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NO MIGRATION VARIANCES TO THE HAZARDOUS WASTE LAND DISPOSAL PROHIBITIONS: A GUIDANCE MANUAL FOR PETITIONERS

U.S. ENVIRONMENTAL PROTECTION AGENCY
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U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

"NO MIGRATION" VARIANCES TO THE HAZARDOUS WASTE LAND DISPOSAL PROHIBITIONS: A GUIDANCE MANUAL FOR PETITIONERS

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DO NOT CITE OR QUOTE

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U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SOLID WASTE
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A "no migration" variance is a formal decision that can be rendered by the EPA to allow the land disposal of specific, prohibited wastes not meeting the treatment standards established by EPA at a particular facility.
In 1986, Congress passed the RCRA authorizing EPA to establish nationwide standards for the management of hazardous wastes. Under HSWA, RCRA Sections 3004(d), (e), and (g) were to include provisions prohibiting the land disposal of all such "listed" and "characteristically hazardous" wastes unless they are first treated. Wastes included in the EPA's land disposal prohibitions will have to be treated by best demonstrated technology to meet the treatment standard established by EPA, unless a "no migration" variance is obtained. Prohibited wastes cannot be stored on the land (unless

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What is a "No Migration" Variance?

A "no migration" variance is a formal decision that can be rendered by the EPA to allow the land disposal of specific, prohibited wastes not meeting the treatment standards established by EPA at a particular facility. The statutory language requires anyone pursuing a "no migration" variance to demonstrate "to a reasonable degree of certainty that there will be "no migration" of hazardous constituents from the disposal unit or injection zone for as long as the waste remains hazardous." The EPA codified this language on November 7, 1986 (40 CFR 268.6). The EPA has interpreted the statutory language to mean that it must be demonstrated, to a reasonable degree of certainty, that hazardous constituents will not exceed Agency-approved human health-based levels (or environmentally protective levels, if they are appropriate) beyond the edge of the disposal unit. In most cases, the disposal unit is defined as the limit of natural barriers and/or engineered components, but may be defined differently in some site-specific cases. **This definition of "no migration" does not allow fate and transport of hazardous constituents above acceptable health-based levels outside the boundary of the unit.**

What are the Land Disposal Prohibitions?

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA) authorizing EPA to establish nationwide standards for the management of hazardous wastes. Regulations promulgated under RCRA in Title 40 of the Code of Federal Regulations, Part 261 (40 CFR 261), include lists of designated hazardous wastes and methods for identifying wastes exhibiting hazardous characteristics. Under the Hazardous and Solid Waste Amendments of 1984 (HSWA), RCRA Sections 3004 (d), (e), and (g) were to include provisions prohibiting the land disposal of all such "listed" and "characteristically hazardous" wastes unless they are first treated. Wastes included in the EPA's land disposal prohibitions will have to be treated by best demonstrated available technology (BDAT) to meet the treatment standard established by the EPA, unless a "no migration" variance is obtained. Prohibited wastes cannot be stored on the land (unless storage is in containers or tanks and is for the purpose of accumulating sufficient quantities to facilitate proper recovery, treatment, or disposal) without a "no migration" variance. The land disposal prohibitions become effective on the dates indicated below.

November 8, 1986	-	Solvents
July 8, 1987	-	California List*
August 8, 1988	-	At Least One-Third of All Other Listed Wastes
June 8, 1989	-	At Least Two-Thirds of All Other Listed Wastes
May 8, 1990	-	All Remaining Listed Wastes and All Characteristic Wastes

No prohibitions are applicable to contaminated soil and debris from the Comprehensive Environmental Response, Compensation and Liability Act (Superfund) sites until November 8, 1988. A complete schedule of the land disposal prohibitions can be found in 40 CFR 268.10 through 268.13. These prohibitions apply to all hazardous wastes identified under RCRA as of November 8, 1984. For hazardous wastes identified in 40 CFR 261 after that date, EPA must make prohibition determinations within 6 months of the date of listing or identification of the new hazardous wastes. However, the statute does not impose an automatic prohibition on land disposal if EPA misses a deadline for any newly listed or identified waste.

Direct land disposal of an untreated waste may be allowed nationally by EPA for up to 2 years if treatment capacity is inadequate. In addition, two 1-year case-by-case extensions of the effective dates of prohibitions may be granted under certain circumstances. The applicant must demonstrate that adequate capacity to treat, recover, or dispose the waste is not available by the effective date and that he has entered into a binding contractual commitment to provide such capacity. (EPA is developing a guidance document for case-by-case extensions.) All other untreated RCRA hazardous wastes will be banned from land disposal unless a "no migration" variance is received from the EPA.

* Based on regulations developed by the California Department of Health Services for hazardous waste land disposal restrictions in the State of California.

Additional Requirements of the Land Disposal Restrictions First Third Rule

In addition to promulgating specific treatment standards and effective dates for "First Third" wastes, the Land Disposal Restrictions First Third Rule [53 FR 31138, August 17, 1988] added new procedural and informational requirements at 40 CFR 268.6 for petitioners seeking to demonstrate "no migration" for land disposal units. Based on inquiries and comments received on the subject of "no migration" petitions, the Land Disposal Restrictions First Third Rule added the following requirements.

Compliance with Other Applicable Laws

40 CFR 268.6(a)(5) requires petitioners to include information demonstrating that units for which they seek a "no migration" variance comply with other applicable Federal, State, and local laws.

Monitoring Plans for Land Disposal Units

40 CFR Sections 268.6(a)(4) and 268.6(c)(1) require continued monitoring of media of concern to verify compliance with the "no migration" demonstration. Monitoring of hazardous waste units is also required unless technically impractical or infeasible.

Reporting of Changes in Operating Conditions From Those Described in the Variance Application

40 CFR 268.6(e) requires reporting of changes from conditions described in the variance application, including changes in the type of waste stream received, operating practices, unit design and construction, or unusual and significant changes in the environment, such as the water table or surface water flow.

Detection of Migration of Hazardous Constituents

40 CFR 268.6(f) requires immediate suspension of receipt of prohibited waste and notification of EPA within 10 days if it is determined that there is migration of hazardous constituents from the unit to any environmental medium.

Who Can Receive a "No Migration" Variance?

A "no migration" variance petition can be submitted by anyone who generates, stores, or disposes hazardous wastes. The petition for a "no migration" variance can be submitted by any interested waste generator or facility owner or operator, either individually or collectively. The petition must clearly demonstrate that the method to be employed protects human health and the environment. This requires showing, to a reasonable degree of certainty, that hazardous constituents will not exceed human health-based levels (or environmentally protective levels, if they are more stringent) beyond the edge of the disposal unit. The petition must also provide long-term assurance that the "no migration" variance criteria will be met. The variance only becomes effective after EPA reviews the petition, solicits public comments, and publishes a final determination in the Federal Register. In most cases, the variance will require monitoring to demonstrate continuing compliance (see substantive and procedural requirements in the Land Disposal Restrictions First Third Rule, August 17, 1988, 53 FR 31138).

In the November 7, 1986 Final Rule (51 FR 40572), the Agency identified several scenarios that may satisfy the "no migration" standard. These scenarios are not the only situations where "no migration" may be demonstrated successfully. The first is the placement of compatible non-volatile waste in a massive and stable geologic formation such as a salt dome. In this case, the Agency would expect the "no migration" demonstration to focus on the stability, extent, and homogeneity of the host formation, rather than on the concentration of hazardous constituents in the waste.

The second scenario is the placement of a waste consisting of fairly immobile constituents in a monofill located in an arid area that has no ground-water recharge. The petitioner would need to demonstrate that hazardous constituents will not migrate out of the unit above health-based (or environmentally protective) levels. Such a demonstration may be successful due to the well-defined characteristics of the waste constituents in a monofill.

In the third scenario, a treatment facility renders the waste nonhazardous through active chemical, physical, or other processes. An example is the neutralization of a corrosive waste, which does not contain hazardous constituents above health-based levels, in a surface impoundment. This scenario is especially applicable to wastes that are considered hazardous due only to their ignitable, reactive, or corrosive characteristics.

In the fourth "no migration" scenario, hazardous waste is stored temporarily for a purpose other than to accumulate sufficient quantities of the waste to allow for proper recovery, treatment, or disposal within the meaning of RCRA Section 3004(j). The waste is stored in a totally enclosed indoor waste pile with a floor or bottom liner, where engineered containment systems and air pollution controls are effective over the period the waste remains in storage. Inspections of the building are performed frequently to ensure that precipitation is not entering the unit.

Except for temporary storage or treatment operations, it should not be assumed that man-made barriers or engineered systems (e.g., liner systems, steel tanks) alone will meet the "no migration" standard. Although artificial barriers in conjunction with partial waste treatment or barriers that are expected to last substantially longer than the hazardous life of the waste may enhance a petition, artificial barriers alone cannot be relied upon to provide the long-term assurances required. For this reason, "no migration" variances are not envisioned for conventional land disposal units (e.g., landfills and surface impoundments).

In addition, the EPA will generally deny variances to any disposal facility with a history of continuing mismanagement of hazardous waste and serious compliance problems, as evidenced by State or EPA monitoring and inspection reports. Minor infractions in compliance should not affect EPA's review of a petition. However, for a unit located in a waste management area where releases have occurred, the owner or operator is not encouraged to submit a "no migration" petition unless he can conclusively demonstrate that the release is not from the unit seeking a variance.

What is the Definition of the "Unit Boundary?"

The unit boundary (and consequently, the point of compliance (POC)) is defined by the extent of the natural or engineered barriers that contain the waste. (In demonstrating "no migration," a strong preference will be shown for units relying upon natural barriers to prevent migration.) For land treatment units, the unit boundary would be the lateral and vertical extent of the treatment zone. The unit also includes within its boundary any dikes or berms that immediately surround it. For the air medium, the POC for demonstrating "no migration" is the downwind boundary of the unit at a height of 1.5 meters.

How are Levels of Constituents Evaluated?

A successful "no migration" demonstration must show that actual or predicted concentrations of hazardous concentrations or emission rates at the edge of the disposal unit do not exceed Agency-approved health-based levels or environmentally-based levels for ground water, surface water, soil, and air. If health-based criteria do not exist for a constituent, the applicant may propose his own health-based levels using the toxicity testing guidelines contained in 40 CFR Parts 797 and 798, and the Agency guidelines for assessing health risks (51 FR 33992, 34006, 34014, and 34028). If no health-based level can be determined for a constituent, that constituent must not exceed analytical detection limits. If health-based levels are below analytical detection limits for a constituent, the petitioner must demonstrate, using modeling, that the health-based levels will be met. However, in any compliance monitoring required for the unit where health-based levels are below detection limits, meeting detection limits would constitute compliance with the demonstration. In calculating these concentrations, the petitioner should use site-specific data to evaluate how the hazardous constituents will be apportioned between media. When site-specific data are not available, worst-case assumptions must be used.

In reviewing the petition, EPA will compare the calculated concentrations of hazardous constituents to Agency-approved levels. For example, the Agency would compare the constituent concentrations in leachate to the Maximum Concentration Levels (MCLs). If an MCL is not available for a constituent, the appropriate health-based levels would be the Reference Dose (RfD) for noncarcinogens and the Risk Specific Dose (RSD) for carcinogenic compounds. These health-based criteria have been calculated by assuming chronic (lifetime) exposure by ingestion of contaminated water. More information on these health-based numbers is available in the Superfund Public Health Evaluation Manual, U.S. EPA, 1986; and the Integrated Risk Information System (IRIS); U.S. EPA, 1988. IRIS is available through various on-line networks such as DIALCOM Inc., the Public Health Network, and the National Library of Medicine's TOXNET.

For a "no migration" petition, it is necessary to evaluate the concentration of contaminants in air, surface water, and soil as well as in ground water. The Agency has published health-based levels for soil ingestion and inhalation for a subset of the hazardous constituents listed in Appendix VIII of 40 CFR 261. The preliminary draft RCRA Facility Investigation (RFI) Guidance (EPA 530/SW-87-001, July 1987); and the preliminary draft Surface Impoundment Clean Closure Guidance, U.S. EPA, 1987 contain tables of health-based criteria, as well as explanatory text on the assumptions used to calculate the numbers. Because all health- based numbers are subject to review and change, EPA recommends that the petitioner contact EPA's Environmental Criteria and Assessment Office in Cincinnati, Ohio at (513) 569-7531 to obtain up-to-date information on health-based levels.

In addition to comparing individual constituents to the appropriate health-based level, the Agency will also consider additivity in evaluating the risk posed by concentrations at the unit boundary. For example, if the petition identifies two constituents that appear at the unit boundary at levels which are below health-based limits for each of the constituents, the Agency will also consider the potential threat posed by adding the two constituents. In general, the Agency will consider additivity only for constituents in the same medium (e.g., air). For more information on the EPA's policy on chemical mixtures, the petitioner should refer to the Guidelines for the Health Risk Assessment of Chemical Mixtures (51 FR 34014).

Petitioners for units in high background situations must demonstrate that the incremental contributions of contaminants from their unit will not, in and of themselves, exceed health-based levels.

How Long is "As Long As the Wastes Remain Hazardous?"

This is a waste- and site-specific determination. For some waste types that degrade naturally to health-based levels in a relatively short time period, the petitioner may only have to demonstrate such degradation and show "no migration" from the unit during the degradation period. On the other hand, where nondegradable constituents such as metals will exist within the unit, the petitioner will potentially have to demonstrate "no migration" forever, unless such constituents are removed at closure or the unit is capped. (Capping will only be acceptable where there is not leaching potential as determined using the toxic characteristic leaching procedure (TCLP) with water.) Note, however, that the UIC program considers a demonstration of "no migration" for 10,000 years to be sufficient. While this time frame may be valid for degradation in the injection zone, is not necessarily valid for other land disposal units.

What is the Relationship Between Land Treatment Units and "No Migration"?

Land treatment units are subject to all of the general provisions of the land disposal restrictions program, since they are considered to be disposal units under RCRA 3004(k). Thus, in order to apply restricted wastes which do not meet the BDAT performance standards, an owner or operator of a land treatment unit should consider applying for a "no migration" variance.

The petitioner for a land treatment unit must demonstrate that the "no migration" standard is met for all media. The land treatment demonstration (LTD) need not be complete in order to receive a "no migration" variance. The "no migration" variance will be granted based upon certain basic monitoring and modeling data. However, the variance will be conditioned upon completion of the LTD within a specified time period (usually two years after the date of granting of the "no migration" variance), or else the variance will be revoked.

Many wastes that are currently land-treated contain significant amounts of volatile constituents and/or metals. The petitioner must demonstrate a sufficient level of degradation and/or immobilization of waste constituents and metals within the treatment zone to assure that hazardous constituent concentrations will remain lower than human health-based or environmentally-based standards at the treatment zone/soil boundary. For land treatment units, the "disposal unit" consists of the treatment zone (plus the liner, if any exists). For volatile constituents, the applicant must demonstrate that the health-based or environmental levels are not exceeded at the downwind edge of the unit boundary at a height of 1.5 meters. This demonstration should be made by using site-verified emission and dispersion models, emission monitoring and/or ambient air monitoring. In addition, an applicant may need to pretreat a volatile waste (e.g., air stripping with appropriate air pollution controls) in order to successfully demonstrate "no migration" of the contaminant to the air. (For more information on "no migration" demonstrations for the air medium, see the Appendix.) The applicant should attach all relevant parts of his land treatment demonstration permit application to the "no migration" petition, including biotoxicity studies, degradation studies, and general site information regarding ground water, surface water, climate, and soil.

The LTD can be used as a basis upon which to build a "no migration" petition. However, the information that is typically provided in the LTD is largely current monitoring information. The petition must contain sufficient modeling and theoretical, long-term projections to insure that migration will not occur to any medium "for as long as the wastes remain hazardous." Because the LTD does not address the air medium, the air demonstration must also be added. Finally, a TCLP using water (at the pH of ambient rain water) to determine metals leachability must be performed at closure, and a closure and post-closure plan must be submitted (as part of the petition) where metals are projected to accumulate above health-based levels. If metals will exceed health-based levels for ingestion at closure, the unit's closure plan must require either capping with post-closure monitoring (where metals are not leachable above health-based levels), or clean closure (where metals are leachable above health-based levels).

What is the Relationship between "No Migration" Variances, RCRA Permits, and Other Federal Laws?

"No migration" variances may only be issued for facilities functioning under interim status or facilities with permits under RCRA. Because much of the information that must be included in a RCRA Part B application must also accompany the petition for a "no migration" variance, facility owners and operators are encouraged to submit petitions with the relevant Part B data summarized, and copies of critical Part B materials attached as needed.

Before being issued a "no migration" variance, the petitioner must assure the EPA that land disposal of the prohibited waste(s) will comply with all other applicable Federal laws. These may include the Clean Air Act, the Clean Water Act, the Safe Drinking Water Act, the Endangered Species Act, the National Historic Preservation Act, the Wild and Scenic Rivers Act, the Coastal Zone Management Act, the Fish and Wildlife Coordination Act, the Atomic Energy Act, and the Marine Protection, Research and Sanctuary Act. The operation for which a variance is sought must also be in compliance with applicable State and local laws and ordinances.

Can Generic Petitions be Submitted Covering Several Similar Facilities?

Yes, but generic petitions should be avoided as a practical matter. The usefulness of a generic petition is limited since petitions must include site- and waste-specific data. Accordingly, petitioners would have to demonstrate that each scenario covered under a generic petition is essentially the same. For example, a demonstration that the hydrogeological characterization of each site is essentially the same would require the detailed assessment of each site addressed in the petition. As a result, the Agency expects few, if any, generic petitions for surface land disposal units.

When Does a Variance Become Effective and How Long Does it Last?

Variances will be effective only after issuance; submittal of a petition will not exempt a facility from complying with applicable land disposal prohibitions.

Variances will be valid for up to 10 years, but not longer than the term of the facility's RCRA permit. The variance will automatically expire upon termination or denial of a RCRA permit, or when the volume of waste for which the variance was issued is reached. In the Land Disposal Restrictions First Third Rule, the Agency has listed notification requirements if migration is detected. Any significant departure from the terms or conditions of a variance would require written notification of EPA, who will determine the appropriate action. Possible actions include termination of waste acceptance at the unit, termination of the petition, or petition modifications. The conditions of the variance may require periodic waste analysis to assure the consistency of waste constituents. If migration from the unit is discovered after a variance has been granted, the owner or operator must immediately stop receipt of the restricted waste and notify EPA. EPA will then decide whether the unit can continue to receive waste, or whether the variance will be terminated. Substantive requirements for variances for waste disposal in deep injection wells may differ slightly from those described above. The reader should refer to the July 26, 1988 rule (53 FR 28118) for more detailed information on injection wells.

What is the Petitioning Procedure for "No Migration" Variances?

Outlined below is a step-by-step process for the submittal and review of "no migration" petitions, illustrated in the figure on the following page. As stated in the preamble to the November 7, 1986 Final Rule, EPA believes that there will be relatively few petitions. Accordingly, EPA is requiring that applicants submit petitions to the EPA Administrator. Petitioners should note that authorized State programs are free to impose disposal prohibitions if such actions are more stringent or broader in scope than Federal programs (RCRA Section 3009 and 40 CFR 271.1(i)). Where States impose bans which contravene an EPA action, such as not allowing provisions for granting a "no migration" petition, the more stringent State standard shall apply and the petition will be denied by EPA.

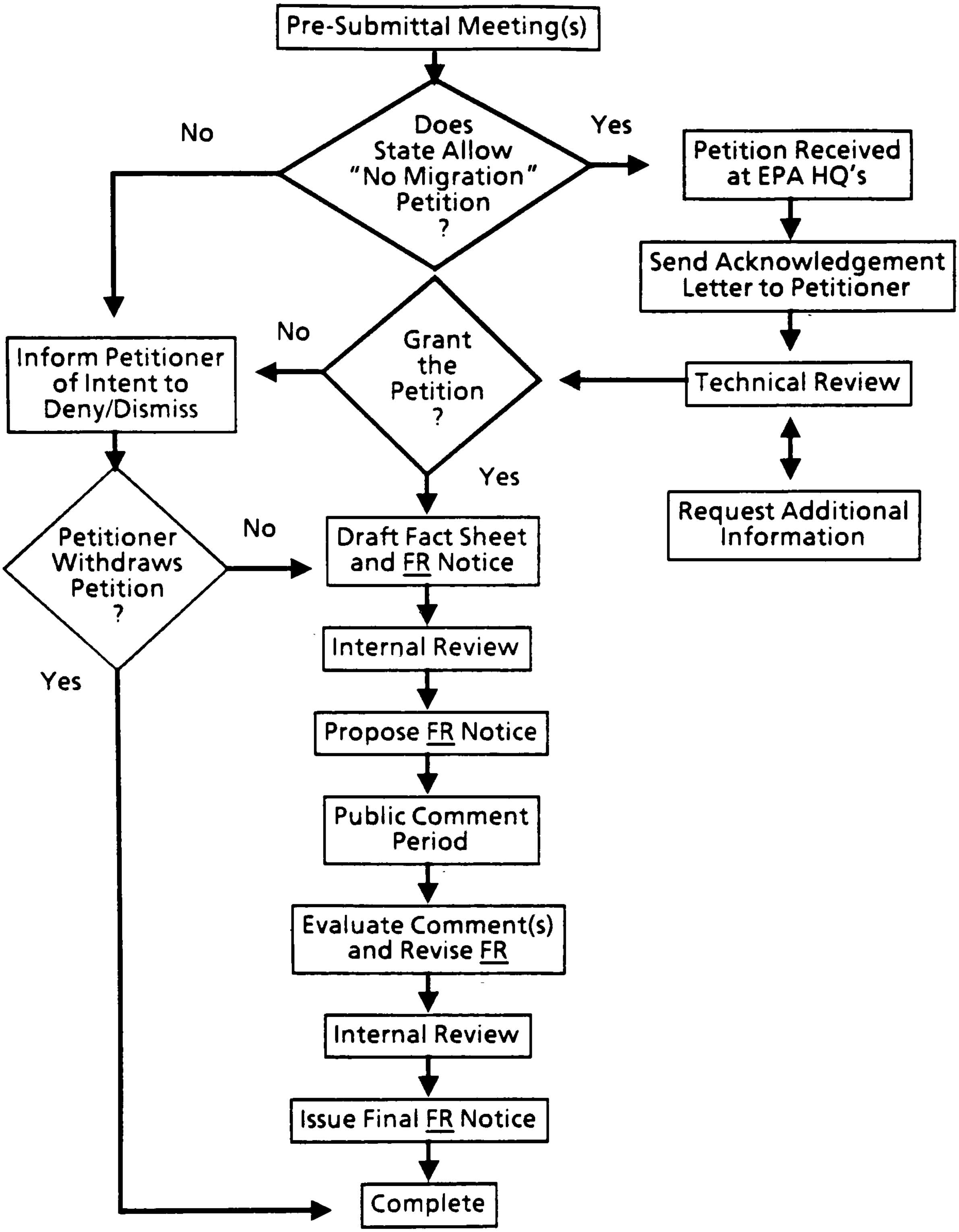
Pre-Submittal

A very important component to the "no migration" process is pre-submittal meetings between the petitioner and the EPA. These meetings are critical in ensuring expeditious decisions on petitions. The purpose of the pre-submittal meeting is to provide the petitioner with an opportunity to identify the hazardous waste, hazardous constituents, and disposal unit(s) to be included in the petition. The EPA can provide some historical background on the review of similar petitions, including a tentative timeframe for the review process. The Agency also recommends that petitioners submit a preliminary outline of their petition for Agency review.

Petition Submittal

As required by Sections 268.6(c) & (d) of the regulations, each petition must be submitted to the EPA Administrator and include the following statement signed by the petitioner or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this petition and all attached documents, and that, based on my inquiry of those individuals immediately responsible for



"No Migration" Petition Review Process

obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

The petition should be sent to the following:

The Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

To facilitate review, a copy of the petition should also be sent to the Assistance Branch in the Office of Solid Waste. The copy should be sent to:

Chief, Assistance Branch
Office of Solid Waste
U.S. Environmental Protection Agency
401 M Street, S.W. (OS-343)
Washington, D.C. 20460

Once the petition has been received by the EPA, a public docket will be established for the petition and a person from the Assistance Branch (the reviewer) will be assigned to the petition. The reviewer will send a letter to the petitioner acknowledging receipt of the petition. This letter may also contain a tentative timeframe for the review of the petition. Copies of this letter will be distributed to the appropriate EPA Regional Office and State Agency.

Petition Review

The reviewer will perform an initial review of the petition. Once this initial review is completed, the reviewer will decide if additional information is needed to make a decision on the petition. If additional information is needed, a letter requesting the information will be sent to the petitioner. Information to aid in the review may also be requested from the Regional or State contact. The request letter to the petitioner will contain a deadline for the submittal of the additional information. This deadline will be dependent on the type of information being requested. However, the deadline will not exceed a period of 180 days from the date of the request letter. Once the reviewer has obtained all of the necessary information for the review, a comprehensive, technical review will be performed. As part of this review, the reviewer will work closely with the Regional and State contact and will normally perform a site visit.

If the additional information is not received by the deadline, or a request for an extension of the deadline is not submitted, the reviewer may recommend that the petition be dismissed. The Agency plans to dismiss incomplete petitions by letter. A dismissal letter will be sent to the petitioner and to the appropriate State and EPA regional contacts. The effect of a dismissal is to remove the petition from the review process and close the petition file. The petitioner may at any time re-submit a complete petition.

Decision to Grant or Deny

Once the technical review is complete, the reviewer will recommend a tentative decision to grant or deny the petition. If the reviewer recommends to grant the petition, the Agency will publish a draft Federal Register notice describing its intent to grant the petition. If the reviewer recommends that the petition be denied, the petitioner will be informed by letter of the intent to deny. This letter will also offer the petitioner the opportunity to withdraw the petition. If the petitioner declines to withdraw the petition, the Agency will publish a draft Federal Register notice describing its intent to deny the petition.

What Information Should be Included in a "No Migration" Petition?

"No migration" petitions will vary considerably. The petition content will be strongly influenced by the type of facility for which a variance is sought and the methods chosen to demonstrate that the facility will adequately protect human health and the environment. The petitioner must provide site-specific information and may, additionally, provide generic and national information for certain requirements. The descriptions of petition content provided on the following pages are intended to illustrate the nature and complexity of the information that may be required.

The information in this manual should be used as a starting point for assessing the level of detail that will be required for each element of the petition. Such assessments can best be accomplished in pre-petition conferences between the Agency and facility owners and operators.

Discussions of each of the principal petition components listed can be found in the following pages. A detailed checklist of possible petition requirements is presented at the end of this manual.

<u>Waste Descriptions</u>

"No migration" variances are available only for the disposal of specific wastes at specific units. Variances are not available for broad categories of wastes; they are issued only for those wastes for which compliance with the "no migration" standard is demonstrated in the petition. Proper management of wastes for as long as they remain hazardous requires that potential incompatibilities and waste transformation mechanisms be assessed.

Hazardous and nonhazardous wastes may interact causing changes in their toxicity and/or mobility. Therefore, it is essential that the applicant individually characterize, to the extent possible, each waste to be placed in the unit, including wastes not subject to the land disposal ban.

All waste descriptions must be properly documented and in compliance with prescribed quality control and quality assurance guidelines. The following is a breakdown of the information required on each petitioned waste.

Waste Types and Sources --

Background information must be provided on each waste to be covered by the variance. Such information includes the applicable waste codes (EPA and industrial), the waste-generating processes, the hazardous constituents and their properties, the quantities of waste to be placed in the unit and the rates of placement, and handling and storage practices.

Waste Characteristics --

Complete physical and chemical characterization is required for each petitioned waste and all other wastes to be placed in the unit. The potential for leachate formation, waste solubilities, hazardous-constituent vapor pressures, and other factors that could affect waste mobility should also be assessed. Analytical information should include results of testing for Appendix VIII constituents reasonably expected to be present in the waste, toxicity characteristic leaching procedure (TCLP) results to determine the leachability of contaminants, simulation models of leachability and transport, and field leachate analyses, if available. Acceptable procedures for waste sampling and analysis can be found in the EPA publication Test Methods for Evaluating Solid Waste.

Waste Incompatibilities --

The codisposal of incompatible wastes can result in the generation of heat, the production of flammable and toxic gases, and the solubilization and mobilization of hazardous constituents. A comprehensive assessment of waste compatibilities would include all potential chemical interactions, reaction products, and product characteristics. The applicant must document, to the extent practicable, any waste incompatibilities and reaction products.

Waste Transformation Mechanisms --

To properly demonstrate that wastes can be contained in the unit, the applicant may be able to show that wastes change over time, resulting in nonhazardous degradation products. In addition, it may be necessary to characterize the mechanisms by which the wastes change over time. Waste transformations may alter waste mobility and/or toxicity and should be predicted to properly determine the resulting concentrations of hazardous constituents at the unit boundary. In either case, thorough characterization should be provided for reaction rates, products, and product characteristics for each transformation mechanism. The petitioner may also be called upon to characterize combinations of transformation mechanisms. An assessment of the stability of the waste matrix, matrix characteristics, and the effect of all transformation mechanisms on the matrix should be provided. The mechanisms that must be accounted for in a "no migration" demonstration are as follows:

Biodegradation. The breakdown of a compound by microbial attack, may be very important for organic compounds. Degradation rates are dependent on environmental conditions (pH, salinity, dissolved oxygen, nutrients), the concentrations of waste and microbes, and the types of microbes.

Photodegradation. A chemical change in a compound resulting from absorption of ultraviolet light, must be considered where appropriate. Tests to determine the photodegradation rates must control for pH, light wavelength, light intensity, competing reactions, temperature, and waste concentrations.

Hydrolysis. The degradation of a chemical compound upon reaction with water, may be a significant transformation mechanism for some wastes.

Oxidation/reduction. The transfer of electrons between molecules, is a common degradation mechanism.

Volatilization. Although technically not a *transformation* mechanism, is the conversion of a solid or liquid material into a vapor state. It may represent a significant waste *transport* mechanism (i.e., from one medium to another). Determination of environmental factors affecting volatilization rates (e.g., temperature, pressure, vapor pressure, solubility) may also be required.

The likelihood of these and other waste transformation mechanisms should be described in the petition. The methods by which petitioners determine transformation rates, whether actual waste data or theoretical calculations, also must be thoroughly described. The actual testing of waste transformation processes or the use of accepted procedures for transformation rate determination may be required.

Facility Description

The petition should include a description of the hazardous-waste management facility where the waste will be disposed in sufficient detail to familiarize the reviewer with its overall operation. The facility name, mailing address, and location should be provided, together with information on a point of contact for correspondence concerning the petition. The nature of the facility's business should be identified and, for onsite facilities, the processes involved in the generation of hazardous wastes should be described. Operators of offsite facilities should identify the types of industries serviced.

Detailed design, layout, and operating plans should be provided for the unit covered by the petition. The type of information and level of detail provided should be similar to those included in RCRA Part B permit applications. (Detailed guidance concerning Part B applications for land disposal units can be found in the EPA's 1984 Permit Applicants' Guidance Manual for Hazardous Waste Land Treatment, Storage and Disposal Facilities.) Unit descriptions should focus on waste isolation capabilities of the unit or environmental setting.

Although man-made barriers and engineered systems alone cannot be relied upon to provide the long-term "no migration" assurances required, they may play a role in the facility operation. The exception is certain temporary storage and treatment facilities that may rely entirely upon engineered systems to isolate wastes. All barriers should be thoroughly described.

The unit boundaries, which will serve as the compliance point for the variance, should be defined and thoroughly described. In the case where there is no engineered boundary above the waste to control air emissions, the downwind edge of the unit at a height of 1.5 meters will be the point of compliance for air emissions.

Other aspects of facility design and operation may be considered in evaluating the petition, including:

Monitoring systems
Procedures employed to prevent hazards

Contingency plans
Personnel training plans
Closure plans
Post-closure plans

These elements of the facility description are also common to Part B applications. Any relevant Part B information should be summarized in the petition, or attached as necessary.

Site Characterization

A thorough description of each facility's natural environmental setting is crucial to a "no migration" demonstration. The site's climatology, meteorology, geology, and hydrology must be described in sufficient detail to permit assessment of the degree of waste isolation achievable. Environmental factors and long-term environmental changes that may impact the waste isolation potential of the unit should be addressed. Moreover, background air, soil, surface water, and ground water quality must be determined to properly assess any potential impacts of land disposal. The information that may be required is similar to the requirements for a Part B permit application and a RCRA Facility Investigation (RFI). (Detailed guidance concerning RFIs can be found in EPA's 1987 RCRA Facility Investigation Guidance Manual.)

However, since a "no migration" demonstration does not allow for consideration of fate and transport of hazardous constituents above acceptable levels outside the unit boundary, the focus of site characterization should be on the potential impacts of the site on the waste to be isolated in the unit. For example, the potential impacts of wind, rainfall, and the fluctuation in the ground-water table on the unit and the waste within it must be addressed. Information on particularly sensitive or vulnerable site characteristics may be useful in determining the degree of certainty required in a "no migration" demonstration.

Geology --

A comprehensive geologic description should include regional, local, and site information. A discussion of regional and local geology should include the following components and contain maps and other supporting documentation:

Structure. Density, distribution, and orientation of faults, folds, and fractures

Subsurface Geology. Identification, lithologic description and thicknesses of all geologic formations underlying the region, available geophysical surveys, well logs, and boring logs

Geomorphology. Discussion of present surface features, processes that could affect surface features, and subsurface features that may be implied

Geologic Stability. Potential for earthquakes and degree of resulting ground motion, faulting, landslides, subsidence, creep, and other types of earth movement

The discussion of local geology should also include soils and topography. The soils information should encompass soil types (Unified Soil Classification System), properties, thicknesses, and depths to bedrock. In addition, similar site-specific geologic information should be provided, whenever possible.

Ground-Water Hydrology --

The petition should include a comprehensive description of regional, local, and site ground-water hydrology. Ground water is particularly vulnerable to contamination with hazardous constituents from land disposal units and, in many cases, can provide an avenue for waste constituent transport to surface waters and municipal and private wells as well as provide a subsurface migration pathway for gases. In some instances ground water may migrate into a unit, mobilizing contaminants out of the unit. The following types of information, including maps and supporting documentation, may be required for a "no migration" petition:

Identity and lateral extent of all aquifers, confining layers, and perched water tables

Characteristics of all necessary aquifers and confining layers, including thickness, porosity, permeability, hydraulic conductivity, and storage

Ground-water elevations and seasonal variations thereof

Existence of aquifer interconnections

Ground-water flow rates, directions, and recharge and discharge areas

Locations of all local municipal and private wells and surface water discharge areas

Surface-Water Hydrology --

A discussion of surface-water hydrology should include identification of all watersheds within the region that could potentially affect the facility. Maps of regional and facility drainage and the effects of facility run-on and run-off controls should be provided. Floodplain maps incorporating appropriate flood frequency data should also be provided. It must be clearly demonstrated that waste isolation will not be adversely affected by floods with a reasonable probability of occurrence during the period in which the wastes are hazardous (e.g., 25-year floods, 100-year floods, etc.).

Climatology and Meteorology --

Sufficient meteorological and climatological information will need to be provided to allow for the assessment of impacts of these factors on the disposal unit and site. The climate and meteorology of the site can have significant impact on the rate of emissions to air, for example. The following types of information may be required:

Site wind roses

Data on precipitation, temperature, and relative humidity data (seasonal maximums and minimums)

Maps of severe storm tracks and statistics on storm occurrence

Data on depth of seasonal freezing

Facilities relying in part on climatic factors to control waste migration (e.g., arid regions with no ground-water recharge) will be required to submit considerably more information than facilities that are not significantly affected by climatic changes.

Background Environmental Quality --

The RCRA regulations specifically require that "no migration" petitions contain analyses of background air, soil, and water quality. The analyses and levels of detail should be site-specific. Those petitioners with facilities in sensitive environments will be required to submit considerably more background data than other petitioners.

Monitoring Plans

Monitoring of all environmental media at land disposal sites is necessary to confirm that "no migration" of hazardous constituents beyond the unit boundary occurs. Accordingly, the Land Disposal Restrictions First Third Rule [53 FR 31189, August 17, 1988] amended 40 CFR 268.6 to require that "no migration" petitions include a plan for monitoring at the unit boundary, to include the following information:

Media to be monitored

Type of monitoring to be conducted at the unit

Location of the monitoring stations

Frequency of monitoring at each station

The specific hazardous constituents to be monitored

An implementation schedule for the monitoring program

Equipment to be used at the monitoring station

Sampling and analytical techniques to be employed

Data recording/reporting procedures

The petitioner should provide sufficient information to justify the design of the monitoring program and to demonstrate that monitoring stations will be located to detect migration from the unit at the earliest practicable time.

Monitoring immediately at the unit boundary may be difficult in certain locations or under unusual physical conditions at the site. Under such circumstances, the petitioner should propose a monitoring plan to be conducted as near as possible to the unit boundary without compromising the integrity of the unit. One such case may be hazardous waste repositories in geologic formations that are so extensive that installation of monitoring wells around the formation itself may not allow detection of migration at the earliest time, and installation of monitoring wells in the formation may damage the integrity of the formation. Monitoring of the repository itself (e.g., pressure monitoring of fluids between well casings in solution-mined caverns, or leachate sumps and pumps in room-and-pillar mines) may be suitable in this case.

In other cases, monitoring of all environmental media at a particular facility may be unnecessary. An example of this might be monitoring of air outside a totally enclosed treatment facility. In such a case, petitioners should include information that clearly demonstrates why monitoring of any medium is unnecessary.

In addition to monitoring at the unit boundary, the petition should also include a plan for monitoring the wastes in the unit to detect any changes in waste composition which could affect the potential for migration of hazardous constituents over time. Such monitoring might include periodic testing of the waste in the unit; leachate collection systems in surface impoundments, landfills, and room-and-pillar mines; and fluid or gas pressure monitoring in well casings above solution-mined cavities in salt domes.

A petitioner may be able to incorporate all or part of a monitoring plan designed to comply with 40 CFR 264 or 265 Subpart F requirements into the "no migration" monitoring plan. For example, a petitioner may be able to use Subpart F monitoring wells if they will detect migration at the earliest practicable time, and may only have to increase the frequency of monitoring. However, the petitioner should be aware that "no migration" monitoring is different from Subpart F monitoring in that it is to be performed immediately at, or as close as possible to, the unit boundary. Subpart F ground-water monitoring, on the other hand, does not necessarily occur at the unit boundary. Furthermore, although Subpart F detection monitoring for indicator parameters may be helpful to demonstrate "no migration", "no migration" monitoring should be for a set of constituents determined based on a unit-specific analysis of the waste.

Waste Mobility Modeling

Accurate and representative modeling of waste constituent mobility may be required for the environment within the unit including unit liners and engineered barriers. Presented below is a brief overview of information requirements for modeling as well as considerations relevant to the choice of a representative model.

Several types of models may be used to predict waste mobility within the confines of the unit for which a variance is sought. Although hazardous constituents must not exceed human health-based levels beyond the natural or engineered boundary of the unit, waste migration within the unit will be acceptable. Models may be developed for predicting leachate and gas generation rates, barrier integrity over time, and many other factors that can affect waste mobility. All such models and the assumptions underlying them must be thoroughly explained, and descriptions of the calculations and codes employed must be provided.

Modeling of waste and leachate migration in the unsaturated zone may be required for some units (e.g., the treatment zone of a land treatment unit). Waste constituent transport within that zone depends on site geology, soils, and climatology, as well as the physical and chemical characteristics of the waste and leachate. The factors affecting flow at or near the land surface are precipitation, run-off/run-on, evaporation, and transpiration.

Physical properties of the site soils that affect flow in the unit and the unsaturated zone that should be described in the petition include:

Water content
Pressure potential
Permeability
Degree of water saturation
Bulk density
Particle density
Water capacity
Hydraulic conductivity
Water diffusivity

The waste or leachate in the unsaturated zone can be affected by various chemical processes, including ion exchange, adsorption, precipitation, dissolution, and complex formation. Those processes appropriate to the waste and its leachates must be considered. Moreover, certain properties of the soil can be affected by the waste or leachate: its hydraulic conductivity can be changed; its permeability can be increased by the removal of organic matter or a change in adsorptive properties; and others of its properties can be altered by the dewatering of clays or a change in pore size. Flow patterns within the soil can also be altered by changes in pore size due to the dissolution and precipitation of chemical species. The impact of these factors must be taken into account in the model.

The potential for air emission of hazardous constituents from the waste surface into the atmosphere must be addressed. Emission rates are influenced by environmental as well as chemical and physical factors. The principal environmental factors influencing air emissions are temperature, soil characteristics (e.g., pH, moisture, grain size), and precipitation. The waste or leachate properties that must be modeled include vapor pressure, solubility, chemical activity, partitioning behavior of the solute (waste) between the atmosphere and water (Henry's Law), diffusivity, absorption, and release rate.

Limitations of any air emission release rate (AERR) and dispersion models must be documented. The applicant should combine the use of models with ambient air and emission monitoring to characterize conditions at the unit to the best extent possible. Any models used must be verified at the site. (For more information on the "no migration" demonstration methodology for the air medium, see the Appendix).

Appropriate models must be chosen for each of the waste mobility cases discussed (i.e., unsaturated zone, air, etc.). The choice depends on the objectives of the study and on the sensitivity of the model to various chemical and physical processes. The chosen model should be one that is sensitive to all of the significant processes and most sensitive to those processes of greatest importance.

Other concerns in choosing a model are how well it represents the field situation, whether it is appropriate for the available data, and whether it can be verified for accuracy by comparison to actual measurements. The most sophisticated models may be inappropriate for the available data.

The petitioner has the following quality assurance and quality control responsibilities for every model used:

Model validation. Comparing the results of analytical and numerical models or matching field data to the model results is critical to model validation. All models must be validated at the site.

Justification of assumptions. Proper justification of all assumptions should be provided. In all cases the most conservative assumptions should be chosen.

Sensitivity tests. An assessment of the influence of changes in the magnitude of model parameters should be provided. Models should show greatest sensitivity to the most influential processes.

Model accuracy assessment. It must be demonstrated that: (1) the model reasonably represents the actual physical system, (2) there are no computational errors in the computer code, and (3) there is a high degree of correlation between the model and measured data.

The EPA is discouraging the use of proprietary models, since the models selected will have to be closely scrutinized to determine their reasonableness and accuracy. Only data developed under appropriate QA/QC procedures as described in the facility QA/QC plan will be considered in the petition review.

Assessment of Environmental Impacts

In a "no migration" demonstration the petitioner must show that hazardous constituents do not exceed human health-based levels at the edge of the disposal unit. If more applicable levels must be met to protect the environment, then those levels will be required. For example, stricter levels may be needed where there is potential impact to a sensitive environment or an endangered species even if human health- based levels are met. The assessment of environmental impacts does not mean that migration of hazardous constituents will be measured outside of the unit. Such an assessment should be undertaken merely to determine if human health-based levels measured at the unit boundary are sufficient to protect any sensitive environmental receptors.

Environmental assessments should identify any factor which may require the use of stricter contaminant levels. This will involve defining the terrestrial and aquatic species that may be exposed to contaminants and the exposure pathways through which the species may be sensitive (e.g., inhalation, direct contact). Acute and chronic toxicity and bioaccumulation factors must be quantified for each constituent with respect to the species involved. Effects of transported and transformed air pollutants (e.g., ambient ozone or photochemical oxidants) on agricultural crops, forests, or materials should be considered by the applicant. Field studies and biomonitoring may be performed in the absence of data, or available data for chemical analogs may be substituted.

Environmental considerations may include but are not limited to evaluation of:

Species diversity and abundance potentially affected by migration from the unit

Bioaccumulation potential in plants and animals

Fishery and habitat impacts

Endangered species of flora and fauna potentially affected by migration from the unit

Biological community structure alteration potential

It is important to note that, for many chemicals, exposure levels deemed safe for humans often have adverse effects upon terrestrial and aquatic life. In addition, toxicants present at low levels in the environment may bioaccumulate, presenting significant health risks to man and animals higher in the food chain.

Prediction of Infrequent Events

The petitioner must identify and quantify the impacts of events that could contribute to or result in inadequate waste isolation. Natural phenomena that should be considered include:

Earthquakes and resulting ground motion
Floods and droughts
Tsunamis (tidal waves)
Hurricanes and tornadoes
Climatic fluctuations
Geologic activity

In addition, human-induced events which may affect the isolation capability of the unit, such as disturbance of the hydrologic regime and future land uses, must be considered. The potential for such events during the period in which the wastes remain hazardous should be determined. Potential impacts of events with a reasonable probability of occurring during that period should then be estimated with respect to the facility's ability to isolate wastes from the environment.

Analyses of predictable events should take into consideration both the disposal unit and the surrounding environment. For example, ground motion resulting from an earthquake may cause the breaching of a unit, the fracturing of surrounding rocks, and surges in the ground-water level. Previously unconsidered avenues for contaminant migration may be created by the earthquake. In analyzing the potential consequences of predictable phenomena, probable worst-case scenarios should be used to ensure that any errors occur on the side of safety.

Quality Assurance and Control

A QA/QC plan that addresses all aspects of the petition demonstration must be included in the petition submittal. Quality goals and methods to assure that these goals are achieved must be included for each of the following aspects of the petition demonstration:

Waste and environmental monitoring, sampling, and analysis activities

Field measurements of the facility setting, such as geophysical exploration, ground-water monitoring, weather observations, and topographic mapping

Validation of computations, codes, models, and methods used in calculating critical facility parameters

Control of construction activities to ensure compliance with design specifications

Evaluation of the integrity of construction materials

At a minimum, the QA/QC plan should identify goals for each of the following quality indicators and describe how they will be achieved:

Data representativeness. The degree to which data accurately and precisely represent a characteristic of a population, a parameter, variations at a sampling point, or environmental conditions.

Data accuracy. The degree to which data agree with an accepted reference or true value. The measurement of accuracy exposes any bias in a system or method.

Data precision. A measure of the mutual agreement between comparable data gathered or developed under similar conditions. Precision is best expressed in terms of a standard deviation.

Data completeness. A measure of the amount of valid data obtained against the amount that was expected.

Only data developed under appropriate QA/QC procedures as described in the facility QA/QC plan will be considered in the petition review.

CHECKLIST OF INFORMATION NEEDS

The following checklist is a comprehensive, but not all-inclusive, list of information needs. Individual petitions may require more or less information than that presented below. The level of detail required will depend on site-specific factors.

Facility Description

- ☐ Name of facility
- ☐ Address of facility
- ☐ Name of owner/operator
- ☐ Anticipated period of operation
- ☐ Status of RCRA permit application
- ☐ Location map
- ☐ Detailed site plan
- ☐ Aerial surveys
- ☐ Advantages/disadvantages of location
- ☐ Evaluation of storage/disposal unit
  - ☐ Design objective
  - ☐ Design criteria
  - ☐ Design performance projection
  - ☐ Materials specifications
  - ☐ Detailed drawings and specifications
  - ☐ Documentation of unit construction
  - ☐ Documentation of unit operation
- ☐ Closure plans
- ☐ Post-closure plans
- ☐ Cover design
- ☐ Design QA/QC demonstration (testing & inspection)
- ☐ Facility operation QA/QC demonstration

Waste Characteristics

- ☐ Waste type by name
- ☐ Processes that produced the waste
- ☐ Hazardous properties
- ☐ Physical characteristics
- ☐ Chemical characteristics
- ☐ Biological properties
- ☐ Constituents and percentages of constituents
- ☐ Analytical methods and results
- ☐ Projection of waste volume to be disposed
- ☐ Quantity of banned waste being disposed
- ☐ Frequency of disposal
- ☐ Period of time waste has been and will be disposed
- ☐ Handling procedures
- ☐ Waste treatment before, during and after disposal
- ☐ Liquid phase mobility information
- ☐ Gas/particulate mobility
- ☐ Solid phase mobility
- ☐ Dust generation potential
- ☐ Gas-liquid phase interactions
- ☐ Persistence/degradation potential in unit and environment
- ☐ QA/QC demonstration

Waste Transformation and Immobilization

- ☐ Estimation of quantity and quality of leachate formation
- ☐ Waste/waste compatibility, interaction, reaction products
- ☐ Waste/liner compatibility
- ☐ Assessment of biodegradation potential
- ☐ Assessment of oxidation/reduction potential
- ☐ Assessment of immobilization due to insolubility
- ☐ Assessment of photodegradation potential
- ☐ Assessment of immobilization due to hydrolysis
- ☐ Assessment of immobilization due to adsorptivity

Site Characterization

- ☐ Surficial geology and soils (regional and local)
  - ☐ Topography
  - ☐ Soil types
  - ☐ Soil properties
  - ☐ Depth to bedrock
- ☐ Bedrock geology (regional and local)
  - ☐ Stratigraphy and lithology
  - ☐ Seismic activity of area

- ☐ Assessment of ground motion potential and degree
  - ☐ Geologic cross sections
  - ☐ Degree of bedrock faulting and fracturing
  - ☐ Rock characterization
- ☐ Ground-water hydrology (regional and local)
  - ☐ Water table map
  - ☐ Seasonal variations in the water table
  - ☐ Identification of all aquifers and aquitards
  - ☐ Characterization of all aquifers
  - ☐ Vertical and horizontal hydraulic conductivity
  - ☐ Aquifer interconnection
  - ☐ Description of ground-water monitoring program
  - ☐ Monitoring QA/QC documentation
- ☐ Surface water hydrology
  - ☐ Location of all watersheds
  - ☐ Map of drainage patterns
  - ☐ Map of floodplain
  - ☐ Flood analysis
- ☐ Meteorology/climatology
  - ☐ Wind rose
  - ☐ Precipitation records
  - ☐ Temperature records
  - ☐ Relative humidity records
  - ☐ Maps of storm tracks

Monitoring Plan

- ☐ Media to be monitored
- ☐ Type of monitoring to be conducted at the unit
- ☐ Location of monitoring stations
- ☐ Frequency of monitoring at each station
- ☐ Specific hazardous constituents to be monitored
- ☐ Implementation schedule for the monitoring program
- ☐ Equipment used at the monitoring stations
- ☐ Sampling and analytical techniques employed
- ☐ Data recording/reporting procedures

Waste Mobility

- ☐ Unsaturated zone soils
  - ☐ Soil sampling
  - ☐ Soil testing
- ☐ Unsaturated zone physical properties
  - ☐ Volumetric water content
  - ☐ Degree of water saturation
  - ☐ Bulk density
  - ☐ Pressure potential
  - ☐ Relative permeability
  - ☐ Unsaturated hydraulic conductivity
  - ☐ Water capacity
  - ☐ Water diffusivity
- ☐ Leachate characteristics affecting mobility
  - ☐ Leachate characterization
  - ☐ Leachate interactions
- ☐ Secondary leachate evaluation
- ☐ Evaluation of transport mechanisms
- ☐ Evaluation of fate of contaminants in unsaturated zone
- ☐ Vapor concentration of constituents at the source
- ☐ Vapor pressure of constituents
- ☐ Solubility data for constituents
- ☐ Activity coefficient
- ☐ Henry's Law constant
- ☐ Background measurements for air
- ☐ Assessment of volatilization potential

Modeling Evaluation

- ☐ Model accounts for all transport mechanisms
- ☐ Model appropriate for petitioned waste
- ☐ Data input accurate and verified
- ☐ Model tested under field conditions
- ☐ Model is accurate over long time periods
- ☐ Limitations of model
- ☐ Model inputs adequately documented
- ☐ Model outputs appropriate and reasonable

Assessment of Environmental Risk

- ☐ Identification of all exposure pathways and routes
- ☐ Identification of all potential receptors
  - ☐ Wildlife
  - ☐ Vegetation
  - ☐ Identification of sensitive or endangered species
- ☐ Assessment of bioaccumulation through the foodchain

Uncertainty Analysis

- ☐ Natural Events

- ☐ Climatic fluctuations
- ☐ Glaciation
- ☐ Stream erosion
- ☐ Magmatic activity
- ☐ Epeirogenic displacement
- ☐ Orogenic diastrophism
- ☐ Diagenesis
- ☐ Static fracturing
- ☐ Dissolution
- ☐ Sedimentation
- ☐ Flooding
- ☐ Undetected features (i.e. faults, lava tubes)
- ☐ Meteorites
- ☐ Fires
- ☐ Hurricanes
- ☐ Tornadoes
- ☐ Earthquakes
- ☐ Ground motion

☐ Waste/facility-induced events

- ☐ Thermal effects
- ☐ Chemical effects
- ☐ Mechanical effects
- ☐ Modification of hydrologic regime

☐ Human-induced events

- ☐ Improper design or operation
- ☐ Past intrusions
- ☐ Future intrusions
- ☐ Intentional intrusion
- ☐ Perturbation of ground-water system
- ☐ Biosphere alterations

Where can I Obtain Additional Information Concerning "No Migration" Variances?

Additional information on "no migration" variances is available from EPA Headquarters in Washington, D.C. Facilities considering submitting a petition are strongly encouraged to meet with the Agency before preparing the petition to assess the exact nature of the information required in the "no migration" demonstration and the level of detail appropriate for the petition. Questions concerning petitions and requests for petition meetings should be directed to:

U.S. Environmental Protection Agency
Permits and State Programs Division
401 M Street, S.W.
Washington, D.C. 20460
Telephone: 202/382-4782

Questions concerning these and other RCRA requirements can also be directed to the RCRA/Superfund Hotline at 800/424-9346 or, in the Washington, D.C. metropolitan area, 202/382-3000. The Hotline can also provide assistance in obtaining copies of Federal regulations and other relevant guidance documents.

The following is a list of selected documents which may be of value to potential petitioners:

Permit Applicants' Guidance Manual for the General Facility Standards. 1983. EPA SW-968.

Permit Applicants' Guidance Manual for Hazardous Waste Land Treatment, Storage, and Disposal Facilities. 1984. EPA 530 SW- 84-004.

Hydrologic Simulation at Waste Disposal Sites. 1982. EPA SW-868.

Test Methods for Evaluating Solid Wastes, Third Edition. EPA SW-846.

A Method for Determining the Compatibility of Hazardous Wastes. EPA 600/2-80-076.

A Guide for Estimating the Incompatibility of Selected Hazardous Waste Based on Binary Chemical Mixtures. 1986. ASTM P-168.

Soil Properties, Classification, and Hydraulic Conductivity Testing. 1984. EPA SW-925.

Criteria for Identifying Areas of Vulnerable Hydrogeology Under the Resource Conservation and Recovery Act. 1986. NTIS 86-224946.

RCRA Facility Investigation Guidance Manual, Draft Final. May 1987.

Solid Waste Leaching Procedure. 1984. EPA SW-924.

Waste Analysis Plan Guidance Manual. 1984. GPO 055-000-00244-4.

Construction Quality Assurance for Hazardous Waste Land Disposal Facilities, Draft. 1985. EPA/530 SW-85-021.

RCRA Groundwater Monitoring Technical Enforcement Guidance Document, 1986.

Surface Impoundment Clean Closure Guidance Manual, Draft Final. September, 1987.

Superfund Public Health Evaluation Manual. EPA/540-1-86-060.

Guidelines for Carcinogenic Risk Assessment. 51 FR 33992-34003.

Guidelines for the Health Risk Assessment of Chemical Mixtures. 51 FR 34014-34025.

Integrated Risk Information System (IRIS) Chemical Files. EPA/600/8-86/032b.

APPENDIX

DRAFT AIR PATHWAY ASSESSMENT METHODOLOGY FOR "NO MIGRATION" DEMONSTRATIONS

OCTOBER 1988

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1.0 INTRODUCTION

The Environmental Protection Agency promulgated a final rulemaking (51 FR 40572) that established the overall framework for the land disposal restrictions as mandated by the Hazardous and Solid Waste Amendments (HSWA) of 1984. A major requirement of the HSWA is that all hazardous wastes must be treated using best demonstrated available technology before placement into the land. Otherwise, the owner/operator is prohibited from land disposal of the waste. Section 3004(d), (e), and (f) also provides an opportunity for generators, owners, and operators to either individually or collectively petition for a variance from the prohibition against land disposal of hazardous wastes not treated according to Agency standards. In order to receive a variance, a petitioner must successfully demonstrate that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the waste remains hazardous [3004(d)(1)].

A no-migration demonstration methodology applicable to air releases has been developed. This methodology has been based on consideration of the emission and atmospheric dispersion potential of air contaminants from land disposal units. Typical hazardous waste disposal units such as land treatment, surface impoundments, and landfills have the potential for air contaminant emissions even with the application of control technology. Local wind conditions will result in the transport of these air contaminants beyond the unit boundary. Therefore, the air pathway assessment methodology presented in Section 2, which accounts for these emission/dispersion mechanisms, is recommended for no-migration demonstrations. An example application of this methodology is presented in Section 3.

2.0 AIR PATHWAY ASSESSMENT METHODOLOGY

2.1 Overview

The intent of a no-migration petition is to demonstrate that there will be no transport of hazardous constituents from the disposal unit. Therefore, the point(s) of compliance for air pathway assessments should be evaluated at the location(s) of the maximum air concentration on the unit boundary. This approach involves the application of standard emission and dispersion models to estimate air concentrations for comparison to available inhalation health criteria.

A standard exposure height of 1.5m should be used for no-migration air pathway assessments. This value corresponds with a typical inhalation height and facilitates the application of standard modeling/monitoring methods. The vertical profile of air concentrations may be quite significant but highly variable within 1m of the surface due to various microscale atmospheric effects. It is frequently difficult to obtain reoresentative air concentration samples or to accurately characterize dispersion conditions at exposure heights of less than 0.1m on or at the edge of area sources such as land treatment areas, surface impoundments, and landfills.

A combination of modeling and monitoring approaches can be used to estimate the maximum air concentration at 1.5m on the unit boundary. An overview of a recommended air pathway assessment methodology for no-migration demonstrations is illustrated in Figure 2-1. This methodology consists of the following major components:

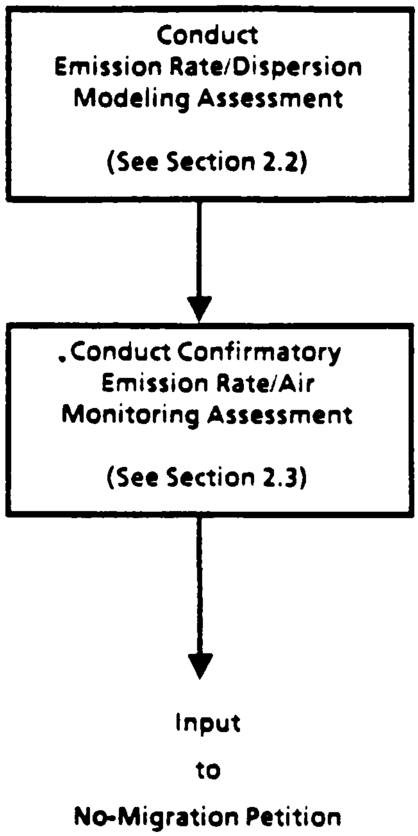
- Conduct of an emission rate/dispersion modeling assessment
- Conduct of a confirmatory emission rate/air monitoring assessment.

A modeling assessment should initially be conducted to characterize the air emission potential for the disposal unit and to estimate maximum air concentrations at the unit boundary. The recommended methodology for the conduct of modeling assessments is presented in Section 2.2.

A monitoring assessment should also be conducted to confirm modeling estimates. Monitoring should be conducted at existing units in order to provide additional information for EPA decisionmaking. Monitoring data from similar units, as available, should be submitted for no-migration demonstrations involving new land disposal units. In addition, the EPA may require confirmatory monitoring as part of the permit conditions for a unit. The recommended

FIGURE 2-1

AIR PATHWAY ASSESSMENT METHODOLOGY FOR
NO-MIGRATION DEMONSTRATIONS



methodology for the conduct of monitoring assessments for no-migration demonstrations is presented in Section 2.3.

2.2 Modeling Methodology

The air pathway assessment modeling methodology for no-migration demonstrations involves applying emission rate and dispersion models. These modeling results are used to estimate the maximum air concentrations at the unit boundary for comparison to health-based criteria. The methodology consists of five steps as follows (see Figure 2-2):

- Step 1 - Obtain Source Characterization Information: This information (e.g., unit size, waste quantity, etc.) is needed to define the emission potential of a disposal unit. The specific source data needed will be a function of the input requirements of the emission rate and dispersion models selected.

- Step 2 - Select Release Constituent/Surrogates: Unit and waste-specific information should be used to identify potential release constituents for modeling purposes. A limited set of surrogates can be selected to represent a wide range of potential release constituents. This approach significantly simplifies the modeling process.

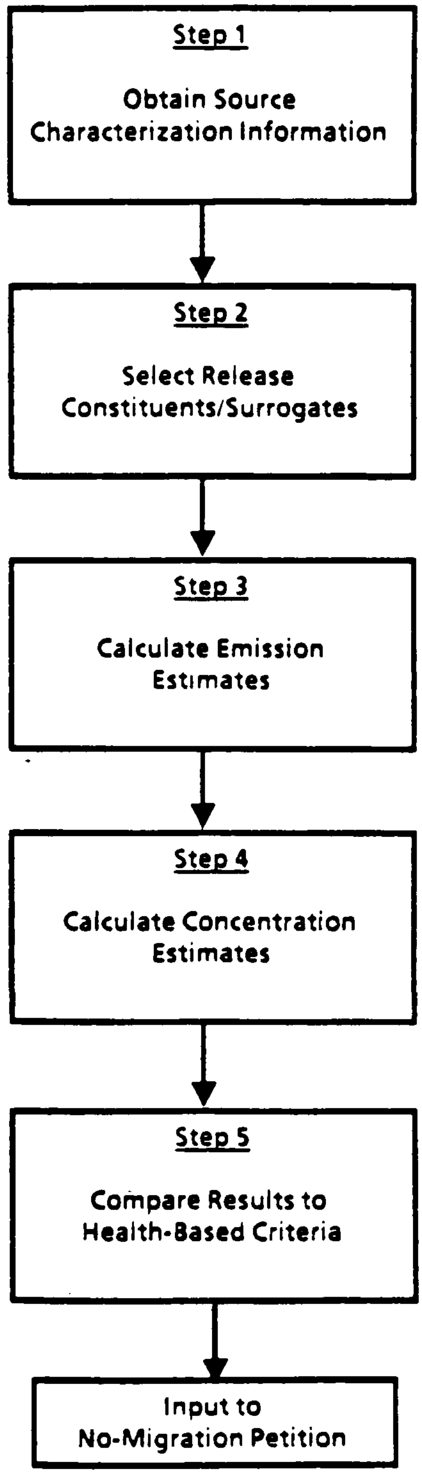
- Step 3 - Calculate Emission Estimates: Unit-specific emission models should be used based on source conditions identified in Step 1 for constituents identified in Step 2. These modeling results will provide emission rate estimates.

- Step 4 - Calculate Concentration Estimates: Emission rates from Step 3 should be used to calculate concentration estimates at the unit boundary. Standard dispersion models should be used to obtain these concentration estimates.

- Step 5 - Compare Concentration Results to Health-Based Criteria: Concentration results from Step 4 should be compared to constituent-specific, health-based criteria presented in the RCRA Facility Investigation Guidance (U.S. EPA, 1988). Chronic exposures for carcinogens should be evaluated by comparison of the estimated maximum annual (1-year) concentration directly to the annual average concentrations (based on health criteria and assuming a 70-year exposure). Interpretation of the ambient concentration estimates should account for the uncertainties associated with the source/waste

FIGURE 2-2

MODELING METHODOLOGY OVERVIEW



characterization data, and modeling inaccuracies. It is also necessary to consider background concentrations and contributions from other sources.

An expanded discussion of this five-step process is available in the Air Release Screening Assessment Methodology. (U.S. EPA, 1988).

Recommended emission rate methods and dispersion modeling methods as they apply to no-migration demonstrations are presented in Section 2.2.1 and 2.2.2, respectively.

2.2.1 Emission Rate Modeling

Air emission models can be used to estimate constituent-specific emission rates based on waste/unit input data for many types of waste management units. (An emission rate is defined as the source release rate for the air pathway in terms of mass per unit time.) The models applicable to land disposal units are based upon theoretical considerations and have been evaluated against pilot-scale and field test results. Often these models are empirically correlated. However, because the models attempt to predict complex physical and chemical phenomena, they should be used carefully. These models are generally considered accurate within an order of magnitude (assuming representative input data) for short-term emission rate estimates. Accuracies for long-term estimates are more favorable and are also limited by mass balance considerations (i.e., the emission rate cannot exceed the waste input to the disposal unit).

The modeling methodology for no-migration demonstrations is based on the application of CHEMDAT6 air emission models (applicable to releases of volatile organics) developed by EPA's Office of Air Quality Planning and Standards and available from NTIS. (U.S. EPA, December 1987). CHEMDAT6 includes air emission rate models for the following land disposal units:

- Land treatment
  - Oil film surface
  - Land treatment soil
- Disposal impoundment
- Landfills
  - Open landfills
  - Closed landfills

Comprehensive technical information regarding these CHEMDAT6 models is presented in the Hazardous Waste Treatment, Storage and Disposal Facilities (TSDF) Air Emission Models. (U.S. EPA, December 1987). This reference also presents air emission rate models for many other units.

The potential variability of the waste and unit input data should be accounted for in the modeling assessment. Therefore, a sensitivity analysis of this variability relevant to emission rate estimates should be conducted to determine the level of confidence associated with the emission modeling results.

For some applications, Step 4 - Calculate Concentration Estimates will not warrant the use of emission models because it can be assumed that all the volatile wastes handled will eventually be emitted to the air. This assumption is generally appropriate for highly volatile organic compounds placed in a disposal unit like a surface impoundment. In these cases, the air emission rate can be assumed to be equivalent to the disposal rate, so that an emission rate model may not be required. This assumption is valid because of the long-term residence time of wastes in the disposal units. In open units like surface impoundments, a substantial portion of the volatile constituents will frequently be released to the atmosphere within several days. However, for more complex situations (e.g., land treatment units and landfills), air emission models can be used to obtain a more refined release rate.

2.2.2 Dispersion Modeling

Emission rate values from Step 3 should be used as modeling input to calculate concentration estimates at the unit boundary. Two alternative types of models (i.e., flux models and dispersion models) are candidates for this application.

Flux models can be used to evaluate concentrations at and in the vicinity of an area source. (Most disposal units such as land treatment areas, surface impoundments, and landfills can be classified as area sources.) Although these models can be technically sophisticated, they generally lack extensive validation.

Standard dispersion models used by EPA for regulatory applications are based on the assumption that the downwind concentration of air contaminants can be characterized by a statistical (Gaussian) distribution. Validation efforts have confirmed the performance of this class of models. Atmospheric dispersion models are typically accurate within a factor of two to three for flat terrain sites (inaccuracy can be a factor of 10 in complex terrains). However, validation studies have been quite limited in regard to receptors near an area source boundary. However, dispersion model predictions for such situations are still considered more dependable than the use of flux models which have little, if any, validation. Therefore, the use of dispersion models is recommended for no-migration demonstrations.

The use of the Industrial Source Complex (ISC) model is recommended as a prime candidate for no-migration demonstrations. The ISCLT version of the model can be used to calculate long-term concentrations for exposure periods ranging from 24 hours to annual average estimates. The model can be used for both flat and rolling terrain. The ISC model software is available from NTIS and the user's guide is presented in Industrial Source Complex (ISC) Model User's Guide. (U.S. EPA, 1987).

Additional guidance on dispersion model selection and application is available in the Guideline on Air Quality Models (Revised). U.S. EPA, July 1986).

Meteorological data (i.e., wind and atmospheric stability summaries) are necessary dispersion modeling input. Data from a representative National Weather Service station can be used as available. Alternatively, onsite meteorological data can be used. Guidance on the conduct of meteorological programs is presented in On-Site Meteorological Program Guidance for Regulatory Modeling Applications. (U.S. EPA, June 1987).

Two alternative dispersion modeling approaches are available for no-migration demonstrations, as illustrated in Figure 2-3. The primary approach involves the direct application of the ISC dispersion model based on site-specific and unit-specific input data. The alternative (screening) approach involves the application of modeling results available for a limited set of source and meteorological conditions. Following is a description of each of these approaches.

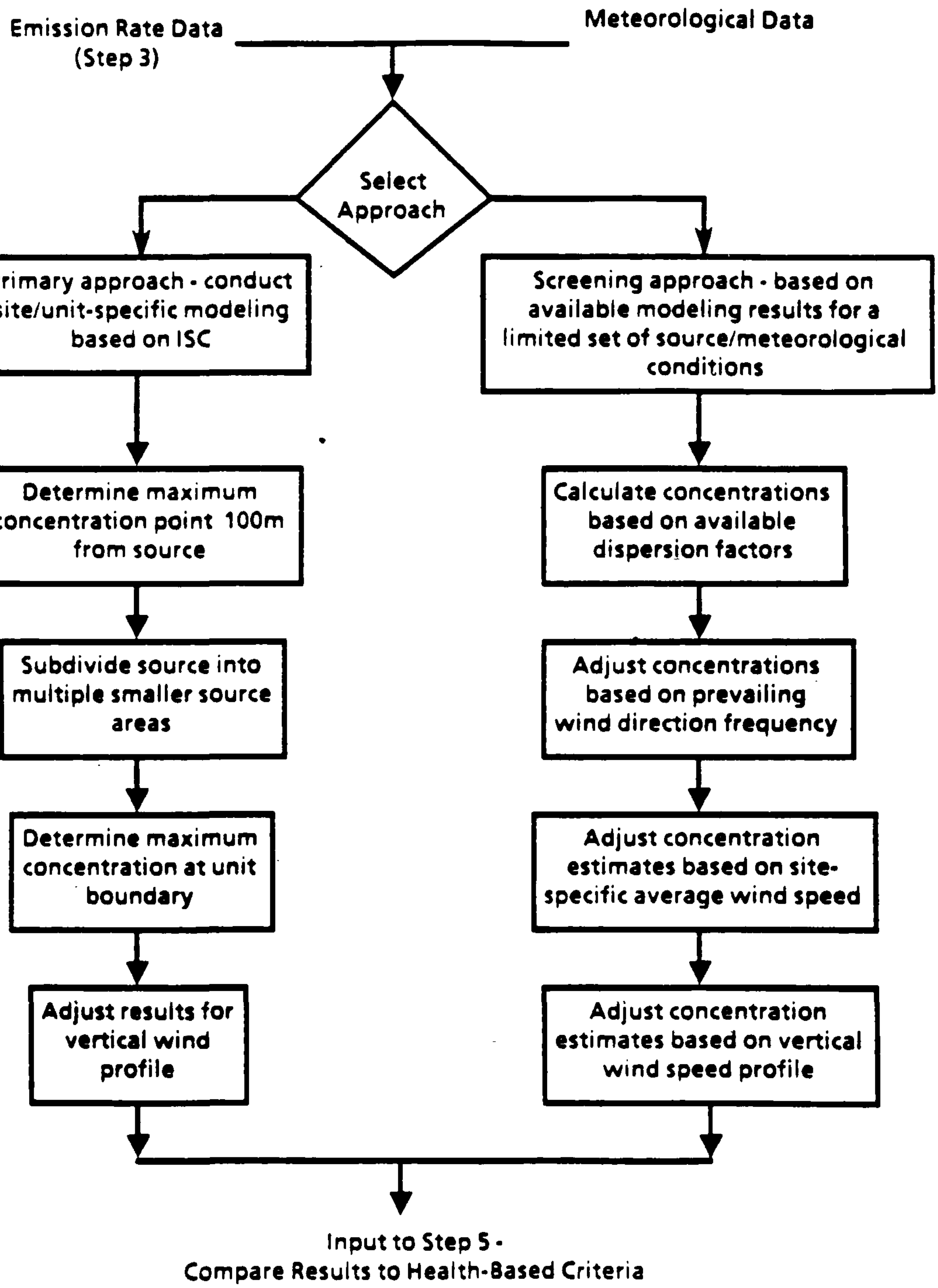
Primary Approach

The conduct of a dispersion modeling study based on site/unit-specific model input data is the recommended approach for no-migration demonstrations. This refined modeling approach involves the direct use of the ISC dispersion model to provide direct estimates of concentrations. This involves the following tasks, as indicated in Figure 2-3:

- Determine the point of the maximum concentration 100m from the source.
- Subdivide the source area into multiple smaller source areas.

FIGURE 2-3

STEP 4 - CALCULATE CONCENTRATION ESTIMATES



- Determine the maximum concentration at the unit boundary.
- Adjust modeling results, as necessary, to account for the vertical wind profile.

Dispersion modeling estimates should be obtained which are representative of unit boundary conditions. A specialized modeling approach is generally needed for standard dispersion models, such as ISC, in order to obtain concentration estimates near the boundary of a large area source. This approach consists of the following tasks, assuming a ground-level area source:

- Determine the point of maximum concentration at approximately 100m from the unit boundary using standard dispersion modeling methods. This is a standard computational distance for the ISC model. Concentration estimates should be obtained for 16 sectors of 22.5 degrees each in order to select the point of maximum concentration. These results will provide the basis to identify the 22.5 degree sector associated with the maximum concentration.

- Estimate the concentration at the unit boundary for the 22.5 degree sector associated with the maximum concentration point located 100m from the boundary. (For modeling purposes, a downwind distance of approximately 1m from the unit boundary can be used for this estimate as necessary.) Contributions to the receptor from all 16 sectors should be accounted for.

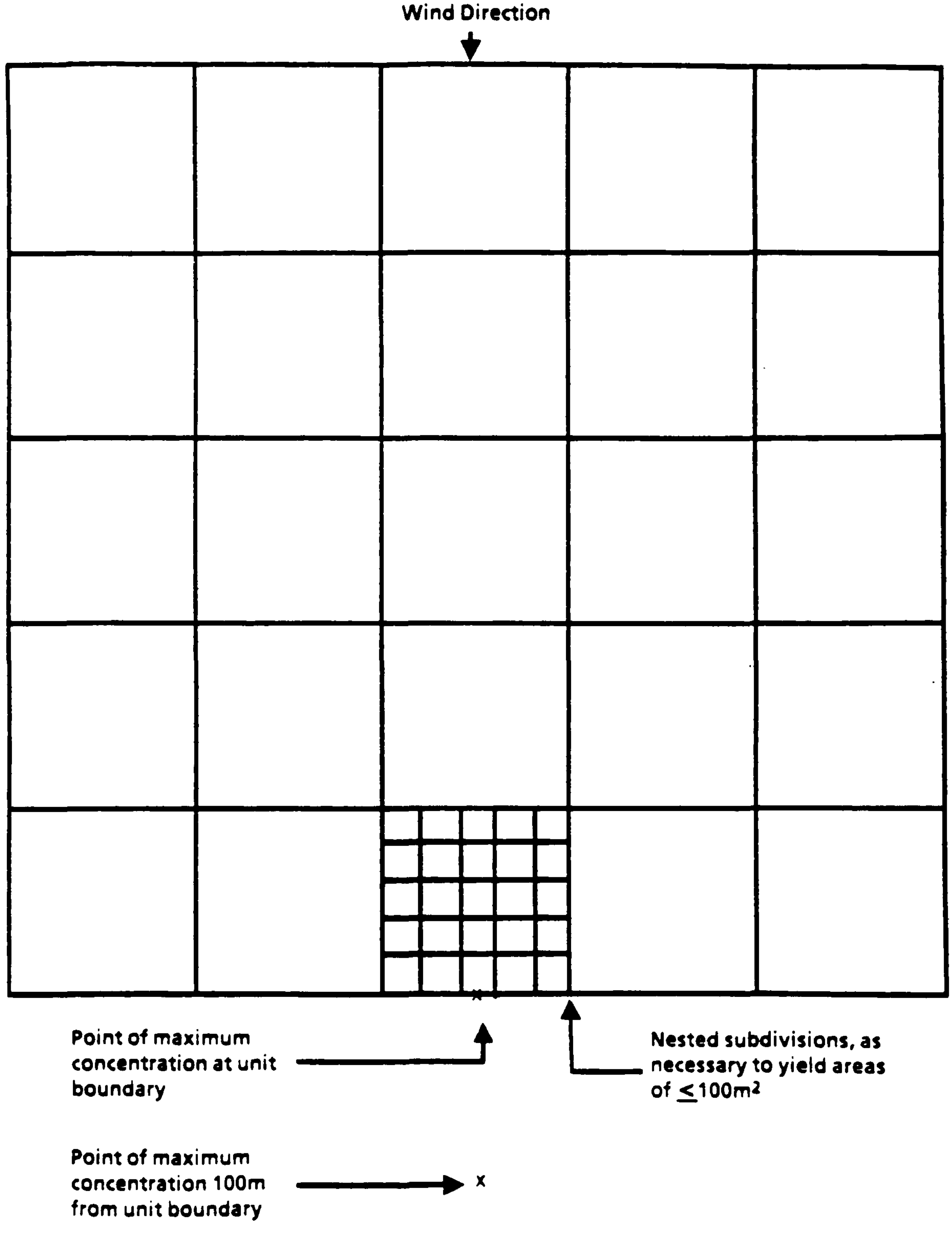
The concentration at 1m from the unit boundary can be obtained from ISC results by subdividing the source area into multiple smaller areas (see Figure 2-4). Computational restraints of ISC require that area sources must be represented as a square or multiple squares. (The ISC user's guide should be consulted for the approach to use for irregularly shaped area sources.) For no-migration demonstrations, it is recommended that the land disposal area should be represented by 25 squares of equal area.

The square along the edge of the unit boundary nearest to the point of maximum concentration should be further subdivided if the side of this square is greater than 10m. This approach will ensure a representative concentration estimate at the unit boundary (i.e., 1m downwind).

Concentration estimates for no-migration demonstrations should be representative of a 1.5m inhalation height. Meteorological data available for most modeling studies are based on a 10m tower height. Air concentrations are inversely proportional to wind speed. Near the surface, the mean wind speed has been found to increase in proportion to the logarithm of the height.

FIGURE 2-4

EXAMPLE SUBDIVISION OF AREA SOURCE



Therefore, wind speed values or modeling results should be adjusted, as necessary, to account for the vertical wind profile. Example wind profile adjustment factors are presented in Table 2-1 based on the logarithmic wind profile law. (U.S. EPA, 1974).

Table 2-1

EXAMPLE ADJUSTMENT FACTORS TO ACCOUNT FOR THE VERTICAL WIND SPEED PROFILE[a]

Wind Speed Measurement Height X (m)	Wind Speed Adjustment Factor [Ratio of Wind Speed (1.5m) to Wind Speed (Height X)]	Concentration Adjustment Factor (CAF) [Ratio of Concentration (1.5m) to Concentration (Height X)]
20.0	0.7	1.5
15.0	0.7	1.4
10.0	0.7	1.4
5.0	0.8	1.2
2.0	0.9	1.1
1.5	1.0	1.0

[a] Assuming neutral stability and uniform surface roughness.

Screening Approach

Screening dispersion modeling is an alternative to the refined modeling approach. The screening approach involves the manual calculation of concentration estimates based on adjusting dispersion modeling results available for a limited set of source/meteorological conditions. Since these results may be less representative than those based on the refined modeling approach, conservative assumptions should be used. Following are the tasks involved in the conduct of screening modeling as indicated in Figure 2-3:

- Calculate concentration estimates at the unit boundary based on available dispersion factors

- Adjust concentration estimates to account for the frequency of the prevailing wind direction

- Adjust concentration estimates to account for the site-specific average wind speed

- Adjust concentration estimates to account for the vertical wind profile.

This process can be summarized by the following equation:

$$C = ER \times DF \times UCF \times \frac{WDF}{100} \times \frac{10}{WS} \times CAF \qquad \text{Equation 2-1}$$

Where

C	=	concentration at unit boundary ($\mu g/m^3$)
ER	=	emission rate (10^6g/yr = Mg/yr)
DF	=	dispersion factor for appropriate source area (sec/m^3)
UCF	=	unit conversion factor (317)
WDF	=	frequency of occurrence of the prevailing wind direction (percent)
WS	=	average wind speed 1.5 (mph)
CAF	=	concentration adjustment factor to account for the vertical wind profile. (dimensionless)

The product of ER times DF times UCF yields an initial concentration estimate. The emission rate estimates from Step 3 should be used as ER values. Dispersion factor (DF) values can be obtained from Table 2-2 as a function of source area. These DF values are based on ISCLT dispersion equations for a receptor on the downwind unit edge assuming a square area source configuration (with no subdivisions of the area), neutral stability, 10 mph winds at a measurement height of 10m and an invariant wind direction (i.e., the receptor point for calculation purposes is directly downwind of the source 100 percent of the time).

This initial concentration estimate should be adjusted (using the parameters WDF, WS and CAF) to account for site-specific wind conditions. Representative National Weather Service or onsite meteorological data should be used as the basis for these adjustments.

TABLE 2-2

EXAMPLE UNIT BOUNDARY DISPERSION FACTOR VALUES

Unit Area (Hectares)	Dispersion Factors[a] (sec/m^3)
0.01	3.9×10^{-3}
0.04	2.6×10^{-3}
0.25	8.9×10^{-4}
1.00	2.8×10^{-4}
4.00	7.9×10^{-5}
25.00	1.5×10^{-5}
100.00	4.3×10^{-6}
400.00	1.4×10^{-6}

a Based on ISCLT results with the following assumptions:

- Ground-level area source (square configuration)
- Average wind speed of 10 mph at a measurement height of 10m (dispersion factors do not account for the expected lower wind speeds at 1.5m exposure height)
- Invariant wind direction
- Dispersion factors are the maximum value at the unit boundary

The receptor should be assumed to be within the 22.5 degree sector associated with the prevailing wind direction (i.e., the direction with the highest frequency of occurrence). Therefore, the WDF parameter should be used to account for this condition.

The modeling results presented in Table 2-2 are based on a 10 mph wind speed. The average wind speed (WS) at the site should, therefore, be used to adjust these modeling results. Similarly, a concentration adjustment factor (CAF) should be used to account for the vertical wind speed profile. Values of CAF are presented in Table 2-1 for a range of wind measurements heights to facilitate scaling concentration modeling results to represent a 1.5m inhalation exposure.

An example application of this approach is illustrated in Section 3.

2.3 Monitoring Methodology

A monitoring program may also be appropriate to confirm modeling estimates. This may involve emission rate monitoring and/or air concentration monitoring as illustrated in Figure 2-5. Recommendations for the conduct of an acceptable monitoring program are presented in the RCRA Facility Investigation Guidance. (U.S. EPA, 1988).

Emission rate monitoring can be used in conjunction with dispersion modeling to estimate concentrations at the unit boundary. (An appropriate dispersion modeling methodology has been discussed in Section 2.2.) Direct emission sampling should be used for point sources (e.g., vents at closed landfills). An isolation flux chamber may be used for area source emission measurements (e.g., land treatment areas). Multiple sampling locations are required to adequately characterize the spatial variability of emission conditions over an area source. Further guidance on the application of isolation flux chambers is provided in Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber: User's Guide. (U.S. EPA, 1986).

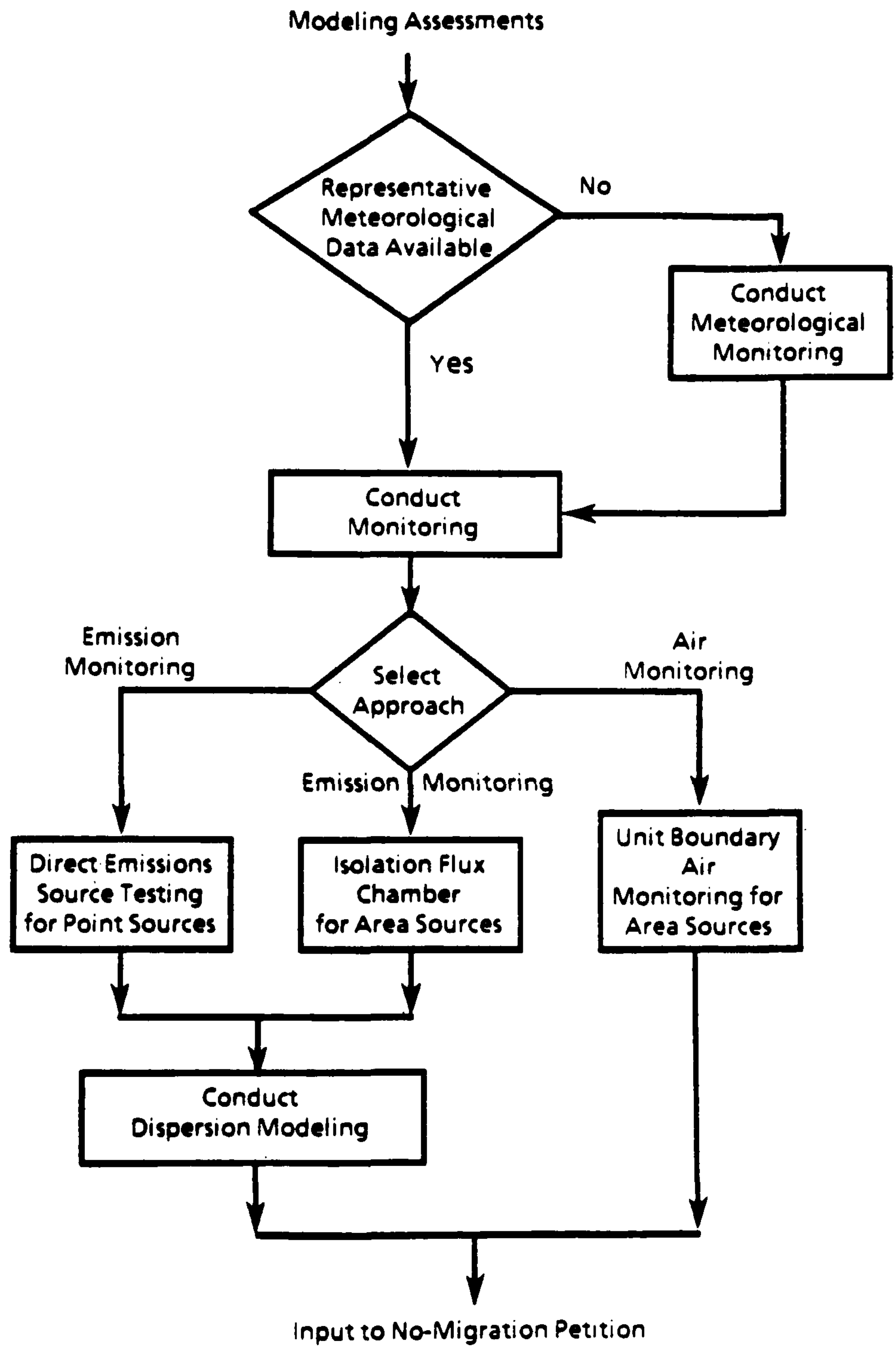
Air monitoring at the unit boundary is an alternative approach for characterizing area source emissions. This facilitates the direct measurement of air concentrations at the point of compliance. However, the selection of appropriate monitoring locations is critical to ensure the measurement of the maximum concentration. Also, the monitoring program duration must be adequate to determine maximum concentrations for averaging periods commensurate with health criteria. Additional recommendations for the conduct of air monitoring programs are presented in RCRA Facility Investigation Guidance. (U.S. EPA, 1988).

Representative meteorological data should be available as dispersion modeling input to calculate concentration estimates based on emission rate monitoring results. Meteorological data will also be necessary to interpret air monitoring results. Recommendations on the conduct of meteorological programs are presented in On-Site Meteorological Program Guidance for Regulatory Modeling Applications. (U.S. EPA, June 1987).

Monitoring results should be compared to health criteria as discussed in Step 5 of the modeling methodology (see Section 2.1).

FIGURE 2-5

MONITORING METHODOLOGY - OVERVIEW



3.0 EXAMPLE APPLICATION

The following case study has been selected to demonstrate the recommended air pathway assessment methodology for no-migration demonstrations. This case study also includes an example application of the screening dispersion modeling approach.

The case study involves a no-migration petition for a new land treatment unit at a site which also has similar existing units. Following is a synopsis of the modeling assessment for the new unit.

Step 1 - Obtain Source Characterization Information

The following information describes the proposed land treatment unit:

- Land area = 2.5 hectares
- Annual waste throughput = 1,800 Mg
- Oil content of waste = 10 percent by weight
- Tilling depth = 20 cm
- Soil air porosity = 0.5
- Soil total porosity = 0.61
- Average molecular weight = 282 g/g mol

Step 2 - Select Release Constituents/Surrogates

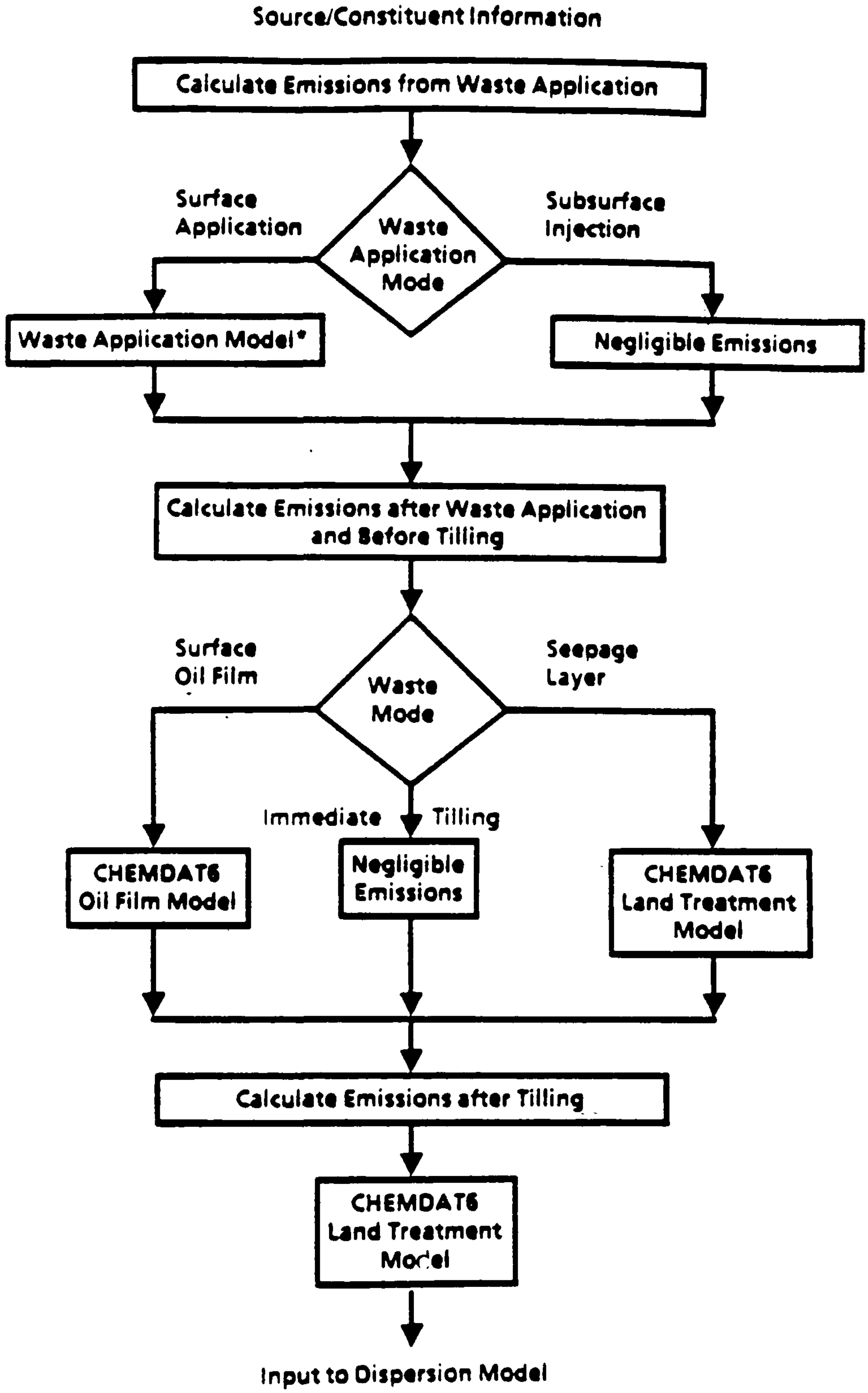
An evaluation of the expected waste constituents indicated that benzene was the constituent with the greatest potential volatility and most restrictive health criteria. Therefore, benzene was selected to represent the total volatile organic concentration (2,000 ppm by weight) of the oil content of the waste. Therefore, the benzene concentration was conservatively assumed to be 2,000 ppm by weight of the oil.

Step 3 - Calculate Emission Estimates

The emission rate modeling process for land treatment units is summarized in Figure 3-1. Air emissions can occur during three stages (i.e., during waste application, after waste application, prior to tilling, and after tiling). The appropriate emission rate models are also a function of the type of waste application (i.e., surface or subsurface injection) as well as the fate of the oil prior to tilling (i.e., formation of a surface oil film, oil seepage through a layer of the soil, or the waste is immediately

FIGURE 3-1

EMISSION RATE MODELING - LAND TREATMENT UNITS



* Equations presented in Hazardous Waste Treatment, Storage, and Disposal Facilities-Air Emissions Models (U.S. EPA, December 1987)

tilled into the soil). For this case study, it has been assumed that the unit will use subsurface injection followed by immediate tilling. Modeling results are summarized below for benzene:

Emission Source	Model	Emission Rate
• Subsurface injection	Not applicable	Negligible
• Immediate tilling	Not applicable	Negligible
• Soil after tilling	CHEMDAT6 land treatment model	0.33 Mg/yr

Step 4 - Calculate Concentration Estimates

The screening dispersion modeling approach was selected for this case study. Representative wind data were available from the National Weather Service. The frequency of the prevailing wind direction is 10 percent and the average wind speed is 8 mph (at a measurement height of 10m).

A maximum concentration at the unit boundary was estimated as follows:

$$C = ER \times DF \times UCF \times \frac{WDF}{100} \times \frac{10}{WS} \times CAF \qquad \text{Equation 3-1}$$

Where

C = benzene concentration at unit boundary ($\mu g/m^3$)

ER = benzene emission rate (0.33 Mg/yr)

DF = dispersion factor for source area of 2.5 hectares based on Table 2-2 (interpolated value of 1.2×10^{-4} sec/m^3)

UCF = unit conversion factor (317)

WDF = frequency of occurrence of the prevailing wind direction (10 percent)

WS = average measured wind speed (8 mph)

CAF = concentration adjustment factor from Table 2-1 to account for the lower wind speeds at the 1.5m receptor height compared to 10m wind measurement height (1.4)

Therefore:

$$C = (0.33) \times (1.2\times10^{-4}) \times (317) \times \frac{10}{100} \times \frac{10}{8} \times 1.4 \qquad \text{Equation 3-2}$$

$$= 0.002\ \mu g/m^3$$

Step 5 - Compare Concentration Results to Health-Based Criteria

A carcinogenic risk-specific dose of 0.12 $\mu g/m^3$ for benzene is presented in the RCRA Facility Investigation Guidance. (U.S. EPA, 1988). The estimated unit boundary concentration from Step 4 (0.002 $\mu g/m^3$) is lower than this health-based criteria. Background concentrations of benzene at this site due to emissions from existing units should also be accounted for.

A monitoring program was conducted at the site to confirm modeling estimates. A combination of emission rate measurements and air monitoring data at the boundary of an existing land treatment unit during worst case emission/dispersion conditions as well as at locations representative of background air concentrations was obtained. These monitoring data confirmed that benzene concentrations at the unit boundary (including background conditions) do not exceed health criteria.

4.0 REFERENCES

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