.

ROD DOCUMENTATION

The Record of Decision (ROD) should indicate clearly what materials are targeted for treatment by immobilization and the rationale that supports the selection of immobilization. The following information should be provided in the ROD for immobilization to be characterized as treatment to reduce TMV:
- Type of waste (i.e., non-volatile organics, semi-volatile organics, volatile organics, or inorganics),
- Constituents in the waste to be remediated by immobilization,
- Treatability study results (literature reference and results of site-specific studies) which demonstrate 90 percent reduction or greater in contaminant concentration or mobility using TWA.
- Treatability study results that demonstrate the effectiveness of immobilization to achieve remediation levels.

This information should be provided in the "Selected Remedy" section of the ROD Decision Summary to ensure that it is documented appropriately. This information also should be provided in the "Description of the Alternatives", "Summary of Comparative Analysis of Alternatives" and the "Selected Remedy" sections of ROD. Please refer to the Interim Final Guidance on Preparing Superfund Decision Documents (OSWER Directive 9355.3-02, November 1989) for additional information on ROD documentation.

FOR FURTHER INFORMATION

The appropriate Regional Coordinator for each Region located in the Hazardous Site Control Division/Office of Emergency and Remedial Response or the CERCLA Enforcement Division/Office of Waste Programs Enforcement should be contacted for additional information.

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