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Title

Supplementary Guidance on Determining Liner/Leachate Collection System Compatibility

Summary of Directive

This memorandum addresses several questions regarding the owner's and operator's responsibility to demonstrate the chemical resistance of liner and leachate collection and removal system components to the waste or leachate to which they are exposed. Outlined is the Agency's current position on High Density Polyethylene, testing of liner and leachate collection system components (other than the liner), environmental stress cracking, and changing leachate during the liner immersion test (Method 9090).

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- ☒ Other *(Specify)* ORD

This Request Meets OSWER Directives System Format

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG -7 1986

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Supplementary Guidance on Determining Liner/ Leachate Collection System Compatibility

FROM: Bruce R. Weddle, Director
Permits and State Programs Division

TO: Hazardous Waste Management Division Directors
Regions I-X

A number of questions have arisen regarding the owners' and operators' responsibility to demonstrate the chemical resistance of liner and leachate collection and removal system components to the waste or leachate to which they are exposed (see especially 40 CFR 264.301, 264.251, and 264.221). This memorandum answers some of these questions and further clarifies existing guidance (See especially the draft Minimum Technology Guidance on Double Liner Systems for Landfills and Surface Impoundments - Design, Construction, and Operation, May 1985.)

Is HDPE* a universal material for liner and leachate collection system components that needs no additional waste/leachate immersion testing?

No. HDPE is a relatively inert synthetic material that can chemically withstand a wide variety of substances; however, there are chemicals that can seriously affect the performance of HDPE (e.g., many aromatic and halogenated hydrocarbon compounds). Many of these chemicals are found in measurable concentrations in leachates generated at hazardous waste facilities.

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* HDPE (High Density Polyethylene) is one type of polyethylene liner material. Polyethylene materials are the most popular synthetic liner material being proposed for new units.

Long-term immersion test results from low level exposure to chemicals of concern showed measurable deterioration of HDPE properties. Therefore, low concentrations of chemicals of concern must be tested for liner compatibility if they will be present in the waste.

EPA has been asked by the Institute of Chemical Waste Management (ICWM) to consider approving HDPE liners as being chemically resistant to certain classes of wastes without chemical resistance testing. EPA is investigating this possibility by reviewing the available data and by discussing this issue with technical experts in the polymer chemistry field. At this time we have not completed our review of the technical issues or received enough data to grant blanket approvals for HDPE. In addition, preliminary conclusions from an EPA meeting with polymer chemistry experts indicate that in the case of a typical land disposal unit, they do not have the ability at this time to establish classes of chemicals that specific flexible membrane liner materials are universally chemically resistant to, primarily because of the complexity of the wastes, liner stresses posed by the typical land disposal environment (e.g., temperature ranges and differential loading), and variations in liner properties [See also response to next question].

Therefore, in general, EPA is unable at this time to approve HDPE (or any other liner material) for use at any hazardous waste unit without unit-specific verification of chemical resistance based on the specific liner material and waste for that unit. (Method 9090 or equivalent).

Does the generic term HDPE imply that all HDPE's are alike?

No. Polyethylene plastics, as defined by ASTM D 1248 (Polyethylene Plastics Molding and Extrusion Materials), are plastics or resins prepared by the polymerization of no less than 85% ethylene and no less than 95% of total olefins, by weight. Within this category HDPE is defined as having a density of greater than 0.940g/cm^3. This higher density is an indication of increased crystallinity that, with all other things being equal, produces a material that is harder, stiffer, more chemical and heat resistant, and stronger than less crystalline material. As density increases, the properties of elongation, resistance to environmental stress cracking, impact strength and permeability decrease. In addition, comonomers are added during resin manufacture that affect the degree of crystallinity and other material properties (depending on the processing technique and the type and amount of comonomer). Process type and process additives, such as carbon black, thermal/ultraviolet stabilizers and antiblocks, will also affect material properties.

When the sheet extruder gets the resin he will, in turn, extrude the material into a sheet using his own proprietary additives. The physical and chemical properties of the finished product will again be affected by the additives and type of extrusion process. (Even the handling of the material immediately after extrusion can affect material properties.)

As can be seen from the above description, individual HDPE liner properties can vary, depending on chemical composition and a number of processing factors.

EPA also notes that the ASTM designation for HDPE is not as meaningful as when originally proposed. Advances in resin manufacturing (such as the addition of new comonomers) have blurred the characteristic distinction between high density and medium density and even low density polyethylenes. Materials are being marketed that are technically medium density polyethylenes, but are labelled high density polyethylene, and, in fact, may exhibit some of the physical characteristics of high density polyethylene. Therefore, the density of the polyethylene is not necessarily as key to overall chemical performance as it once was. Since the designation HDPE is no longer as relevant as when first published by ASTM, EPA prefers to designate the various polyethylenes as "polyethylene" and distinquish one from another by their other properties, including resistance to environmental stress cracking, chemical resistance, yield strength, impact strength, seamability, etc. Density is but one of the factors affecting overall field performance.

For these reasons EPA is continuing to insist that owners and operators verify liner/leachate compatibility on the specific waste and liner material that will be used in each disposal unit. Verifying the compatibility of waste/leachate with a particular polyethylene does not guarantee in itself compatibility with other polyethylenes.

Therefore, permit writers should require owners and operators to demonstrate the chemical resistance (immersion testing) of the specific liner material(s) they expect to use in the actual construction. When the owner or operator has already performed the immersion test, and proposes to install a different manufacturer's polyethylene or a different "batch" or formulation of polyethylene, he must demonstrate that the alternate polyethylene is compatible by either running Method 9090 (or equivalent) on the material selected for installation or demonstrate material equivalence through a "fingerprinting" process (see attachment).

The attached guidance for "fingerprinting" is very general. If the owner or operator selects this option, agreeing on the nature of the testing program and interpreting test results will present difficulties. The effect of a change in any given "fingerprinting" characteristic (e.g., percent ash) is poorly understood.

What other liner and leachate collection system components are required by current regulations to be compatible with wastes?

Landfill design and operating requirements state that the leachate collection and removal system, as well as the liner, must be constructed of materials that are chemically resistant to the waste managed at the landfill and the leachate expected to be generated (§264.301(a)(2)). Landfill, waste pile, and surface impoundment design and operating requirements also state that liners and leachate collection systems must protect human health and the environment. It is, therefore, incumbent upon owners and operators to assure EPA that each component of the liner(s) and leachate collection system(s) is compatible with the leachate or waste to which it is subjected. Suggested general procedures for various components are as follows;

1. Piping - Piping should be prepared for strength testing per ASTM D 2412 or equivalent. At least one prepared sample should be subjected to the same immersion test as performed on the liner material (e.g., the immersion test outlined in Method 9090). After the immersion test, the pipe sample should be dried (per Method 9090) and subjected to a strength test (see especially ASTM D 2412 paragraphs 6-9). Testing of a control specimen (a sample not subjected to the immersion test) should be performed. A report should be prepared similar to that outlined in ASTM D 2412 paragraph 11 (including 11.1.7 and 11.1.9) comparing the test results of the immersed and control samples.

2. Geotextiles - Geotextiles can be used to perform any of three major functions in the land disposal unit: 1) protection of the flexible membrane liner, 2) use as filtering media, or 3) use in the transmission of liquid (water or leachate). Testing procedures for a given geotextile depend on its function. When the geotextile is used either as a filter or as a protective media for the flexible membrane liner, immersion testing like that for flexible membrane liners should be performed. After drying the immersed specimen(s),

both the immersed specimen(s) and identical control specimen(s) should be subjected to the ASTM D 1682 Grab Strength Test and the ASTM D 751 Puncture Strength Test to determine if a significant loss of strength has occurred.

Synthetic fabrics used for drainage, such as nets, should also be immersed in the expected waste/leachate. Following immersion, both a control specimen and the immersed specimen should be tested for in plane transmissivity. At this time no ASTM method exists to evaluate in-plane transmissivity; however, the Federal Highway Administration's Geotextile Engineering Manual references a technique by Koerner and Bove.[1]

This method (or another method to determine in-plane transmissivity) can be used to compare the in-plane transmissivity of the immersed specimen to a control specimen.

Two specific recommendations need to be made to implement the test.

(1) The final pressure exerted on the geotextile should be at least 1.5 times the maximum expected pressure to be experienced during the active life and post-closure period of the unit.

(2) The geotextile should be placed in the apparatus under expected field conditions; i.e., both sides of the geotextile should be placed against the materials experienced in the field (e.g., soil, sand/gravel, flexible membrane liner, or other geotextile).

3. Earthen Materials - When rock or gravel are used in the leachate collection system, the owner or operator should verify that the mineral content of the rock is compatible with the waste/leachate mixture. The owner or operator will need to demonstrate that the rock will not be dissolved or form a precipitant that would clog the leachate collection system.

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1. Koerner, R.M. and Bove, J.A., "In-Plane Hydraulic Properties of Geotextiles," Geotextile Testing Journal, GTJODJ, Vol. 6, No. 4, Dec. 1983, pp. 190-195.

For soil used as a liner or a component of a liner, the material should be subjected to EPA Method 9100, using the expected leachate to determine its effect on the hydraulic conductivity of the compacted low permeability soil. The owner or operator may use the fixed-wall or triaxial test. (Note: Method 9100 is currently under revision.)

Should environmental stress cracking be considered as a modification to Method 9090?

Although environmental stress cracking (ESC) is not currently included in Method 9090, recently reviewed data and discussions with technical experts, including polymer manufacturers, have reemphasized the need to require an ESC test for crystalline and semicrystalline polymeric membrane liners. We are currently making revisions to Method 9090 that will outline available that ESC testing be methods.

Until specific test procedures for ESC can be developed that represent land disposal facility conditions, we suggest that permit writers discuss the need for ESC data on these materials and suggest that the owner or operator conduct ESC testing. The type of test and initial interpretation of the data would be the responsibility of the applicant.

Should the leachate be changed during the immersion test?

Some of the constituents of greatest concern in the chemical resistance immersion test are those that are volatile or that enter into the material being tested. The owner or operator must assure that the chemical composition of the leachate remains relatively constant during the test to provide a representative atmosphere for samples being immersed.

The owner or operator must attempt to seal the immersion vessel as tightly as possible to prevent loss of volatiles. In addition, the concentration of chemicals in the leachate that are suspected to affect the samples (such as aliphatic and halogenated hydrocarbons) must be determined prior to immersion testing, and should be checked when samples are removed at the first 30-day testing period (for Method 9090). If the composition of the leachate

has changed significantly, the owner or operator should change the leachate in the immersion vessels and continue to change the leachate on a frequent basis (frequency to be negotiated with the permit writer) to assure that the liner samples are experiencing exposure conditions similar to those in the field.

Attachment

cc: RCRA Branch Chiefs, Regions I-X
RCRA Permits Section Chiefs, Regions I-X
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Frank Langone, Region II
Greg Uetrecht, Region VI
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ANALYSIS AND FINGERPRINTING OF UNEXPOSED AND EXPOSED POLYMERIC MEMBRANE LINERS

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ABSTRACT

A plan is presented for analyzing polymeric membrane liners for waste storage and disposal impoundments before and after laboratory or pilot-scale exposure and field service. These analyses can be used to fingerprint a material and to follow the changes that take place in a polymeric membrane liner during exposure to waste. They can also be used to determine components of a waste liquid that are absorbed and are aggressive to polymeric liners.

This analysis plan includes determination of volatiles, extractables, specific gravity, ash and crystallinity of polymeric liners. The plan also includes gas chromatography and infrared analysis of the extractables (and possibly of the organic volatiles) and thermogravimetric analysis of the liner. Also suggested is the use of pyrolysis gas chromatography, which can be performed directly on unexposed and exposed liner materials. Typical analytical results for unexposed and exposed liners are presented.

INTRODUCTION

Because of the wide range of compositions and constructions of flexible polymeric membrane liners that are currently available and being developed for lining waste impoundments, analysis and fingerprinting of the membranes is needed for a number of purposes. For example, a liner manufacturer needs to test his sheeting as new polymers are used and as new compounds and constructions are developed. He also needs tests to control the composition of the liner being manufactured.

The analysis of a polymeric membrane liner at the time of placement can be used for three purposes: first, as a means of characterizing and identifying the specific sheeting; second, as a baseline for monitoring the effects of exposure on the liner; and third, to assess the aggresive ingredients in the waste liquid to determine chemical compatibility.

During exposure to waste liquids, polymeric liners may change in composition in various ways that may affect their performance and result in actual failures. Polymeric materials may absorb water, organic solvents and chemicals, organometallic materials, and possibly some inorganics if the liners become highly swollen. On the other hand, the extractable materials in the original liner compound may be leached out and result in stiffening and even brittleness on the part of the liner membrane. The solid constituents of a polymeric compound (which include carbon black, inorganic fillers, and some of the curing agents) will be retained in the liner compound, as will the polymer of which the liner is made (particularly if the polymer is crosslinked). If organic materials are similar to the liner in solubility and hydrogen bonding characteristics, the liner may swell excessively. Some thermoplastic

lining materials may even dissolve, when in contact with some solvents.

The objective of this paper is to present an analytical methodology that can be used to fingerprint and identify liner materials and to give a baseline for assessing the changes in composition of these materials when they are under test or in service. Also presented are the analytical procedures for testing exposed liner materials to determine these changes. Data on representative liner materials, before and after waste exposure, are presented.

POLYMERS USED IN MEMBRANE LINER MANUFACTURE

Polymers used in the manufacture of lining materials include rubbers and plastics differing in polarity, chemical resistance, basic composition, etc., and can be classified into four types:

- Rubbers (elastomers) that are generally crosslinked (vulcanized),
- Plastics that are generally unvulcanized (such as PVC),
- Plastics that have a relatively high crystalline content (such as the polyolefins), and
- Thermoplastic elastomers that do not need to be vulcanized.

Table 1 lists the various types of polymers that are used and indicates whether they are used in vulcanized or nonvulcanized form and whether they are reinforced with fabric. The polymeric materials most frequently used in liners are polyvinyl chloride (PVC), chlorosulfonated polyethylene (CSPE), chlorinated polyethylene (CPE), butyl rubber (IIR), ethylene propylene rubber (EPDM), neoprene (CR), and high-density polyethylene (HDPE). The thickness of polymeric membranes for liners ranges from 20 to 120 mils, with most in the 20 to 60-mil range.

TABLE 1.POLYMERIC MATERIALS USED IN LINERS

Polymer	Use in liners: Thermoplastic	Use in liners: Vulcanized	Fabric reinforcement: With	Fabric reinforcement: W/O
Butyl rubber	No	Yes	Yes	Yes
Chlorinated polyethylene	Yes	Yes	Yes	Yes
Chlorosulfonated polyethylene	Yes	Yes	Yes	Yes
Elasticized polyolefin (partially crystalline)	Yes	No	No	Yes
Elasticized polyvinyl chloride	Yes	No	Yes	No
Epichlorohydrin rubber	Yes	Yes	Yes	Yes
Ethylene propylene rubber	Yes	Yes	Yes	Yes
Neoprene (chloroprene rubber)	No	Yes	Yes	Yes
Nitrile rubber	Yes	---	Yes	---
Polyethylene (partially crystalline)	Yes	No	No	Yes
Polyvinyl chloride	Yes	No	Yes	Yes

Most polymeric lining materials are based on single polymers, but blends of two or more polymers (e.g., plastic-rubber alloys) are being developed and used in liners. Consequently, it is difficult to make generic classifications based on individual polymers in the liners, even though one polymer may predominate. Blending of polymers introduces the long-range possibility of the need for performance specifications, but long-term liner performance in the field cannot presently be completely defined by current laboratory tests.

The basic compositions of the different types of compounds are shown in Table 2. The crosslinked rubber compositions are usually the most complex because they contain a crosslinking system that requires more ingredients (e.g., the sulfur system). Thermoplastics, except for CSPE compounds, contain no curatives. Although supplied as thermoplastic membranes, CSPE liners contain inorganic crosslinking chemicals that allow the compound to crosslink slowly over time during service. Crystalline materials have the simplest composition and generally consist of polymer, a small amount of carbon black for ultra-violet protection, and antidegradants.

Of the various liner components (except for the polymer), the following are potential extractables:

- Small amounts in the original polymer (i.e., stabilizers and antidegradants)
- Oils and plasticizers
- Antidegradants added to the compound.
- Organic constituents of the sulfur crosslinking system (e.g., vulcanization accelerators and activators).

These ingredients are extracted in the determination of extractables.

Most of the polymeric membrane liners currently manufactured are based on unvulcanized or uncrosslinked compounds and thus are thermoplastic. Even if the polymer in the vulcanized form is more chemically resistant (such as CPE and CSPE), it is generally supplied unvulcanized because it is easier to obtain reliable seams and to make repairs in the field. Thermoplastic polymers can be heat-sealed or seamed with a solvent or bodied solvent (a solvent containing dissolved polymer to increase the viscosity and reduce the rate of evaporation). Crystalline sheetings, which are also thermoplastic, are seamed by thermal welding or fusion methods. Information on individual polymers and liners is presented in the EPA Technical Resource Document on liners (Matrecon, 1982).

TABLE 2.BASIC COMPOSITIONS OF POLYMERIC MEMBRANE LINER COMPOUNDS

Component	Type of polymeric compound		
	Crosslinked	Thermoplastic	Crystalline
Polymer or blends (alloys)	100	100	100
Oil or plasticizer	5-40	5-40	0-10
Fillers:			
Carbon black	5-40	5-40	2-5
Inorganics	5-40	5-40	---
Antidegradants	1-2	1-2	1
Crosslinking system:			
Inorganic system	5-9	(*)	---
Sulfur system	5-9	---	---

*An inorganic curing system that crosslinks over time is incorporated in CSPE liner compounds.

ANALYSIS AND FINGERPRINTING OF UNEXPOSED POLYMERIC LINING MATERIALS

Analyses of liners run before and after exposure to different environments include:

- Volatiles
- Ash
- Extractables
- Gas chromatography
- Thermogravimetric analysis
- Differential scanning calorimetry if liner material is crystalline
- Specific gravity

The following subsections describe the tests performed on unexposed polymeric linings.

Volatiles

The volatile fraction is represented by the weight lost by an unexposed specimen of the liner on heating in a circulating air oven at 105°C for 2 hr. Polymeric compositions generally contain a small amount of volatiles (<1.0%), usually moisture. The recommended specimen is a disk cut from the membrane.

The volatiles test can also be used to determine the direction of the grain that has been introduced in the membrane during manufacture. By identifying the orientation of the 2-in. disk specimen with respect to the sheeting at the time the specimen was died out, the grain direction can be identified. The grain direction must be known so that tensile and tear properties can be determined in machine (grain) and transverse directions. Upon heating in the oven at 105°C, sheeting with a grain will shrink more in the grain direction than in the transverse direction (Figure 1).

Volatiles need to be removed before determining ash, extractables, and specific gravity. Ash and extractables are reported on a dry basis (db). Volatiles contents of representative membrane liners are presented in Table 3. Monomeric plasticizers that are generally used in PVC compositions have a limited volatility and can slowly volatilize at 105°C. Thus the air oven test must be limited to 2 hr.

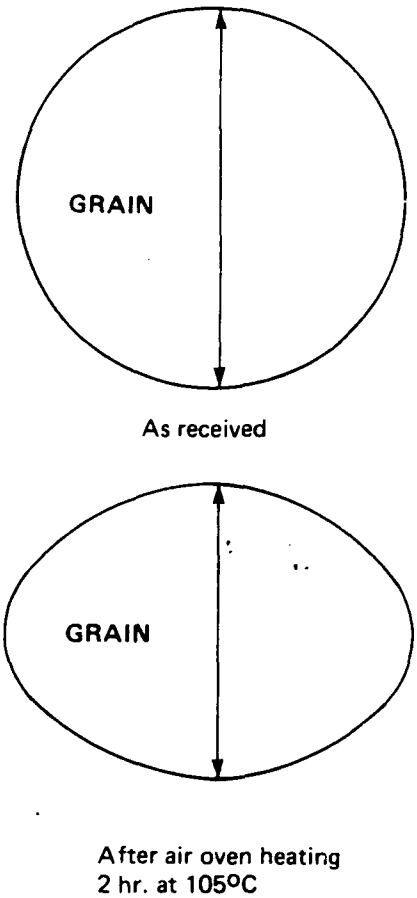


Figure 1. Machine direction determinations.

A standard test for the volatility of plasticizers in PVC compounds is performed in accordance with ASTM D1203. In this test, activated charcoal is used to absorb volatilized plasticizer.

Ash

The ash content of a liner material is the inorganic fraction that remains after a devolatilized sample is thoroughly burned at 550°±25°C. The ash consists of (1) the inorganic materials that have been used as fillers and curatives in the polymeric coating compound, and (2) ash residues in the polymer. Different liner manufacturers formulate their compounds differently, and determining the ash content can be a way to "fingerprint" a polymeric liner compound. The residue obtained by ashing can be retained for other analyses (such as metals content) needed for further identification and for providing a reference point to determine trace metals that may have been absorbed by the liner. The test method

described in ASTM D297, Section 34, is generally followed in performing this analysis. Ash contents of representative membrane liners are presented in Table 3.

Extractables

The extractable content of a polymeric sheeting is the fraction of the compound that can be extracted from a devolatilized sample of the liner with a solvent that neither decomposes nor dissolves the polymer. Extractables consist of plasticizers, oils, or other solvent-soluble constituents that impart or help maintain specific properties such as flexibility and processability. A measurement of extractable content and an analytical study of the extract can be used as part of the fingerprinting of a sheeting.

During exposure to a waste, the extractable constituents in a liner may be removed and result in property changes. At the same time during exposure, the liner might absorb nonvolatilizable constituents from a waste. Measuring the extractable content of unexposed lining materials is therefore useful for monitoring the effects of exposure. The extract and the extracted liner obtained by this procedure can be used for further analytical testing (e.g., gas chromatography, infrared spectroscopy, ash, thermogravimetry, etc.) and fingerprinting of the liner.

The procedure for extraction generally follows ASTM D3421, "Extraction and Analysis of Plasticizer Mixtures from Vinyl Chloride Plastics". Also see ASTM D297, "Rubber Products-Chemical Analysis", paragraphs 16-18.

Because of the wide differences among the polymers used in liner manufacture, a variety of extracting media must be used.

TABLE 3. ANALYSIS OF UNEXPOSED POLYMERIC MEMBRANE LINERS*,+

Polymer	Base polymer, specific gravity	Compound			
		Specific gravity	Volatiles, %	Extractables, %	Asn, %
Butyl rubber	0.92	1.206	0.45	10.96	5.25
		1.176	0.46	11.79	4.28
Chlorinated polyethylene	1.16-1.26	1.360	0.10	7.47	14.40
		1.362	0.00	9.13	12.56
		1.377	0.05	...	17.37
Chlorosulfonated polyethylene	1.11	1.433	0.84	1.49	33.95
		1.343	0.51	3.77	3.28
Elasticized polyolefin	0.92	0.938	0.15	5.50	0.90
Epichlorohydrin rubber	1.27-1.36	1.490	0.63	7.27	4.49
Ethylene propylene rubber	0.86	1.173	0.38	23.41	6.78
		1.122	0.50	31.77	5.42
		1.199	0.31	18.16	0.32
Neoprene	1.25	1.503	0.76	10.15	12.98
		1.480	0.19	13.43	13.43
		1.390	0.37	21.46	4.67
Polybutylene	0.91	0.915	0.12	...	0.08
Polyester elastomer	1.17-1.25	1.236	0.26	2.74	0.38
Polyethylene (low density)	0.92	0.921	0.18	2.07	0.13
Polyethylene (high density)	0.96	0.961	0.12	0.49	0.46
Polyethylene (high density) alloy	0.95	0.949	0.11	2.09	0.32
Polyvinyl chloride	1.40	1.275	0.11	33.90	6.20
		1.264	0.09	37.25	5.81
		1.231	0.05	38.91	3.65
		1.280	0.31	35.86	6.94
		1.308	0.03	25.17	5.67

*Source of some of the data: Haxo et al. (1982).

+Multiple figures represent materials from different manufacturers.

Table 4 lists the recommended solvents for extraction of membrane liners of each polymer type.

Typical values for the extractables in polymeric membranes are given in Table 3.

Gas Chromatography

Gas chromatography can be used to find the level of the plasticizer (e.g., diethylhexyl phthalate (DEHP), a dioctyl phthalate) compounded into a PVC liner material. Figure 2 shows the quantification of DEHP in the solvent extract of a PVC liner material. The weight percent of the DEHP in the liner can then be calculated, assuming the extraction to be 100% efficient. A typical procedure is summarized below.

A weighed sample of liner is extracted with an appropriate solvent. The extract is evaporated to dryness over a steam bath. The dry residue is redissolved in solvent and brought to an accurately known volume. Following the development of appropriate chromatographic conditions, injection of this solution into the instrument will separate it into chemically pure components characterized by different retention times. An injection of a DEHP standard solution will identify the retention time of the DEHP component. Comparison of the peak height (area) data obtained from the injection of equal volumes of the extract solution and from quantitatively prepared standard solutions allows the interpolation of the DEHP concentration in the extract solution (Figure 2).

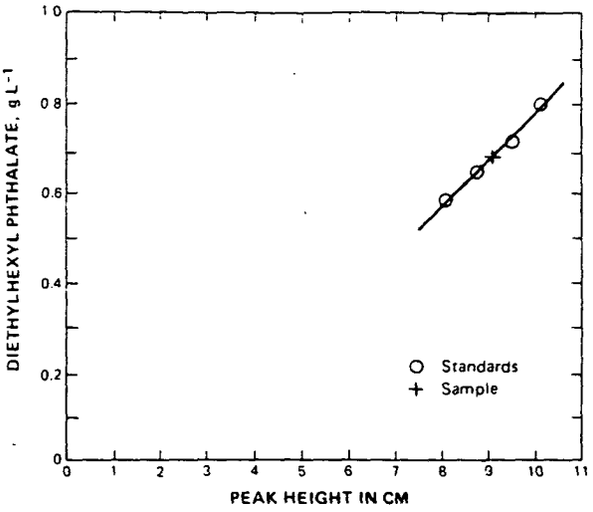


Figure 2. Gas chromatograph determination of the diethylhexyl phthalate content in an extract of a PVC membrane. Column: 6'x1/8" 3% OV 101 on Chromosorb WHP. Temperature: 200°-300°C at 8°C/min. He carrier gas: at 30cc/min.

TABLE 4. SOLVENTS FOR EXTRACTION OF POLYMERIC MEMBRANES*

Polymer type	Extraction solvent
Butyl rubber (IIR)	Methyl ethyl ketone
Chlorinated polyethylene (CPE)	n-Heptane
Chlorosulfonated polyethylene (CSPE)	Acetone
Elasticized polyolefin	Methyl ethyl ketone
Epichlorhydrin rubber (CO and ECO)	Methyl ethyl ketone or acetone
Ethylene propylene rubber (EPDM)	Methyl ethyl ketone
Neoprene	Acetone
Nitrile rubber (vulcanized)	Acetone
Nitrile-modified polyvinyl chloride	2:1 blend of carbon tetrachloride and methyl alcohol
Polyester elastomer	Methyl ethyl ketone
High-density polyethylene (HDPE)	Methyl ethyl ketone
Polyvinyl chloride (PVC)	2:1 blend of carbon tetrachloride and methyl alcohol
Thermoplastic olefinic elastomer	Methyl ethyl ketone

*Because lining materials can be sheetings based on polymeric aloys marketed under a trade name or under the name of only one of polymers, this list can only be taken as a guideline for choosing a suitable solvent for determining the extractables. Once a suitable solvent has been found, it is important that the same solvent be used for determining the extractables across the range of exposure periods.

Pyrolysis gas chromatography

Pyrolysis gas chromatography is an alternative method for measuring a plasticizer in liner materials. In this technique, a small, weighed sample of liner is heated very rapidly to a temperature sufficient to volatilize all of its organic components. The plasticizer and other lower-molecular weight organics will be driven off as chemically unchanged vapors. The polymer will undergo pyrolysis, or high temperature decomposition, and will volatilize as lower-molecular-weight organic compounds. The resulting volatiles may be separated and quantified by gas chromatography as previously described, and the plasticizer content of the liner may be calculated.

This method has the strong advantage of not requiring extraction of the liner sample, but it may not be as reliable a means of quantification because of the very small sample size and the large number of components that must be separated by the gas chromatograph.

Thermogravimetric analysis (TGA)

TGA is a thermal technique for assessing the composition of a material by its loss in weight on heating at a controlled rate in an inert or oxidizing atmosphere. For example, when a material is heated in an inert atmosphere from room temperature to 600°C at a controlled rate, it will volatilize at different temperatures until only carbon, char and ash remain. The introduction of oxygen into the system will burn off the char and carbon black. Thus from the weight-time curve which can be related to weight and temperature, the amounts of volatiles, plasticizer, polymer, carbon black, and ash can be calculated. In some cases, thermogravimetric analysis can replace measurements of the volatiles, ash, and extractables contents discussed above. The TGA curve and the derivative of the TGA curve can thus be used as part of a fingerprint of a polymeric composition. This technique is described by Reich and Levi (1971).

A Perkin-Elmer TGS-2 thermogravimetric system, consisting of an analyzer unit, balance control unit, heater control unit, and first derivative computer, is used in our laboratory. Temperature control is supplied by the temperature controller on the Perkin-Elmer DSC-2 (Differential Scanning Calorimeter). A double side-arm furnace tube was used to allow rapid changing of the atmosphere from inert (N_2) to oxidative (N_2/O_2 mixture). For the oxidative atmosphere, N_2 purge is maintained through the analyzer unit head, and O_2 is introduced at the upper side arm where it mixes with the N_2 to burn the carbon black and any carbonaceous residue that forms during the pyrolysis of the polymer. Use of the double side-arm furnace tube shortens the turnaround time because it eliminates the need to flush the analyzer head completely to remove O_2 between runs, as would be necessary if O_2 were introduced through the head. A dual pen recorder Perkin-Elmer Model 56 allows a simultaneous display of thermocouple temperature in the furnace and the change in weight of the specimen or the first derivative of the change in weight.

An example of the TGA procedure for the analysis of a polymeric liner is described below.

A 5-mg specimen of the liner was placed in the balance pan and weighed in a nitrogen flow of 40 cc/min. The instrument was adjusted to give a 100% full-scale deflection for the weight of the sample, so the percent of weight change can be read directly from the chart.

The specimen was heated to 110°C and held there for 5 min to determine whether measurable volatiles were present; it was then heated from 110° to 650°C at a rate of 20°C/min in a nitrogen atmosphere. The specimen was held at 650°C until no more weight loss occurred, usually 2 to 3 min, after which it was cooled to 500°C and O_2 was introduced at a rate of 10 cc/min with an N_2 flow rate of 30 cc/min.

Typical thermograms for HDPE and EPDM appear in Figures 3 and 4, respectively. Analyses of a variety of polymeric membrane liners are presented in Table 5.

Differential Scanning Calorimetry (DSC)

DSC is a thermal technique for measuring the melting point and the amount of crystallinity in partially crystalline polymers such as the polyolefins polyethylene, polypropylene, and polybutylene. This technique measures the heat of fusion of a crystalline structure; it can also give an indication of the modification of crystalline sheeting with other polymers

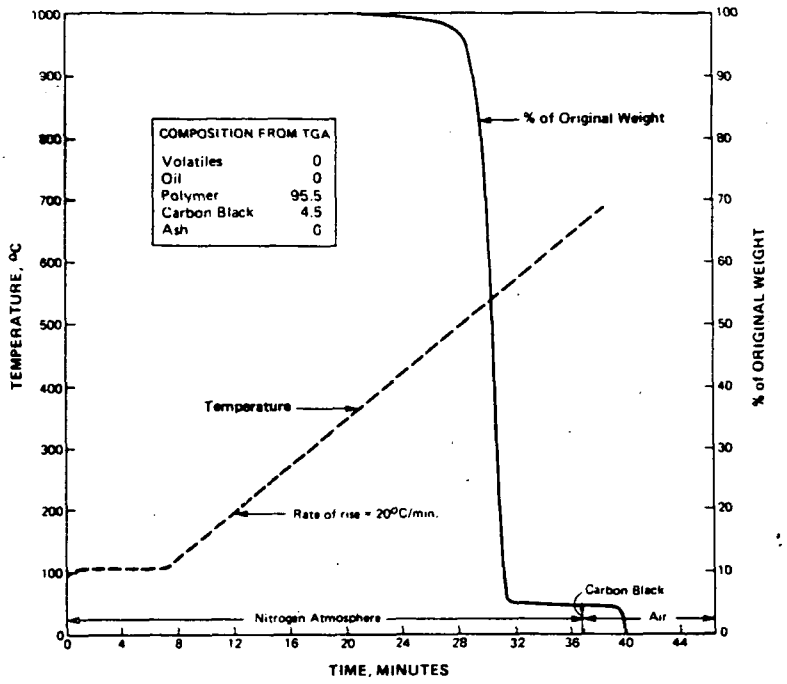


Figure 3.TGA of an unexposed black HDPE liner. The plots of sample weight and temperature as a function of time are shown. Under an N_2 atmosphere, the black HDPE sample lost approximately 95.5% of its mass as hydrocarbons were evolved. The carbon black added as an ultraviolet light absorber remained as a carbonaceous residue and was not volatilized until it was oxidized when oxygen was allowed into the system.

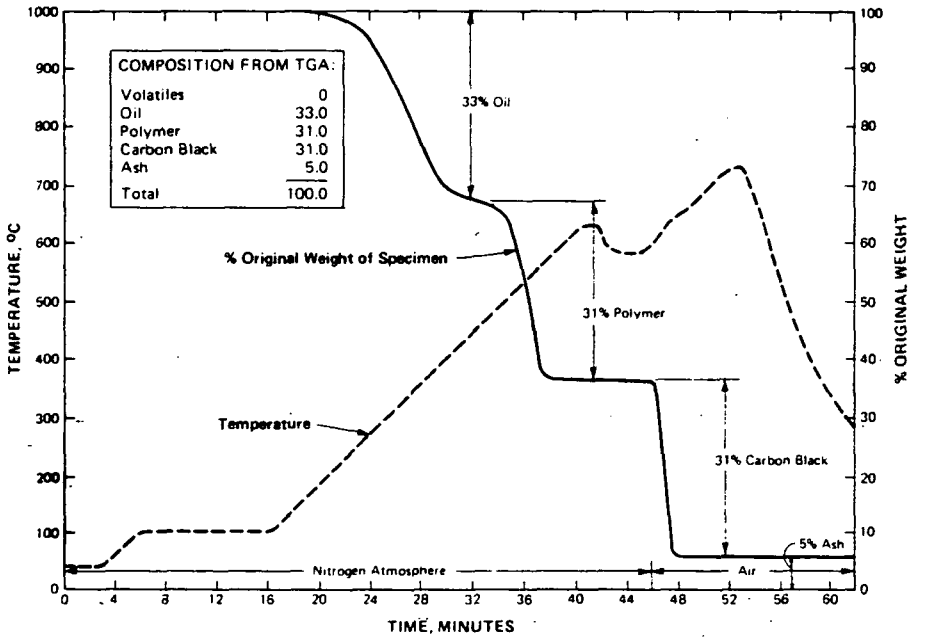


Figure 4.Thermogravimetric analysis of an unexposed EPDM liner membrane. The dotted line shows the temperature program and the solid line shows the percent of the original specimen weight. At 46 minutes the atmosphere was changed from nitrogen to air to burn the carbon black.

TABLE 5.THERMOGRAVIMETRIC ANALYSIS OF POLYMERIC MEMBRANE LINERS

Polymer type	Volatiles, %	Polymer, %	Oil or plasticizer, %	Carbon black, %	Ash, %
Butyl rubber	0	45.0	12.2	37.1	5.7
Chlorinated polyethylene	0	72.2	7.6	5.3	14.9
	0	71.3	9.1	6.5	13.1
	0.4	53.9	13.9	21.0	10.8
Chlorosulfonated polyethylene	1.0	49.3	1.5	45.6	2.6
	0.9	47.7	3.2	45.2	3.0
	0.1	58.1	5.5	9.8	26.5
Elasticized polyolefin	0	93.1	1.7	4.0	1.2
Epichlorhydrin rubber	0	49.3	8.2	37.7	4.8
Ethylene propylene rubber	0.1	30.8	32.9	30.9	5.3
	0.2	33.5	23.2	35.5	7.6
Neoprene	1.0	42.3	10.7	34.9	11.1
	0	44.0	10.7	33.8	11.5
Polyethylene (high density)	0	97.9	0	2.1	...
	0	95.6	0	4.2	0.2
	0	97.0	0	1.8	1.2
Polyvinyl chloride	0	48.7	38.2	6.2	6.9
	0	46.0	42.1	7.8	4.1
	0	51.0	35.0	7.0	7.0

by alloying. Thus this type of analysis can be used as a means of fingerprinting crystalline polymeric liner materials (particularly high-density polyethylene) and assessing the effects of aging and exposure to wastes. This technique is described by Boyer (1977) and Ke (1966).

The differential scanning calorimeter used in this work was the Perkin-Elmer Model DSC-2C, equipped with an Intracooler I subambient temperature accessory to provide an operating temperature range of -40 to 725°C.

The equipment is used to characterize the thermal transitions of materials such as melting, boiling, and changes in crystal structure. A sample and reference cell are provided. A weighed sample is placed in the sample holder; the reference cell is generally run empty to provide an absence of thermal transitions. The two cells are simultaneously heated or cooled so that the average cell temperature follows a preset program. When the sample undergoes a thermal transition, an endothermic or exothermic reaction will occur. The change in power required to maintain the sample cell at the same temperature as the reference cell is recorded as a deflection of the recorder pen. The recorder plots the temperature (°C) versus the differential energy flow (mcal/sec) required to maintain the sample cell temperature. An endothermic transition such as melting is shown as a positive peak; an exothermic reaction such as crystallization is shown as a negative peak. The magnitudes of these peaks and the temperatures at which they occur are characteristic of the material analyzed.

An example of the use of the DSC to determine the polyethylene crystallinity in an HDPE liner is shown in Figure 5.

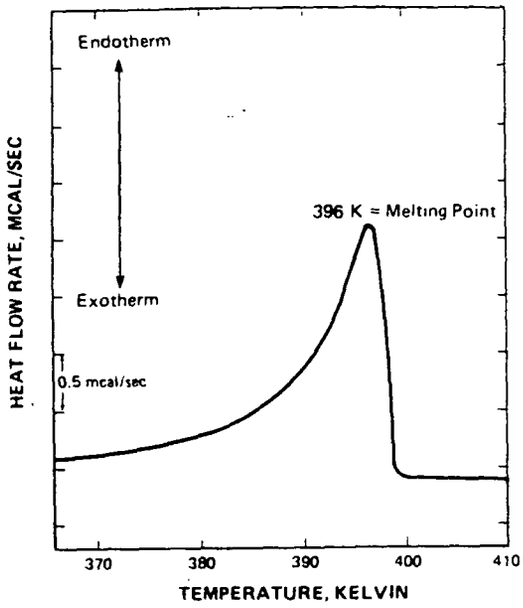


Figure 5. DSC determination of the polyethylene crystallinity in an HDPE liner. The x-axis is the temperature which was raised at 5°C/min. The y-axis is calibrated in mcal/sec, or rate of energy flow. A positive deflection of the plot indicates that the sample is absorbing energy (e.g., during melting). The amount of energy absorbed during the melting process may be determined by calculating the peak area and relating it to the peak area resulting from the melting of an Indium standard of known weight. The energy absorbed is termed the "heat of fusion" (H_f). Assuming that H_f for the fully crystalline polymer is known, the degree of crystallinity of the sample can be determined as a simple ratio.

Specific gravity

Specific gravity is an important characteristic of a material and is generally easy to determine. Because of differences in the specific gravities of the base polymers, specific gravity of the liner compound can give an indication of the composition and identification of the polymer. Specific gravities of base polymers and of different liner compounds based on them are presented in Table 3. They show the the differences among polymers and the variations in compounds from one manufacturer to another.

ASTM Method D792, Method A-1, and D297, Section 15.1.2, Hydrostatic Method, are generally used in performing this test.

ANALYSIS AND FINGERPRINTING OF EXPOSED POLYMERIC MEMBRANE LINERS

During service, several processes can take place to change the composition of a liner and thus affect physical properties and possibly performance. First, the liner can absorb waste liquids including water, various organics, and possibly some inorganic substances. The composition of the absorbed chemicals will probably reflect that of the waste liquid, but it will vary depending on the relative solution characteristics and the waste liquid constituents. The absorbed organics can be both volatile and nonvolatile. The total amount generally softens the liner, resulting in possible loss of tensile strength and other mechanical properties, loss of elongation, and increased permeability. While the organic constituents are being absorbed, some of the extractables such as plasticizer and oils may migrate out of the compound, either by evaporation, dissolution in waste liquid, or biodegradation. Severe loss of plasticizer could result in stiffening and loss in mechanical properties. Losses in properties can occur also through UV degradation and oxidation of the polymer if the liner is exposed to the weather. Figure 6 schematically represents the compositions of a polymeric liner before and after exposure and after extractions.

In assessing the long-term effects of exposure to wastes and the other conditions in a disposal facility, it is necessary to know which waste constituents have affected the lining material and what degradation may have taken place. An analysis of exposed liners is most useful to determine these factors. Figure 7 illustrates a proposed plan of analysis that we have used in our analyses of exposed materials, recovered from the laboratory or the field.

The various tests that are performed on exposed membranes are the same as those discussed in the previous section for unexposed lining materials, with modifications and special precautions required in each test for the exposed materials. These individual tests are described in the following subsections.

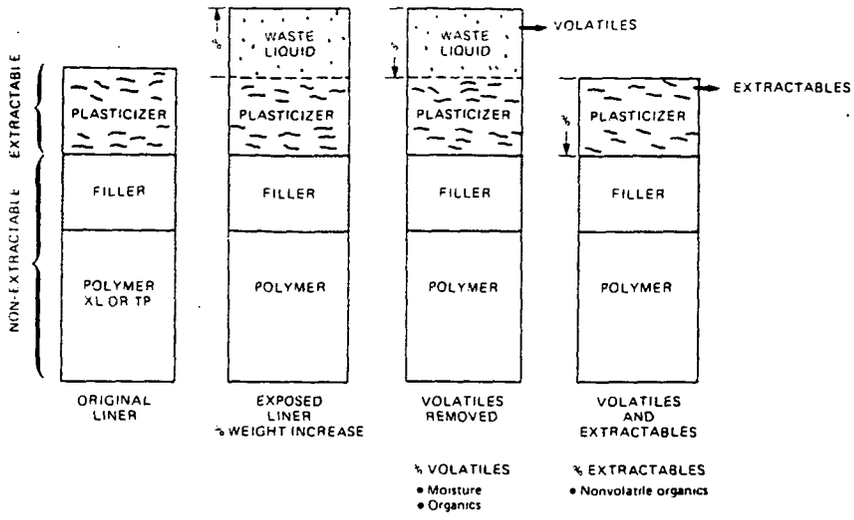
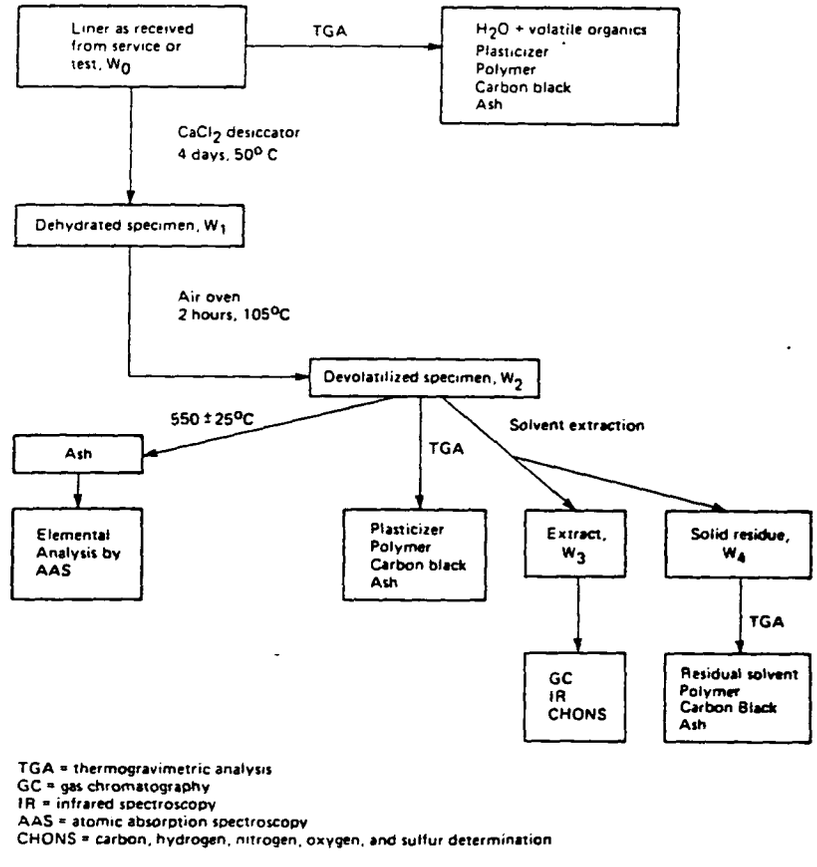


Figure 6. Schematic presentation of changes in composition of a polymeric liner compound on exposure to a waste liquid, on removal of volatiles, and on extraction with an appropriate solvent.



TGA = thermogravimetric analysis
GC = gas chromatography
IR = infrared spectroscopy
AAS = atomic absorption spectroscopy
CHONS = carbon, hydrogen, nitrogen, oxygen, and sulfur determination

Figure 7. Plan for the analysis of exposed polymeric lining materials.

Volatiles

The initial analytical test generally performed is a determination of the volatiles content, which gives an indication of the amount of waste liquid that has been absorbed by the liner. As an approximation, the weight increase can be calculated by dividing the percent of volatiles by the percent of nonvolatiles. For example, if the volatiles are 15%, and the nonvolatiles are 85%, the percent increase in weight based on the original liner would be 17.6%.

Inasmuch as the volatiles contain both water and organic components, it is desirable to separate these two. A study was made to dehydrate the specimens of the exposed liner to remove the water. A series of desiccants was studied at room temperature and 50°C. Four days of exposure of the exposed liner at 50°C in a small individual desiccator containing calcium chloride removed the moisture from the 2-in. disk specimen without removing organic constituents. After removal of the water, a 2-hr heating of the specimen in a circulat-ing air oven removed the remaining organic volatiles. Collection of the organic volatiles and determination of composition by gas chromatography would be desirable but has not been attempted to date. The water and the organic volatiles equal the volatiles obtained in bypassing the desiccator exposure. Such a bypass removes the moisture by exposure at room temperature for 1 week in moving air followed by heating in a circulating air oven for 20 hr at 50°C and 2 hr at 105°C. We have found, however, that the highly swollen CPE liner may take up to 6 days at 50°C to come to constant weight. The time required to remove volatiles depends on the thickness and permeability of the liner and the care taken to avoid the "skin" that forms on the surface of the specimen when using too high an initial temperature to devolatilize. After the volatiles are removed, the exposed materials can be subjected to the other tests, including specific gravity, extractables, ashing, etc.

Total volatiles can also be determined through the use of TGA which is discussed below.

Extractables

Extractables of exposed materials will probably differ from the original values because of the loss to the waste liquid and absorption of nonvolatile organics (e.g., oils). After the volatiles have been removed from the liner, the extractables are determined by the same method used on the unexposed liner materials. Examples of extractable contents after exposure are given in Table 6. If the liner has been in contact with wastes containing nonvolatile constituents, the extractables recovered may be greater than the original values. Analysis of the extractables by gas chromatography and infrared analysis may give an indication of the nonvolatile organics that were absorbed. The analysis of the extractables will give an indication of the constituents of the waste that are aggressive to the liner, as they are the constituents that have been absorbed. They may show up in minor amounts in a waste analysis, but because of their chemical characteristics such as solubility parameters and hydrogen bonding, they may be scavenged by the polymeric liner.

Ash

The ash content of an exposed membrane liner is determined after the volatiles have been removed from the specimen. As in the case of the unexposed membrane, the exposed liner is ashed in a muffle furnace at 550°C. The ash value usually differs from that of the unexposed material, depending on how many nonvolatile organics were lost or gained during the exposure period. If plasticizer is lost, the value will increase because of the nonash content of the plasticizer. Also, if any organic metal compounds are absorbed by the liner, they will show as an increased ash content. A comparison of the elemental analysis of the ash with that of the original liner will determine whether any absorption of metal species occurred during the exposure. No such absorption has been observed, but metal organics might be absorbed by a liner. In general, the inorganics that make up the ash are retained in the liner and maintain a constant ratio with respect to the polymer content, as polymer is generally not dissolved by the waste liquid.

Thermogravimetric analysis

The TGA analysis can be used to give a quick analysis of the composition of an exposed polymeric membrane liner. The test is run similarly to that of the unexposed material, except that care must be taken in handling the small specimens of exposed

TABLE 6.EXTRACTABLES OF DIFFERENT POLYMERIC MEMBRANE LINERS BEFORE AND AFTER VARIOUS EXPOSURES

Polymer	Unexposed	Type of exposure by waste	Extractables after exposure
Butyl rubber	11.79	Aromatic oil	27.23
		Spent caustic	10.87
		Oil 104	40.34
Chlorinated polyethylene	9.13	Oil 104	17.00
		Roof exposure	5.99
Chlorosulfonated polyethylene	4.08	Aromatic oil	59.81
		Oil 104	15.92
		Slop water	3.70
Elasticized polyolefin	5.50	Oil 104	20.74
		Aromatic oil	23.37
		Slop water	2.96
Ethylene propylene rubber	23.64	Aromatic oil	38.35
		Oil 104	43.45
		Spent caustic	22.89
Neoprene	21.46	Aromatic oil	58.47
		Oil 104	23.85
		Slop water	17.63
Polyvinyl chloride	33.90	Aromatic oil	40.55
		Roof exposure	26.27
		Pesticide	35.38
		Oil 104	17.95

liners that contain the volatiles. These volatiles can be easily lost. Figure 8 is a thermogram of an exposed PVC membrane liner that had absorbed more than 7% of the waste liquid, which was predominantly water. The results are shown on the figure, but the losses show the effect of the char formation of the PVC when it is heated in a nitrogen atmosphere. Chlorinated polymers lose HCl and leave a char for which correction must be made in the calculations of the polymer content. These calculations have been made on the figure, and the results compare favorably with those obtained by direct analysis of the volatiles, extractables, and ash.

Specific gravity

The specific gravity of exposed membrane liners is also determined after the membrane specimen has been thoroughly devolatilized. Three steps must be taken to avoid the formation of bubbles in the liner mass during a direct devolatilizing process (which would affect the specific gravity results). First, the specimens must be allowed to "dry" at room temperature in an air stream in a hood until constant weight is achieved, which could take several days. Second, they must be placed in an oven at 70°C for 16 hr; and third, they must be heated at 105°C for 2 hr.

The specific gravity of an exposed membrane can differ from that before exposure, depending on how much of the original extractable material was lost and how much material from the waste was absorbed during exposure. The procedure followed was ASTM D297 using the hydrostatic method.

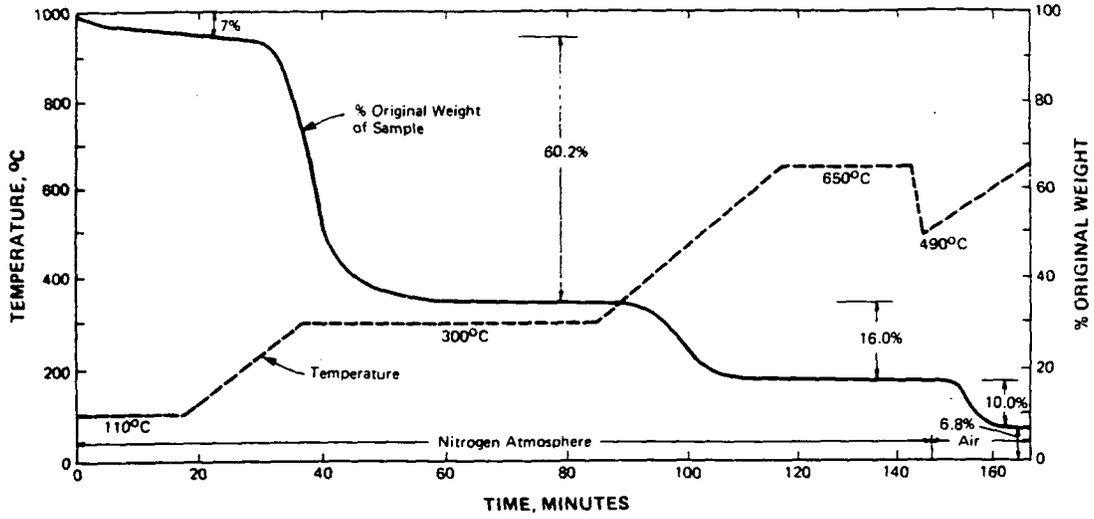


Figure 8. TGA of an exposed polymeric PVC liner.

Weight loss A = 7.0% volatiles = moisture + possible organics.
Weight loss B = 60.2% = plasticizer + HCl from the polymer (PVC).
Weight loss C = 16.0% = residual polymer.
Weight loss D = 10.0% = carbonaceous polymer residue + carbon black.
Residue weight E = 6.8% = ash.

Composition of the exposed liner as received calculated from above data. Values by direct analysis are shown in parentheses.

Volatiles	7.0%	(7.9)[a]
Polymer (PVC)	44.7%	
Plasticizer	34.1%	(32.2% as extractables)[a]
Carbon black	7.4%	
Ash	6.8%	(6.4)[a]

[a]By direct analysis.

SUMMARY AND CONCLUSIONS

A protocol is presented for the analysis of polymeric membrane lining materials before and after exposure to waste liquid.

The results of the analysis can be used as a fingerprint of the unexposed liner and as a baseline for assessing the changes that occurred during exposure to a waste liquid.

The analysis of an exposed liner furnishes information regarding the change in the composition of the membrane and the chemical materials that are actually absorbed during exposure. This latter information indicates the constituents of the waste that are aggressive to the lining material.

Thermal analysis and gas chromatography are particularly useful in the analysis and fingerprinting of polymeric membranes. The use of gas chromatography coupled with mass spectroscopy needs to be investigated to determine the specific chemicals that are absorbed by a polymeric liner.

The use of this analysis may lead to techniques which will better predict the service life of a flexible membrane liner.

ACKNOWLEDGEMENTS

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The author wishes to thank Robert E. Landreth, Project Officer, for his support and guidance in these projects.

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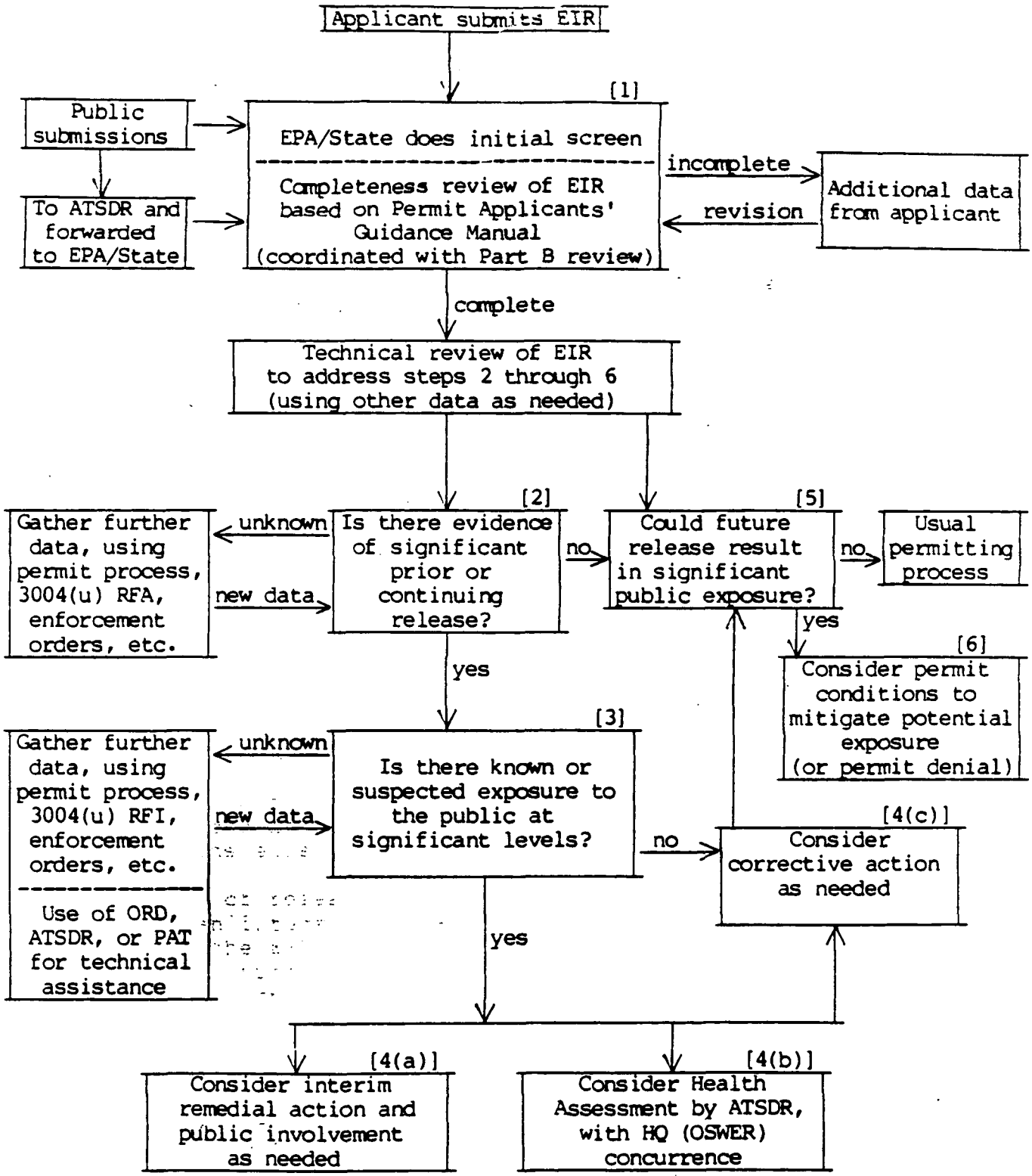
Figure 1. Outline of EIR Review Process



This Guidance is organized according to the steps in Figure 1. A checklist and tables are presented in this Guidance to assist in summarizing the results of the EIR review. These checklists and tables are provided as examples only. The Regions are welcome to revise the format and content of these documents in order to conform to Regional priorities and methods. Attachments at the end of the Guidance include a completeness checklist (Attachment II), and the types of health evaluations ATSDR may perform when requested (Attachment III).

E. Relationship to Existing RCRA Programs

This Guidance describes the overall §3019 review process, and how this review should be integrated into existing RCRA activities. RCRA programs are already in place to identify, investigate, and clean up prior/continuing releases to ground water (Subpart F regulations) and other pathways (RFA/RFI process). Therefore, the two primary goals in implementing §3019 are to: (1) identify human exposures to past releases that may require ATSDR involvement; and, (2) to identify potential exposures from future releases that may be mitigated by specific permit conditions.

The RFA/RFI and permitting programs should provide the information needed to determine if a release has occurred and if human exposure is likely. These activities should also generate most of the documentation the EIR reviewer needs for the §3019 review process. The EIR reviewer is required to prepare a separate report for §3019 when the Regional Administrator (or his designee) believes that a site is a candidate for referral to ATSDR for a health assessment. This requires the submittal of a summary report to EPA Headquarters for concurrence prior to referral to ATSDR (see Section III.C.2). The EIR reviewer should also produce a brief memorandum for the administrative record at other important decision points, i.e., the results of the completeness check/initial screen (Step 1), and the examination of potential exposures to future releases (Step 5). In addition, the reviewer should write a short memorandum for the record documenting a decision not to refer a site to ATSDR, and summarizing why the site does not meet the necessary criteria for referral (see Section III.B.1). Documentation of these decisions may be more important for sites where public concerns exist.

The prevention of releases and subsequent human exposure should already be an integral part of the permitting process. However, Step 5 of the EIR review process provides the permit writer with the opportunity to identify sites that require special permit conditions to mitigate possible risks from future releases. Section III.D provides a qualitative approach that may be used in completing Step 5.

The exposure information review process outlined in Figure 1 illustrates the need to integrate this review with ongoing and planned permitting and enforcement activities. Which of the Steps are completed prior to permit issuance depends, to some extent, on Regional priorities for a particular site. Normally,

Steps 1, 2, 5, and 6 will be completed at most sites prior to issuing the permit. In addition, the permit writer should make at least an initial decision whether the potential for significant public exposure (Step 3) warrants action via enforcement orders (e.g., 3008(h)) before permitting. Recommendations on the appropriate use of the investigation/corrective measure authorities for the EIR review are described in Section III.B.

F. State Roles in EIR Reviews

States with final authorization are required under 40 CFR 271.21(e) to adopt requirements equivalent to any new Federal requirements. Pursuant to Section 3006(g) of RCRA, the requirements of Section 3019 will be implemented by EPA until each State receives authorization for this provision. Until States receive such authorization, the Regions may amend existing grant Memoranda of Agreement (MOA) with States to allow them to assist in reviewing the EIRs. This may be especially helpful where the State is already reviewing the Part B application. The State's role in implementing Section 3019 should be clearly defined in the MOA or other agreements with EPA. The Region will need to oversee State reviews and follow up if more information is needed under Section 3019, if referral to the Agency for Toxic Substances and Diseases Registry (ATSDR) is deemed necessary, or if new permit conditions are needed under 3005(c). Section 3005(c) (the "omnibus" provision) is discussed in Section III.E. of this guidance.

II. EIR INITIAL SCREEN AND COMPLETENESS REVIEW (STEP 1)

A. Setting Priorities for EIR Reviews/Identifying Imminent Hazards

Since the EIR is based in large part on information from the Part B application, it makes sense in most cases to perform the Part B and EIR reviews concurrently. Accordingly, the order in which EIRs are reviewed depends largely on the order in which the Part B applications are reviewed. (Since Part B reviews should generally be conducted in order of environmental significance, as reflected in the annual Agency Guidance and the National Permits Strategy, the priorities for EIR reviews will therefore have an environmental basis as well.) Nevertheless, the permit writer should conduct an initial screen of all EIRs upon receipt. If the initial screen indicates that the EIR provides new evidence of a release and/or potential exposure, the permit writer should reevaluate the environmental significance of the facility and consider raising the technical review of the Part B and EIR to a higher priority. If the EIR reviewer suspects an imminent hazard, program and enforcement personnel should be consulted immediately to formulate an appropriate course of action. Section III.C describes interim remedial measures and corrective action responses that may be necessary in these cases.

There will be situations where the Part B and the EIR will not be reviewed concurrently. For instance, when an EIR is submitted for a facility whose draft permit has been prepared, it will usually be appropriate to conduct a full EIR review as soon as possible even though the Part B review has already been completed. The EIR reviewer in this case must be particularly careful to ensure that the data provided in the EIR and in the Part B are consistent and that no new information is provided in the EIR which affects the draft permit conditions. Unless the draft permit has already been issued, the EIR reviewer is advised to review the EIR before the draft permit goes to public notice.

B. Performing the EIR Completeness Review

1. EIR Completeness Review Format

The EIR should be reviewed for completeness based on the Permit Applicants' Guidance Manual for Exposure Information Under RCRA 3019 (PAGM). The EIR completeness review may be conducted in a fashion similar to that used for a Part B application completeness review. The EIR reviewer may fill out a completeness checklist and develop corresponding comments to summarize any important omissions in the EIR. A completeness checklist has been provided in Attachment II and may be used as a guide by the EIR reviewer during a completeness check. This checklist is based on the permit applicants' checklist found in the PAGM; however, it has been expanded and revised to include a section on the "potential for human exposure" narrative required of the owner/operator.

Although the Part B and EIR reviews should be conducted concurrently whenever possible, any requests to the owner/operator for missing information required under 3019 should remain separate from a Part B Notice of Deficiency (NOD) because the EIR is not legally a part of the permit application. The regulations in 40 CFR 270.10(c) were amended on July 15, 1985 to provide that a Part B which is not accompanied by an EIR will not be deemed incomplete on that basis alone. The permit writer may find deficiencies in the Part B which impact the EIR. In this case, a warning letter or enforcement order containing the EIR completeness comments should note these deficiencies by referencing the deficiency comments in the Part B Notice of Deficiency (NOD). For example, if the Part B inadequately described overtopping control at the surface impoundment, then the EIR checklist and comments may simply instruct the applicant to: "See Part B NOD Comment # __ regarding overtopping control." Any comments generated from an EIR review should be simply entitled "EIR Completeness Review Comments" rather than "Notice of Deficiency Comments", to further distinguish the EIR review from the Part B review.

2. Other Information Sources

a. Permit Writer and Compliance/Enforcement Personnel

In addition to the Part B application, several other information sources may be useful in a completeness review of the EIR. Both the permit writer and the enforcement official may have knowledge of the facility's history which will be helpful in determining whether there are significant omissions in the applicant's submittal or in pursuing any EIR reference to other RCRA documents, such as 3004(u) SWMU response letters or previous facility inspection, compliance, or enforcement reports.

b. Other Federal/State Agencies

The EIR reviewer may consider contacting other Federal or State environmental agencies during the completeness review if an applicant's EIR refers to relevant information which is contained in documents located at these agencies. For example, the EIR may reference or summarize NPDES permit information or air monitoring reports which may be located in the Regional EPA offices or State Water/Air Offices. If the information appears to be important (e.g., if a release is indicated) the reviewer may wish to confirm that the document is accessible and contains the expected information. If important documents are not accessible to the EIR reviewer (s)he may request the applicant to submit a copy of the relevant information.

c. Public Submissions

The Exposure Information provision of RCRA also allows the public to submit information on possible exposures. Public submittals may be received by EPA either directly, or via reports forwarded to EPA from ATSDR. Upon receipt of public submissions relating to a RCRA site, ATSDR should contact the appropriate EPA Regional staff and forward a copy of the submission. Regional staff should attempt to coordinate any needed response to the public with any response planned by ATSDR, and EPA Public Involvement staff should be consulted in these situations. In addition to providing important information to the reviewer, a report of suspected human exposure from the public may create a rather sensitive situation in terms of public fears and expectations. The Revised National Permits Strategy (July, 1985) encourages early public involvement in permitting facilities and directs the Region or authorized State to prepare public participation plans for "environmentally significant" facilities. Furthermore, the Permits Strategy recommends that the exposure information be included early in the public participation process for these environmentally significant facilities.

3. Determining the Adequacy of Submitted Information

RCRA Section 3019 requires the applicant to provide all "reasonably ascertainable information." Although much of the information in the EIR can be cross-referenced to the Part B application, the PAGM does require the applicant to submit

additional information. The legislative history of Section 3019 indicates that Congress did not expect applicants to develop major pieces of new information; however, if applicants do have access to already existing data, they should submit or cite the data, or provide an explanation as to why they could not obtain the data. See the PAGM for additional discussion of this topic.

Unlike the requirements for the Part B, there is no regulatory requirement for a "complete" EIR beyond the 40 CFR 270.10(j) requirement to submit exposure information. The PAGM states that applicants who fully provide the information outlined in that document will be considered to have satisfied the information requirements of Section 3019. From a practical viewpoint, EIR reviewers should focus on missing information that will be important in defining one of the three components of exposure, i.e., data on releases, pathway characteristics, and target populations. Therefore, a reviewer need not literally apply the PAGM information requirements and request that the applicant submit missing information just for the sake of completeness. Additional or missing information should only be requested when it would be useful in determining human exposure. For example, if an applicant discussed surface water use within a two-mile radius of the facility, rather than the three-mile radius requested in the PAGM, the permit writer should decide whether the additional one-mile radius would really be helpful in determining human exposure potential.

An important question the EIR reviewer needs to consider is the best way to collect the further information he/she feels is necessary to complete the EIR review. If the EIR submission is obviously incomplete and information missing is deemed important, the EIR reviewer may request through a warning letter or an enforcement order issued under the authority of Section 3008, that the owner/operator submit the information. If a Part B Notice of Deficiency (NOD) is issued for the facility, the EIR warning letter should accompany the NOD, if possible. Additionally, the EIR information request may be included in an enforcement order that is issued to require additional Part B information.

However, the needed information might also be gathered by the reviewer directly from other sources (e.g., State files) either during the EIR review or, perhaps, as part of the initial data gathering efforts for any RCRA Facility Assessment activities planned under Section 3004(u). The EIR reviewer must determine which approach makes the most efficient use of resources while also allowing important information to be gathered in a timely and complete fashion.

III. EIR TECHNICAL REVIEW (Steps 2 through 6)

A. Evidence of Significant Prior or Continuing Release (Step 2)

Once the EIR is determined to be complete, the reviewer should review existing data for evidence of significant prior or continuing releases from the subject landfill or surface impoundment. As noted previously, existing RCRA permitting and corrective action programs should provide the information to answer this question.

1. Definition of "Significant Release"

In the case of ground-water releases, Subparts F to 40 CFR Parts 264 and 265 provide regulatory definitions of a "release". Detection of any parameter above background usually forces the owner/operator to undertake an extensive monitoring program to characterize the extent of the contamination. Therefore, essentially all releases to ground water from units subject to §3019 will be examined through the permitting process.

Definitions of "release" for the corrective action authorities (3004(u) and 3008(h)) are given in the RFA Guidance and in the Preamble to the Codification Rule (50 FR 28713, July 15, 1985). These documents define "release" as any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment. Furthermore, the "environment" includes all media, i.e., air, surface water, ground water, and unsaturated soils. The RFA process attempts to identify releases that threaten human health and the environment. Although Section 3019 is concerned with only human exposure, these definitions used by the RFA process are generally applicable to the 3019 process.

A "significant" release can be further analyzed in terms of the three exposure criteria, i.e., the type and amount of material released, possible pathways for migration, and the presence of nearby populations. However, in this initial stage of identifying releases, the primary concern is gathering enough data to confirm that a release of potential significance has occurred. The extent and seriousness of a release will usually require further investigation by the owner/operator.

2. Useful Information Sources

If the EIR does not contain conclusive evidence of prior or continuing releases at the facility, or if the data concerning the release are not complete, then the EIR reviewer can obtain additional data via a number of information sources. These sources are described in more detail in the RFA Guidance, and relevant information should be gathered and assessed during the initial stage of the RFA process.

a. RCRA Part B Permit Application

One of the best sources of information is the Part B permit application. Most importantly, information concerning releases to ground water is a required element of the application. If the facility has an adequate well system, the ground-water monitoring data developed under Part 265 and § 270.14(c) should reveal if releases to ground water have occurred. Owners/operators that have submitted inadequate ground-water data in their Part Bs must upgrade their monitoring systems or conduct additional sampling as needed. See the Draft RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (August, 1985) for details in addressing inadequate ground-water data.

In addition, required Part B information concerning contingency plans, unit designs, and other features of the facility can provide useful background on any releases indicated. The completeness checklist for the EIR given in Attachment II lists portions of the Part B that may be relevant for assessing releases.

b. RCRA Sections 3004(u) and 3008(h)

Information concerning releases to surface water, air, soil, and via subsurface gas may be obtained under the authority of RCRA Sections 3004(u) and 3008(h), which authorize corrective action for continuing releases. Data can be gathered from the SWMU letter responses, from the RFA process, and through 3008(h) Interim Status Compliance Orders. As described previously, these authorities will perhaps provide the most effective means of obtaining additional information. The EIR reviewer should consult the RFA Guidance for implementing 3004(u) and the Porter/Price memo (December 16, 1985) on the use of 3008(h).

c. Compliance and Enforcement Records

Information pertaining to the general compliance and enforcement status of the facility should be evaluated with the EIR. In addition to the records of the operator's compliance with the 40 CFR 265 requirements for ground-water monitoring, any problems in compliance with other RCRA Standards may also be indicative of potential releases. Both the permitting and enforcement files should be examined for evidence of improper management of waste that may have led to releases to any other pathways.

Additional data gathered from other EPA programs, especially CERCLA and NPDES, may also provide data on possible releases. Superfund sources that may be useful include CERCLA PA/SI and RI/FS reports and Reportable Quantity notifications. Information from Federal/State air and water agencies, OSHA, and transportation related agencies may provide further evidence of release via

the air, water, worker management, and transportation pathways, respectively. Especially useful are records of chronic violations indicative of releases. Although the owner/operator should have summarized much of this data in the EIR, the reviewer may have to gather referenced documents or incomplete/missing data from these sources.

3. Deciding Future Course of Action

After considering the data initially available the EIR reviewer must decide whether or not (s)he needs additional data to rule out or confirm the occurrence of a prior (or continuing) release. If the available information is adequate, the reviewer may decide that no evidence for a significant release exists; in this case, the only Steps remaining in the EIR review process are 5 and 6, i.e., the consideration of any impacts of future releases and possible permit conditions needed to address these concerns. On the other hand, if releases of potential significance are known (or suspected) to have occurred, then a more detailed examination of the exposure potential is required as described in the following section (Step 3).

In some cases additional information will be needed to address possible releases to one or more of the exposure pathways. As noted above, these questions may be answered through the RFA or normal permitting processes. Alternatively, the EIR reviewer may be able to gather enough information from existing records or other Regional, State, or local officials to satisfy lingering doubts or conerns about particular leaks, accidents, etc.

Figure 2 provides an example of how evidence of releases and possible follow-up actions for each pathway were summarized, following review of an actual EIR and other information regarding a RCRA site. While this example was derived from a review of data from an actual facility, the case was simplified somewhat for illustratative purposes. In order to put this example in perspective, Figure 2 also contains background information on the site.

Figure 2 describes the follow up actions that might be undertaken during Step 2 to determine if a release has in fact occurred, and whether the release warrants further investigation. The EIR reviewer may wish to write up a short summary of the results of his/her analysis at this stage in the process. However, other reports or records produced as part of the permitting or RFA process should be adequate to document this stage of EIR review.

Figure 2. Example of Summary Sheet Following Initial Review of Release Data: Release Evidence and Suggested Follow Up.

Background Summary of Example Site

Operations: A small off-site commercial facility treats and stores hazardous waste; operations include waste oil/gasoline recycling, cyanide waste treatment, solvent recovery, other treatment.

Units of Concern: Surface impoundments are used to store and treat wastes before discharge to waste water treatment plant on site.

Location: The facility is located in an industrialized area, also bounded by residential areas.

Pathway	Summary of Release Evidence	Possible Follow Up Action
Ground Water	Existing Part B data not adequate; monitoring plan in development.	Follow permitting/enforcement procedures to obtain necessary monitoring data.
Surface Water	Possible releases via contaminated run-off from area around unit which enters water through municipal sewer system; subsequent treatment by POTW unclear.	Determine if run-off should be managed as hazardous waste. Collect available analytical data on run-off and determine if discharge goes to POTW.
Air	Definite release based on odor. State monitoring program in development. Some corrective action also taken.	Obtain data from air monitoring program when available, then consider need for futher investigation to study extent of potential exposure and adequacy of corrective action taken.
Soil	Likely releases from spills, leaks, and accidents. Extent of clean up of these past releases unclear.	Examine any existing soil analysis undertaken and assess need for RFA or RFI follow up.

Figure 2. (continued)

Pathway	Release Evidence	Possible Follow Up Action
Subsurface Gas	No evidence; unlikely for surface impoundment.	None necessary.
Transportation	Facility sweeps nearby streets to remove dirt, perhaps due to track-out problem; may not be related to operation of surface impoundments. No record of releases from spills off-site.	Review existing soil analysis as noted above. Consider requiring o/o to analyze dirt found on nearby residential street for likely hazardous constituents via RFA or RFI.
Management Practices	Occupational records submitted do not indicate significant illnesses due to unsafe operating conditions. No other serious enforcement problems found for facility operation, beyond those already noted.	None necessary

B. Determination of Known/Suspected Public Exposures at Significant Levels (Step 3)

Once a prior or continuing release from the surface impoundment or landfill has been documented, the EIR reviewer must determine whether the public has been exposed to the release, and if so, whether there is "substantial potential risk" due to that exposure (see §3019(b)).

The three human exposure elements noted earlier must be addressed in order to determine whether the public has been exposed to a hazardous release and the significance of this exposure. Listed below are the three exposure elements and the information needed by the reviewer to assess the presence of these components. When a release of concern from a unit is identified, then the reviewer must assess the adequacy of the supporting evidence to confirm that all three elements for public exposure are documented.

1. Human Exposure Components

a. Evidence that the release from the landfill or surface impoundment contains hazardous wastes or constituents. Documentation would include:

- Monitoring data confirming a release from the unit; and
- Data indicating that the hazardous materials or constituents of concern are present in the release from the unit.

b. Evidence that the release containing hazardous materials or constituents of concern has migrated off-site (or to on-site human exposure point). Evidence includes:

- Monitoring data confirming off-site contamination; and
- Monitoring/modeling data indicating the extent of release and migration via a plausible pathway.

c. Evidence showing a likelihood that a nearby population has been, or is being, exposed to toxic constituents from the release at levels constituting a substantial risk to human health. Information needed would include:

- Monitoring/modeling data suggesting that the public is being, or has been, exposed (e.g., contaminated drinking water wells); and
- Data showing levels of constituents at the exposure point indicative of a health threat (e.g., levels exceed existing Agency standards or criteria).

2. Gathering Data to Document Exposure

a. Use of the Permitting Process

The permit writer should use the permit process and the 3004(u) program to gather information concerning possible releases and human exposure. The first exposure element, the existence of a documented release, should have largely been satisfied by a positive determination for Step 2. Any release should be documented through the usual permitting process (for ground water) or through 3004(u)/3008(h) RFA studies (for other pathways). The second element, documented off-site migration, will normally require the owner/operator to investigate the extent of migration, both in terms of the constituents released and the area contaminated.

In the case of ground water contamination, the existing RCRA Subpart F regulations require the owner/operator to characterize the plume of contamination in some detail, and devise a corrective action program. The contaminated ground water must be cleaned up to Ground Water Protection Standards set at background levels or existing drinking water standards, unless an Alternate Concentration Limit (ACL) is approved. An ACL demonstration is essentially an exposure/risk assessment for a ground water contaminant, and a successful demonstration should be sufficient evidence that no potential for significant human exposure exists for that constituent. An unsuccessful ACL demonstration may still provide information useful to the EIR reviewer in deciding if human exposure is likely.

However, the existing Subpart F regulations only require the owner/operator to clean up contamination to the facility boundary. Section 3004(v) of HWSA requires corrective measures (for releases to all pathways) beyond the facility boundary, but §3004(v) has not yet been codified in the regulations. (Pending promulgation of these regulations, EPA may issue 3008(h) orders to implement the directives of 3004(v).)

In some cases of suspected off-site migration of unit releases, the owner/operator may elect to gather off-site data to establish the presence and extent of any contamination. In the past, cooperative owner/operators have been willing to monitor off-site ground water for plume movement in order to devise adequate corrective action plans, or to support ACL demonstrations. Permit writers are encouraged to try to obtain data on off-site releases from willing owners/operators.

For releases to pathways other than ground water, the owner/operator may be required to gather data on the extent of contamination under either 3004(u) or 3008(h) authorities. The permit writer must realize, however, that an investigation under 3004(u) on the extent of the contamination may not be initiated until after the permit is issued. Generally, compliance schedules will be used in the permit to require the owner/operator to

conduct a RCRA Facility Investigation (RFI) under 3004(u). Some information on the level of contamination may be gathered from the owner/operator's response to the initial SWMU letter and from the RFA investigation performed under 3004(u). However, in most cases, monitoring results at this stage will probably be focused on detecting a release from a SWMU, not on determining the extent of contamination.

Because RFIs required under 3004(u) will not generally be used to gather data prior to permit issuance, the permit writer (in conjunction with appropriate enforcement staff) should consider whether enforcement orders are needed to ensure an investigation of releases and the likely human exposure potential before permit issuance. The following section describe the enforcement authorities that might be used and the situations that may warrant their use.

b. Use of Enforcement Orders

An enforcement order may be issued to require the owner/operator (o/o) to gather information (on-site or off-site) under 3013 or 3008(h) authorities for releases to any pathway. The issuance of a 3013 order requires evidence showing that the presence or release of hazardous waste from a facility may present a substantial hazard to human health or the environment. Note that 3013 gives EPA the authority to perform any needed investigations and recover the costs later if the o/o is incapable of (or refuses to) gather the required information. The use of a 3008(h) order requires evidence that a release (to any medium) has occurred. See the RCRA Ground-Water Monitoring Complicance Order Guidance (August, 1985) for a description of these two types of orders, and the recent Porter/Price Memo on the use of 3008(h), "Interpretation of Section 3008(h) of the Solid Waste Disposal Act" (December 16, 1985).

Whether to undertake the investigation of a release from a facility through the permitting process or an enforcement order will depend on Regional priorities, resources, and various site specific factors. This decision will encompass considerations that go beyond the human exposure concerns of the 3019 EIR review process. For example, 3008(h) orders may be used when a release is migrating rapidly and may move off-site. In addition, the corrective action programs will be used to investigate releases from all suspect SWMUs at a facility, not just regulated landfills and surface impoundments.

Another important factor to consider is how close the facility is to receiving a permit. If permit issuance appears likely within the near future, the permit writer might decide to incorporate a compliance schedule for a RFI in the permit, rather than hold up the permit while awaiting the issuance of an order to gather more information. A related concern is the level of cooperation exhibited by the owner/operator in the past, and the likelihood that he will meet the compliance schedule for RFI in the permit.

Situations which might prompt the permit writer to seek more immediate exposure information than could be provided through the 3004(u) process include cases in which the existing data indicate a high potential for human exposure. The EIR reviewer should undertake a preliminary analysis of available information to estimate the potential impact of a known release. For example, if evidence of a release and movement off-site to surface water exists (e.g., fish kill, complaints of tainted water), the EIR reviewer should consider the likelihood of releases from the unit reaching surface water (distance to river, characteristics of intervening terrain), potential transport and dilution (river flow and size vs. potential release, the properties of likely constituents in a release), and the likelihood of human exposure (distance to downstream intakes, other uses of surface water).

After such a preliminary analysis, the EIR reviewer may determine that the release requires attention prior to permit issuance. In such cases, the EIR reviewer should consult with enforcement and permitting personnel to map out an appropriate strategy (which may include the use of 3008(h) or 3013 orders) to obtain the needed data and initiate corrective action.

Even in cases of suspected human exposure, the RFI may be implemented through the use of 3004(u) compliance schedules if there is no current (or imminent) exposure potential. For example, a case of past human exposure (e.g., eating of contaminated fish) due to a prior (but not continuing) release to surface water, might be addressed after permit issuance if no current or imminent human exposure is expected. [Note, that if the elements of exposure can be adequately documented, these situations may still be candidates for referral to ATSDR as described in Section III.C.2.]

c. Other Sources of Information

Many of the additional information sources used in determining evidence of a release may also provide data on migration of the waste off-site and possible human exposure. Particularly important at this stage in the review is any evidence of health complaints related to the site. Public submissions may provide indications of exposure. For sites with suspected human exposure, local or State health departments should also be contacted by the EIR reviewer to check for any reports of health concerns in the immediate vicinity of the facility. It is important for Regional and State permitting staff to establish contacts with the local health departments for sites at which real problems may exist. For sites that are eventually referred to ATSDR for health assessments, one of the first steps taken by ATSDR would be to contact these local departments for health complaints in the area.

3. Technical Assistance

The EIR reviewer is encouraged to use all of the above information sources and routes for gathering the data necessary to

confirm the existence (or absence) of all three exposure components (release, migration, receptor location). After examining the data gathered under the permitting and enforcement processes, the EIR reviewer may have some questions concerning the potential health impacts of documented/suspected human exposures. The primary contact for technical assistance will be the Permit Assistance Team (PAT) at Headquarters as described below. The capabilities and possible uses of ORD and ATSDR are also discussed. Finally, existing EPA manuals which could provide the EIR reviewer with possible approaches for interpreting the assembled data are noted.

a. Permit Assistance Team (PAT)

The EPA Permit Assistance Team (PAT) at Headquarters (FTS/382-4740) stands ready to provide technical assistance, to coordinate assistance from ORD and ATSDR, and to provide help in deciding when referral to ATSDR is warranted. ORD and ATSDR may, to a limited extent, be accessed directly by the EIR reviewer on a consultative basis by telephoning the appropriate individuals (see below). Such informal consultations could provide quick response to questions on possible health effects raised by information available at that point. However, if the EIR reviewer needs more extensive technical assistance (e.g., detailed review of written reports, monitoring data, models, etc.), (s)he should contact the PAT at Headquarters. The PAT will draw on the expertise available within OSW, other EPA Offices, and ATSDR as needed to respond to the Regional request for assistance. If warranted, health assessments may be recommended for some facilities, as described in Step 4 of EIR review process.

b. Office of Research and Development (ORD)

The office within ORD which may be useful to the EIR reviewer is the Office of Health and Environmental Assessment (OHEA). Within OHEA, the two groups which can provide the most assistance in evaluating EIRs are the Exposure Assessment Group (EAG), located in Washington, D.C., and the Environmental Criteria and Assessment Office located in Cincinnati, Ohio (ECAO-Cin).

ECAO-Cin can provide assistance in determining whether any constituents found at off-site exposure points constitute a public health threat at measured or projected exposure levels. ECAO-Cin has developed a Rapid Response Toxicity Program to aid Regional and State offices in quickly (i.e., 48 hrs.) evaluating potential human health hazards posed by chemical releases. These responses may include: rough estimates of cancer risk or toxic potential; identification of key chemicals for further monitoring; a rough description of possible exposure situations and their potential health hazards; and some recommendations for future assessment efforts.

Most recommendations will require the involvement of EAG to evaluate monitoring data/methods and for a discussion of likely exposure scenarios and their uncertainties. While this program is designed to provide only preliminary estimates of health hazards, more detailed site assessments can also be provided. Requests for rapid technical response from ECAO-Cin may be forwarded directly to Chris DeRosa (FTS/684-7534). Requests for more detailed assessments should be sent to the PAT, which will coordinate ECAO/EAG assistance.

Through the PAT, OHEA may be able to help the EIR reviewer complete an exposure/risk analysis to project the likely effects from past or ongoing exposure to hazardous constituents. With the expertise available in OSW and ORD, the PAT can recommend a variety of models for use at a particular site, and may be able to assist in using this type of analysis in determining the extent of constituent transport via the usual pathways and the likely levels of contamination at projected exposure points. The PAT may also provide assistance in reviewing any analyses or projections submitted by the owner/operator.

b. The Agency for Toxic Substances and Disease Registry (ATSDR)

RCRA §3019 specifically identifies ATSDR as a potential participant in the evaluation of exposure information. ATSDR is an agency within the Public Health Service, Department of Health and Human Services. Its overall function is to carry out health-related responsibilities under CERCLA and RCRA. An Inter-agency Agreement (IAG) has been established to define RCRA-ATSDR interactions, and a Memorandum of Understanding (MOU) is currently under development.

Sites will be referred to ATSDR when a health assessment is warranted, as described in Step 4(b). ATSDR has the ability to perform several different levels of health assessment (see Attachment III), and the more extensive studies will usually be preceded by more limited investigations. ATSDR's major task in any level of health assessment will be to evaluate populations with known (or suspected) exposure to hazardous constituents as a result of a release from a regulated surface impoundment or landfill.

As noted in the Attachment III, ATSDR may also provide informal "health consultations" to provide health advice and/or health effects information regarding a specific site. The Regions should limit their consultative use of ATSDR before referral to situations that require relatively short-term assistance, e.g., assistance available through a telephone call. Requests for more extensive work should be sent to the PAT (ATSDR will also have a representative on the PAT), and the PAT will coordinate ATSDR assistance. The EIR reviewer may contact Ralph Touch at ATSDR (FTS/236-4551) directly for short-term technical assistance.

c. Technical Documents

The EIR reviewer may consult a number of EPA manuals which provide a variety of approaches in assessing the exposure potential and health impact of releases from hazardous waste sites. As mentioned previously, the RFA Guidance may prove useful in the early stages of release investigation. Perhaps most helpful in cases when the EIR reviewer feels a more extensive analysis of exposure potential is waranted is the Superfund Public Health Evaluation Manual (December, 1985) and the companion Superfund Assessment Manual (January, 1986). Copies of these manuals have been distributed to Regional Division Directors and Branch Chiefs; current information on the availability of these documents may be obtained by contacting OERR (382-2182).

Elements of the Public Health Evaluation Manual that may be useful in cases where serious exposure problems are suspected include: procedures for selecting indicator chemicals; physical/chemical and toxicity data for chemicals; and a summary of existing EPA standards and criteria for hazardous substances.

The Exposure Assessment Manual is a complex and highly technical compendium of approaches and models to use in assessing exposure potential. The data requirements of the various models discussed are provided. The extensive data needs illustrate the major problem in undertaking such a detailed analysis, i.e., much of the information needed to use quantitative modeling will not be available at many RCRA sites, and expensive and lengthy data gathering efforts would be required. Therefore, the EIR reviewer is urged to limit the use of complex models unless the data are available, and may seek assistance in the use of these manuals from the PAT.

C. Possible Actions in Cases of Human Exposure (Steps 4(a), 4(b), and 4(c))

If the EIR reviewer believes that more information is required to decide if a release has resulted in known or suspected exposure to the public at significant levels, (s)he should obtain the necessary data as outlined above. If (s)he decides that the criteria for human exposure (see Section III.B.1) are not met, and that significant human exposure is unlikely, then the EIR reviewer must still consider whether corrective action is needed to clean up the release (Step 4(c)). After this, the reviewer should also consider the impact of future releases (Step 5) and possible permit changes, if needed (Step 6). These steps are discussed in later sections of this guidance. The EIR reviewer may wish to prepare a short report for the administrative record summarizing decisions not to refer facilities for health assessments. Such reports may be useful documents for explaining the decision during public hearings.

If the components for human exposure given in Section III.B.1 are present, there are several actions the EIR reviewer should

consider. These actions include implementing interim remedial actions with appropriate public involvement (Step 4(a)), referral to ATSDR for a health assessment (Step 4(b)), and final corrective action (Step 4(c). Which actions are completed and the order in which these activities are pursued will depend on the situation; normally, however, the need for interim measures should be assessed first to insure that continuing public exposure is minimized. Furthermore, while a completed health assessment could be useful in designing a final corrective action plan, corrective action should not be significantly delayed.

1. Interim Remedial Action (Step 4(a))

Interim remedial measures may be necessary to prevent further human exposure. These may be pursued through the various enforcement and program authorities available to EPA, such as RCRA Sections 3008 and 7003, and CERCLA Sections 104 and 106. Examples of interim remedial action would include off-site and source control measures, such as:

- o evacuation of the public from the area if the problem is so serious as to pose an imminent and substantial endangerment;
- o requiring the owner/operator to provide bottled water and/or drinking water treatment when public drinking water is the pathway of exposure;
- o temporary suspension of facility operations that may cause or exacerbate the problem;
- o temporary removal/storage of wastes of concern, and other interim measures to contain or prevent releases (e.g., berm stabilization).

The EIR reviewer should consult with appropriate permitting and enforcement staff to map out a plan for needed remedial actions. A review of response actions available under §3008(h) may be found in the draft guidance, "RCRA §3008(h) Corrective Action Interim Measures", issued by OWPE (latest draft, May 13, 1986). The reviewer should also contact public participation staff in order to design and implement a public information program to inform the public of the health concerns associated with the facility and the immediate and long-term actions planned to address the problems.

2. Referral to ATSDR for Health Assessment (Step 4(b))

a. Referral Authority and Concurrence

If there is sufficient evidence that a release from a regulated surface impoundment or landfill has resulted in significant human exposure (i.e., if the three necessary components of exposure have been established for any of the exposure pathways), then EPA (or authorized States) may refer the facility to ATSDR for a health assessment (Step 4(b)). While the statute originally

assigned the authority to refer a facility to ATSDR to the EPA Administrator, this authority has been delegated to the Regional Administrators. The Regional Administrator, if (s)he so chooses, may redelegate the authority to the Division Director level.

However, the Delegation provides that, before seeking a health assessment from ATSDR under §3019, the Region must obtain the concurrence of the Assistant Administrator for Solid Waste and Emergency Response. This concurrence requirement is designed to ensure that important sites are assessed first, and to encourage national consistency in the types of sites that are referred to ATSDR. Regions seeking concurrence for referrals to ATSDR should contact the Permit Assistance Team (PAT) at EPA Headquarters (contact Terry Grogan or Bob Kayser, FTS/382-4740). The PAT will coordinate the review of the information by OSW, OWPE, ATSDR, and other EPA offices (e.g., ORD) as needed, and make recommendations to the Assistant Administrator concerning the referral.

b. Documentation of Referral Request

When a Region believes that a health assessment by ATSDR is necessary, the EIR reviewer must prepare a written report for submission to Headquarters which summarizes the exposure analysis completed to date, and identifies the pathways of concern. This report will serve several functions, including: (1) forcing the EIR reviewer to formally consider the adequacy of the assembled evidence prior to referral; (2) allowing the Headquarters concurrence group to review the data in a timely manner; and, (3) providing a useful summary document for initial review by ATSDR, if a health assessment is required.

This report must summarize the evidence that the three elements for human exposure are present at the site. Section III.B.1 describes the kinds of evidence needed to document human exposure. The report should follow a logical format and should include:

- background information on the facility (location, types of wastes handled, brief description of all units on site, nearby land use, map of facility);
- evidence confirming a significant release from the regulated surface impoundment or landfill (monitoring data and the level of confidence in data, all hazardous constituents detected, approximate quantitity of wastes released, identification of major constituents in waste);
- evidence indicating extent of contamination and migration pathway of released constituents (monitoring data or modeling results showing movement off-site, the ranges of substances detected throughout contaminated area);
- evidence indicating a likelihood of human exposure via ingestion, inhalation, or direct contact at levels suggesting a potential health threat (location of nearby populations, monitoring

data at exposure point, health complaints from public, records of local health departments, constituents measured or projected at levels exceeding Agency standards or other health-based criteria);

- on-going or planned activities to collect more data and institute remedial action at the site (including public participation plans);
- results of any preliminary evaluations or assessments of site data undertaken by the State, Region, ORD, ATSDR, the o/o, or others;
- level of health assessment sought (if possible, include specific questions); and,
- name and phone number of Regional/State contacts most familiar with details of the site.

The report should summarize pertinent monitoring data in tabular form with clear indications (i.e., on a map) of the sampling locations. Any analysis of the data (e.g., by the owner/operator, contractors, Regional/State staff) should be succinctly described, and any references used must be cited. While the level of effort required to prepare the referral report will vary with the complexity of the site, the report should be a summary document, not a lengthy treatise on the facility. Source documents (Part B, EIR, etc.) should be referenced for details, and copies of important pages from these documents may be provided.

3. Corrective Action (Step 4(c))

Corrective action will be considered whether or not the EIR reviewer determines that significant exposure to the public has occurred. If exposure routes have been documented and a health assessment is initiated, appropriate permitting and enforcement staff should be kept informed. Permit and/or enforcement staff developing the corrective action plan should coordinate the plan with the health assessment, if necessary. The level of clean-up may be affected by the results of the assessment, if for example, the health assessment uncovers a causal link between the level of the hazardous constituent at the exposure point and the particular health effects in the exposed population. In most cases, however, the permit writer is urged to proceed with permit issuance to begin initial clean up activities if the available data on the extent of contamination are adequate. The permit may be modified to incorporate any useful information arising out of health assessment activities. As described in section III.B, §3008(h) orders may be used to institute corrective action prior to permit issuance.

The EIR reviewer may decide that the evidence does not indicate that significant public exposure due to prior/continuing releases has occurred, and therefore, that referral to ATSDR is not warranted. However, the permit writer should still examine the need

for corrective measures to lessen the possibility of future exposures to past releases. In the case of ground-water contamination, of course, the Subpart F regulations (§264.100) require clean up to levels set by Ground-Water Protection Standards. There are other corrective action measures to take and several vehicles for requiring these measures. Guidance is being developed to assist the permit writer in instituting corrective measures under 3004(u), 3004(v), and 3008(h). These authorities are the primary vehicles available to the permit writer for clean up of releases from regulated units to media other than ground water.

In those situations involving an imminent and substantial endangerment to public health, EPA may take action under 7003 of RCRA or 106(a) of CERCLA to institute remedial action. The "Endangerment Assessment Memorandum" issued by J. Winston Porter (November 22, 1985) provides guidance on the preparation of endangerment assessments to support all administrative and judicial enforcement actions under CERCLA Section 106 and RCRA Section 7003. An endangerment assessment must be developed in order to document and justify that an imminent and substantial endangerment to public health or welfare exists. A supplement to the Guidance has also been prepared by the Office of Waste Programs Enforcement, in draft form, entitled the Endangerment Assessment Handbook (August, 1985).

These authorities described above allow EPA to force clean up of releases prior to actual human exposure. Therefore, the EIR reviewer and/or permit writer should consult with enforcement staff in cases that warrant corrective measures prior to permit issuance. Section III.E. of this guidance should also be consulted for possible use of the new "omnibus" provision (3005(c)(3)) in establishing additional permit conditions to address potential exposure concerns.

D. Determining the Potential for Significant Public Exposure From Future Releases (Step 5)

In addition to evaluating prior/continuing releases from all regulated surface impoundments or landfills (steps 2 through 4 in Figure 1), the EIR reviewer must also address the potential for human exposure in the case of future releases† (step 5). As such, Step 5 is the most conjectural part of the EIR review. When reviewing EIRs for new landfills and surface impoundments, the EIR review will consist only of this Step and Step 6, consideration of permit conditions necessary to prevent human exposure. The timing of Step 5 may vary depending on the need to investigate prior releases. In addition, the EIR reviewer and/or permit writer may wish to use this analysis of the impact of future releases as a tool in focusing attention on human exposure potential throughout the permitting and RFA/RFI processes.

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†"Future releases" also include releases that may have already occurred, but are not yet detected.

1. General Approach

The reason for examining the impact of future releases is to highlight pathways of concern and allow permit conditions to be modified or strengthened to mitigate site-specific potential problems (Step 6). Of course, the occurrence of prior releases to a particular pathway, and any evidence of subsequent migration and human exposure, should be used as the primary indicator of the potential impact of future releases. This is why the flow chart in Figure 1 also leads the EIR reviewer to consider the impacts of future releases (Step 5) after the process for prior releases (Steps 2-4) is followed.

In the absence of a history of past releases, however, the EIR reviewer should consider the potential exposure if a release should occur. The EIR reviewer is encouraged to use a qualitative approach for screening facilities for possible exposure concerns from future releases. In a limited number of cases a more detailed evaluation may be warranted if the initial qualitative screen indicates that a future release from the unit is likely to result in significant human exposure. In these cases, the permit writer may wish to quantify possible exposure scenarios in order to justify the imposition of permit conditions that go beyond the existing Part 264 standards (see next section for a discussion of the new "omnibus" provision). Future guidance will provide information on applying a more quantitative approach.

The EIR reviewer may follow the general approach outlined below to qualitatively screen units. This approach examines the same elements for exposure as defined for past releases (i.e., release, migration, and receptor location). Due to the prospective nature of the evaluation, however, the approach first examines the route characteristics and receptor information assuming a release occurs. If a potential concern is identified, the design and operating features of the unit should be critically examined for their adequacy to prevent or detect releases. The infomation needed to evaluate the major pathways should be available from the EIR, the Part B, or the other information sources mentioned in Section I.

The requirement under 3019 to consider the impact of future releases (i.e., Step 5) has many features in common with the RCRA RFA process designed to implement 3004(u) and 3008(h). The potential for future releases becomes an important factor if the EIR reviewer decides that a particular pathway is of concern. Therefore, the EIR reviewer (and permit writer) should use the results of a RFA investigation as a valuable source of information in deciding if the location, design, and operating features of the unit are adequate to prevent (or render less likely) future releases to pathways of concern.

Because the RFA and EIR review processes share many similar concerns relating to the potential for a release and subsequent migration off-site, many elements of the methods given in the RFA guidance have been incorporated into the following qualitative

approach. The following sections describe important factors for each pathway that should by considered in an initial qualitative screen.

2. Pathway-Specific Factors

a. Ground Water

The EIR reviewer should examine the pertinent hydrogeological and geological factors of the site, as well as the location of possible target populations, in order to assess the potential impact if a future release to the ground-water pathway occurred. The important route characteristics and receptor information to examine are described below.

Route Characteristics Affecting Exposure Potential

An evaluation of the ground water pathway should indicate the potential for contaminant movement through the unsaturated zone to the aquifer and subsequent off-site migration in the ground water to human receptors. Therefore, the important characteristics to examine should include the soil characteristics (i.e., permeability) of the unsaturated zone, the depth of the aquifer, and the flow rate and direction of the ground water. If the hydrogeology of the site is properly defined in the Part B (including at least the permeablity of the saturated zone and the hydraulic head), the EIR reviewer should be able to estimate the time-of-travel (TOT) for the ground water to the facility boundary, and perhaps to the nearest off-site downgradient well. Other factors which may be important at some sites include the local climate (e.g., net precipitation, which would effect the generation of leachate), the existence of confined aquifers, the discharge of ground water to surface water, and seasonal variations in the water table.

Receptor information of prime importance include the location of the nearest down gradient wells, the uses of the ground water in the area, and magnitude of the population served by nearby wells. While drinking ground water is an obvious exposure route, other ground water uses may lead to human exposure through contamination of food crops (irrigation uses) or other food products (milk). In addition, nearby populations may be impacted if the site characteristics promote basement seepage into nearby buildings.

An example of a site of obvious concern would be one at which the unit overlies a highly permeable unsaturated zone (sand, silt, permeability $> 10^{-4}$ cm/sec), the aquifer is shallow, the ground-water flow is moderately fast, perhaps due to faults, joints, or solution channels (TOT to facility boundary < 5 yrs.), and nearby drinking water wells lie down gradient (TOT to nearest well < 10 yrs.). Conversely, if the aquifer were situated below an extensive impermeable layer (clay; permeability $< 10^{-6}$ cm/sec), the ground water flow was slow (TOT to facility boundary > 50 yrs.), and the aquifer was not presently used by nearby

populations, then the EIR reviewer could decide that exposures via this route are unlikely if a release occurred.

Situations which are not so clear-cut may still be of only limited concern if either a reasonable migration route (i.e., moderately fast ground water flow to off-site wells), or likely target receptors (i.e., nearby populations using the ground water) are not present. For these intermediate cases, however, the EIR reviewer may require more information on the hydrogeology, receptor locations, or aquifer uses. More definitive guidance on evaluating ground-water vunerability may be found in the manual Criteria for Identifying Areas of Vunerable Hydrogeology Under the Resource Conservation and Recovery Act (OSWER, July, 1986). The EIR reviewer should refer to this guidance if a more complete analysis of ground water location characteristics is warranted.

Unit Design and Operating Features

If the EIR reviewer has some concerns about the possible exposure to the public from releases to the ground water, then (s)he should undertake a review of the relevant design and operating features of the unit. The relevant features of landfills and surface impoundments are related to the containment of leachate and the leak detection/monitoring systems. The adequacy of the liner and leachate collection systems, leak detection procedures (e.g., routine leachate analysis), and the ground-water monitoring systems around the units should be reexamined. During this examination, the EIR reviewer should decide if any modifications to the existing systems are necessary to reduce the likelihood of releases (or increase the probability of detecting releases) to the ground water. Any special waste characteristics, or pre-treatment process that might affect the amount of liquid waste managed should also be considered.

b. Surface Water and Drainage

Assuming a release might occur, the EIR reviewer should first evaluate the potential for human exposure. Releases that occur to surface water and off-site surface drainage areas may arise from leaks, surface run-off, spills, or floods. The effectiveness of pertinent design/operating features should be examined if the EIR reviewer concludes that this pathway is of concern.

Route Characteristics Affecting Exposure Potential

The primary considerations in evaluating the potential for human exposure for this pathway are the proximity of the unit to surface water, the likelihood that a release would migrate overland, and the current uses of the surface water. Therefore, the requirements for a realistic surface water pathway for human exposure generally would include all of the following:

° surface water located close to the unit;

° the characteristics (slope, soil type, vegetation, paved areas) of the likely paths for run-off from the unit are sufficient for a relase to reach the water; and

° use of the surface water for drinking water, commercial fishing, shellfish harvesting, or extensive agricultural (irrigation of food crops) or recreational uses.

For example, releases from units located in topographically depressed areas are unlikely to leave the site as run-off. Also, facilities located close to surface water may still be unlikely to contaminate this medium if the intervening terrain is characterized by sandy soil and heavy vegetation; in this case run-off is likely to migrate into the unsaturated or saturated zone. On the other hand, a pathway characterized by clayey soils, little vegetation, and/or the presence of natural or man-made run-off routes (e.g., ditches, paved areas, storm sewer systems, etc.) may indicate a potential problem if the usage of the surface water makes human exposure likely (e.g., drinking water intake or commercial fishing areas are a short distance downstream). The permit writer should also consider possible discharge of contaminated groundwater into surface water.

In the case of a likely route to the surface water, the EIR reviewer may examine the features of the surface water itself to estimate the impact of a release. For example, a release from a relatively small surface impoundment or a limited amount of run-off from a nearby landfill may not have a significant impact on a large, fast flowing river due to dilution. However, the validity of this type of assumption depends to a great degree on the characteristics of the chemical constituents which might be released, i.e., the toxicity and fate/transport properties of the substances. If the EIR reviewer feels that a more detailed evaluation of the potential for significant exposure due to future releases to surface water is required, (s)he may refer to the procedures contained in the RFA Guidance which discuss how to assess such releases.

Design and Operating Features

If a significant potential for exposure due to a future release to nearby surface water exists, the EIR reviewer should examine the pertinent design features. The effectiveness of landfill and surface impoundment run-off and erosion controls, the adequacy of collection and secondary containment systems, overflow alarms, automatic cut-off systems, and dike design should be considered for surface impoundments. (The EIR reviewer should also consult an OSW policy memorandum from John Skinner to the Regions dated November 14, 1985 for details on the management of precipitation run-off at landfills). In addition, if the unit is within the 100-year foodplain, procedures to ensure

protection from wash-out during flooding should be reviewed. The EIR reviewer and/or the permit writer should decide if changes or additions to the unit design/operating features in the permit are needed to address potential exposure from releases to a surface-water pathway identified as a concern.

c. Air

In general, the two types of air releases of concern are continuous, chronic releases, and releases that are intermittent and sudden in nature. Continuous air releases associated with surface impoundments usually arise from the volatilization of organic constituents of the waste handled. For landfills, air releases may occur by volatilization through inadequate daily covers, or by particulate releases generated by filling operations or wind erosion. (Subsurface gas is a unique type of air problem treated separately in the next section). Intermittent air releases may result from accidents (fires, explosions) occuring during the mishandling of incompatible, reactive, or ignitable wastes.

Route Characteristics Affecting Exposure Potential

Population density and distance from the unit are the primary factors in the potential for exposure to an air release. Another factor to consider is if people are located along the line of the predominant wind direction at the site. While wind velocity and direction are variable at most locations, people located along this vector are more likely to receive increased exposures to air releases (especially chronic releases). In general, however, releases to the atmosphere may be rapidly dispersed throughout the area around the facility, and some exposure to any of the nearby populations may occur.

Design and Operating Features

Because route characteristics are of limited use in determining if a release from a unit would pose an exposure problem, the EIR reviewer may instead focus on the potential for air releases. This approach is essentially identical to the approach incorporated in the RFA Guidance and the EIR reviewer should refer to this manual for details. In general, this approach relies heavily on the characteristics of the wastes handled and unit design/operating features to uncover potential releases. For example, an impoundment with a large surface area containing fairly concentrated solutions of volatile organics may warrant examination if people are immediately downwind from the unit. Conversely, surface impoundments handling wastewaters containing only non-volatile metals should not pose a significant exposure problem. If volatile wastes are handled at the unit, and population centers are nearby, the EIR reviewer should examine (and consider permit changes to correct) unit characteristics that may promote air releases, such as: large, uncovered surface impoundments, treatment methods using aeration, inadequate daily/permanent landfill covers, and trench fill operations.

Potential release and exposures to nearby populations due to accidents such as fires and explosions also will depend on waste characteristics. If significant amounts of ignitable, reactive, or incompatible wastes are handled, the EIR reviewer should examine the Part B submission to ensure that the relevant 264 standards (264.17, 264.312-314, 264.229-230) are adequately addressed. Waste analysis/management plans, including procedures to identify such wastes when received and special handling, treatment, or mixing procedures employed, should be scrutinized to ensure that additional permit conditions are not needed to prevent violent reactions, fire, or explosions.

d. Subsurface Gas

Routine subsurface gas releases are most likely from sites where biodegradable wastes are managed. Landfills used for codisposal of putrescible refuse with hazardous waste pose the most serious problem because of the potential for other volatile hazardous constituents to become mixed with the methane generated from the decomposable material. If codisposal has not occurred (and will not occur in the future), the EIR reviewer may generally disregard this exposure pathway. However, if codisposal is known or suspected, the factors that affect migration of subsurface gas should be examined.

If an analysis is warranted by codisposal practices, the RFA Guidance should be consulted for details on procedures to assess the potential for release and off-site migration of subsurface gas. Subsurface gas migration may be facilitated by man-made underground conduits used for power lines, drainage/sewer pipes, and telephone cables. The presence of natural or engineered barriers or controls (surface water, ground water, synthetic liners, slurry walls, gas venting systems) will impede or prevent lateral migration of gas produced. The geological setting and climate will have a large impact on gas movement, e.g., soils with high permeability and effective porosity tend to allow upward (rather than lateral) gas migration, while relatively impermeable (or frozen) soils may promote lateral movement. Nearby buildings must also be present in order for subsurface gas to consitute a potential threat via explosion of methane gas, or through human exposure to toxic gases (e.g., vinyl chloride).

If codisposal at a landfill is known or suspected, and if the site characteristics promote the lateral migration of gas to nearby buildings, then a potential for human exposure exists. Any existing monitoring or control systems for subsurface gas should be examined, including any passive venting designs (gravel walls, vents to surface), any active recovery system, and treatment procedures used for recovered or vented gas. Normally, the usual path to assess the significance of this pathway would be as part of a RFA investigation. Probably only after completion of the RFA (and RFI, if necessary) would the permit writer consider additions to the permit that would address these concerns, e.g., installation of gas venting systems.

e. Soil

Potential exposures due to direct contact with contaminated soils should be negligible if the site at which the unit is located has the required security (see relevant section of Part B). Therefore, the prime concern should be intermedia transfer of contaminated soil to another pathway and subsequent off-site transport. For example, any potential for transport off-site by run-off to surface water or through wind dispersion to air should be examined under the appropriate pathway evaluations described in the preceding sections. The potential for food chain contamination should also be considered if any food crops are grown near contaminated soils.

Design and operating features relevant to contaminated soil intermedia transfer have been previously described. The EIR reviewer should review these procedures, as well as the security procedures and equipment used to limit public access to active portions of the units, and spill clean-up procedures for routine spills, accidents, and leaks. An additional concern related to the transportation of waste (see next section) is the adequacy of current operating procedures in preventing the "track out" of contaminated soils by transportation vehicles from active portions of the site.

3. Transportation Factors

Routine transportation releases are associated with leaks or unloading/loading practices. The EIR reviewer should examine the type, capacity, and adequacy of vehicles and other conveyances (e.g., pipelines) used, and the procedures taken to minimize releases. The traffic pattern information should be examined to determine if the routes traveled through nearby populated areas pose potential exposure concerns. For example, the potential for exposure is increased if large quantities of waste (especially acutely toxic, highly volatile, ignitable, or explosive wastes) are transported through highly populated areas. Transportation routes through thinly populated area, or on-site waste disposal, are less likely to lead to significant human exposure.

If the permit writer has concerns about the potential exposure arising from transportation of waste, (s)he should examine the past compliance records of the facility, noting any accidents and transportation violations. The permit writer should also consider requiring improved emergency spill/clean-up procedures used for transportation accidents, special contingency plans with nearby localities, or other ways of dealing with the problem.

4. History of Management Practices

Proper management practices are necessary to ensure the operation of the unit is adequate to render releases unlikely or to detect and correct problems. Obviously, the most definitive

indicator of problems is a past release, and the EIR reviewer must examine the design and operation of the unit to see if changes in permit conditions are warranted to address these past problems. Other less definitive types of information that are indicative of the adequacy of the operation/design of the unit include insurance claims and settlements, and the compliance history of the unit with Federal, State, and local regulations, especially inspection records and any violation citations. The EIR reviewer should consider the history of complicance with RCRA regulations, as well as other records that the owner/operator submitted or identified in the EIR, such as:

° occupational health and safety records;

° NPDES compliance records;

° compliance records for applicable air regulations; and

° spills reported under CERCLA.

For example, worker data on injuries, accidents, and illnesses related to operation of the unit may be used to help identify those facilities with questionable management practices, and hence, with potential for releases. The EIR reviewer should focus on the nature and frequency of these and other chronic violations to assess the likelihood that a future release to <u>any</u> pathway might occur.

If a chronic compliance problem exists, the EIR reviewer should examine relevant permit conditions (e.g., worker training problems, contingency plans, inspection schedules, proposed compliance schedules) to ensure that the unit is operated in an adequate manner. The EIR reviewer should also discuss compliance problems and possible remedies with appropriate RCRA enforcement staff.

5. <u>Example of Exposure Potential Determination</u>

Figure 3 summarizes an example of the results of a qualitative screen of the potential for exposure from future releases (Step 5). This example examines the same site that was reviewed in Figure 2 (for prior releases, Step 2) and the same background information applies. Figure 3 illustrates the types of decisions that can be made concerning: the potential impact of future releases to each pathway; when release potential should be considered; and, possible follow up action to address potential problems. Note that the existence of prior releases is given important consideration in assessing release potential, and the outcome of investigations of past releases will greatly affect possible follow up actions.

Figure 3. Example of Summary Sheet Following Qualitative Screen for Future Releases

Background Summary

See Figure 2 for general background. Concerning Management Practices, no chronic RCRA compliance problems documented; occupational and CERCLA records do not indicate problems. (Odor violation being examined through prior release analysis; see air pathway)

Pathway	Potential for Exposure	Release Potential and Possible Follow-Up Action
Ground Water	Very low. Aquifer not used for drinking water; ground-water flow very slow ($K < 10^{-5}$cm/sec, minimal hydraulic head).	Not required due to low exposure potential.
Surface Water	Very low. Use of nearest surface water severely limited due to existing pollution. No overland route; run-off goes to POTW before discharge.	Not required due to low exposure potrential.
Air	Possible due to population areas adjacent to site and the handling of some volatile wastes. Level of concern raised due to odor violation.	Based on past releases, future release likely. Await results of monitoring to decide if new permit conditions warranted.
Subsurface Gas	Very low. While underground conduits exist, unlikely route for surface impoundment.	Not required due to low exposure potential.
Soil	Possible concern due to record of facility sweeping nearby residential street. Direct exposure of nearby population could result from track-out of contaminated soil.	Potential for track-out exists; if subsequent RFA or RFI shows soil contamination, consider permit conditions (e.g., cleaning trucks prior to off-site transport).
Transportation	No indication of potential problems beyond track-out concern raised under soil pathway.	Not required due to low exposure potential.

E. Considering Permit Conditions to Mitigate Potential Exposure (Step 6)

If the analysis outlined for Step 5 indicates the potential for significant public exposure due to future releases, then the EIR reviewer should examine the design and operating features of the unit as described in the preceding section to decide if additional permit conditions are necessary to decrease the potential for releases. If this examination suggests that the existing design and operating features are adequate to address any potential exposure pathways, then the EIR reviewer may end the EIR review process.

Alternatively, if the EIR reviewer feels that additional permit conditions are required, (s)he must consider what conditions are warranted and how these can be required in the permit. In some cases, strengthening permit conditions already required under existing 264 standards may be adequate. In the case of concerns over releases to ground water, for example, the owner/operator might be required to undertake more frequent monitoring of existing wells, or sink new wells, in order to insure that a release will be detected in a timely manner. Because the existing regulations were designed to address primarily ground-water contamination, the permit writer may find a variety of ways to decrease exposure potential for this pathway under the existing regulations.

Concerns about releases to other media may also be addressed, to a limited degree, under existing 264 standards. For example, release potential to the air might be reduced through a strengthening of conditions related to waste analysis (to ensure that accidental releases through explosion, fire, or productions of toxic gases do not occur through mismanagement). Exposure potential via air releases may be decreased by insisting on well designed contingency plans and other agreements with the surrounding communities. In some cases, however, the permit writer may have to go beyond the standards contained in Part 264. Permit denial (the "ultimate" permit condition) is the final option in extreme cases of serious exposure potential.

The Hazardous and Solid Waste Amendments of 1984 (HWSA) provided EPA with a new "omnibus" authority in Section 3005(c)(3), and this provision has been codified in the RCRA regulations in 40 CFR Part 270.32(b)(2). This provision enables the permit writer to require the owner/operator to comply with permit conditions "necessary to protect public health and the environment". The accompanying legislative history indicates that Congress intended EPA to add permit conditions beyond those specified in the exisiting regulations (see the codification rule, 50 FR 28722, July 15, 1985).

Therefore, EPA may require permit conditions that go beyond existing 264 standards if an examination of the exposure potential of the facility warrants such action. In these cases, the EIR

reviewer/permit writer may wish to perform a more extensive analysis of future release/exposure potential to justify additional permit conditions. However, for sites at which past releases and exposures have been documented for a particular pathway (e.g., via the process beginning with Step 2 in the EIR review process), further documentation of future release potential via this route may not be needed.

Examples of additional permit conditions that could be added under 3005(c) include:

- new design/operating features to rapidly detect releases (e.g., require routine air monitoring for indicator parameters at or near the site);

- additional release control design features (e.g., covers or wind screens to decrease air emissions from surface impoundments; increased dike stability requirements and/or secondary containment systems to prevent release to surface water); and,

- limitations on the operations of the unit/site (e.g., limit the handling of wastes with volatile constituents to mitigate air releases; limit the acceptance and treatment of ignitable or reactive wastes to prevent possible explosions or intermittent air releases; limit the acceptance of certain acutely toxic wastes).

Attachment I Section 3019 Statute

Section 3019. Exposure Information and Health Assessments

"Sec. 3019. (a) EXPOSURE INFORMATION.—Beginning on the date nine months after the enactment of the Hazardous and Solid Waste Amendments of 1984, each application for a final determination regarding a permit under section 3005(c) for a landfill or surface impoundment shall be accompanied by information reasonably ascertainable by the owner or operator on the potential for the public to be exposed to hazardous wastes or hazardous constituents through releases related to the unit. At a minimum, such information must address:

"(1) reasonably forseeable potential releases from both normal operations and accidents at the unit, including releases associated with transportation to or from the unit;

"(2) the potential pathways of human exposure to hazardous wastes or constituents resulting from the releases described under paragraph (1); and,

"(3) the potential magnitude and nature of the human exposure resulting from such releases.

The owner or operator of a landfill or surface impoundment for which an application for such a final determination under section 3005(c) has been submitted prior to the date of enactment of the Hazardous and Solid Waste Amendments of 1984 shall submit the information required by this subsection to the Administrator (or the State, in the case of a State with an authorized program) no later than the date 9 months after such date of enactment.

"(b) HEALTH ASSESSMENTS.—

"(1) The Administrator (or the State, in the case of a State with an authorized program) shall make the information required by subsection (a), together with other relevant information, available to the Agency for Toxic Substances and Disease Registry established by section 104(i) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980.

"(2) Whenever in the judgment of the Administrator, or the State (in the case of a State with an authorized program), a landfill or a surface impoundment poses a substantial potential risk to human health, due to the existence of releases of hazardous constituents, the magnitude of contamination with hazardous constituents which may be the result of a release, or the magnitude of the population exposed to such release or contamination, the Administrator or the State (with the concurrence of the Administrator) may request the Administrator of the Agency for Toxic Substances and Disease Registry to conduct a health assessment in connection with such facility and take other appropriate action with respect to such risks as authorized by section 104(b) and (i) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980. If funds are provided in connection with such request the Administrator of such Agency shall conduct such health assessment.

"(c) MEMBERS OF THE PUBLIC.—Any member of the public may submit evidence of releases of or exposure to hazardous constituents from such a facility, or as to the risks or health effects associated with such releases or exposure, to the Administrator of the Agency for Toxic Substances and Disease Registry, the Administrator, or the State (in the case of a State with an authorized program).

"(d) PRIORITY.—In determining the order in which to conduct health assessments under this subsection, the Administrator of the Agency for Toxic Substances and Disease

Attachment I (Continued)

Registry shall give priority to those facilities or sites at where there is documented evidence of release of hazardous constituents, at which the potential risk to human health appears highest, and for which in the judgment of the Administrator of such Agency existing health assessment data is inadequate to assess the potential risk to human health as provided in subjsection (f).

"(e) PERIODIC REPORTS.—The Administrator of such Agency shall issue periodic reports which include the results of all the assessments carried out under this section. Such assessments or other activities shall be reported after appropriate peer review.

"(f) DEFINITION.—For the purposes of this section, the term 'health assessments' shall include preliminary assessments of the potential risk to human health posed by individual sites and facilities subject to this section, based on such factors as the nature and extent of contamination, the existence of potential for pathways of human exposure (including ground or surface water contamination, air emissions, and food chain contamination), the size and potential susceptibility of the community within the likely pathways of exposure, the comparison of expected human exposure levels to the short-term and long-term health effects associated with identified contaminants and any available recommended exposure or tolerance limits for such contaminants, and the comparison of existing morbidity and mortality data on diseases that may be associated with the observed levels of exposure. The assessment shall include an evaluation of the risks to the potentially affected population from all sources of such contaminants, cinluding known point or nonpoint sources other than the site or facility in question. A purpose of such preliminary assessments shall be to help determine whether full-scale health or epidemiological studies and medical evaluations of exposed populations shall be undertaken.

"(g) COST RECOVERY.—In any case in which a health assessment performed under this section discloses the exposure of a population to the release of a hazardous substance, the costs of such health assessment may be recovered as a cost of response under section 107 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 from persons causing or contributing to such release of such hazardous substance or, in the case of multiple releases contributing to such exposure, to all such release.

TACHMENT II

Facility Name _____
ID No. _____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

A. General Information

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
A-1.	Information in Part B Application					
A-1a	General description of facility	270.14(b)(1)	____	____	____	_____
A-1b	Chemical and physical analyses of wastes	270.14(b)(2) and (3)	____	____	____	_____
A-1c	Access control and security description of active portion	270.14(b)(4)	____	____	____	_____
A-1d	General inspection schedule and procedures	270.14(b)(5), 270.17(d), and 270.21(d)	____	____	____	_____
A-1e	Preparedness and prevention documentation	270.14(b)(6)	____	____	____	_____
A-1f	Contingency plan	270.14(b)(7)	____	____	____	_____
A-1g	Preventive procedures	270.14(b)(8)	____	____	____	_____
A-1h	Facility location information	270.14(b)(11)(i) and (ii)	____	____	____	_____
A-1i	Closure plan	270.14(b)(13)	____	____	____	_____
A-1j	Post-closure care plan	270.14(b)(13)	____	____	____	_____
A-1k	Documentation of insurance	270.14(b)(17)	____	____	____	_____
A-1l	Topographic map (site plotted on USGS quadrangle maps)	270.14(b)(19)	____	____	____	_____
A-1m	List of wastes placed or to be placed in each unit	270.21(a) and 270.17(a)	____	____	____	_____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

A. General Information (continued)

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
A-2.	Additional Information					
A-2a	Existing risk assessment reports and information, including liability insurance analyses, claims, and settlements	270.10(j)				
A-2b	Land use and zoning map(s) for an area of 4 miles around the unit	270.10(j)				
A-2c	Existing aerial photographs of the facility	270.10(j)				
A-2d	Identify and summarize any waste analysis data not already submitted; provide additional data as discussed in text	270.10(j)				
A-2e	Current estimate of annual amount of waste received and description of any pretreatment process used	270.10(j)				
A-2f	Identification of any Federal, State, or local inspection or compliance records related to environmental and health programs; include descriptions of any major violations	270.10(j)				

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

B. Ground-Water Pathway

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
B-1.	**Information in Part B Application**					
B-1a	Interim status ground-water monitoring results	270.14(c)(1)	____	____	____	____
B-1b	Identification of uppermost aquifer, including flow rate and direction	270.14(c)(2)	____	____	____	____
B-1c	Topographic maps related to ground-water protection (well location, water table elevation contours, etc.)	270.14(c)(3) and 270.14(b)(19)	____	____	____	____
B-1d	Description of existing contamination	270.14(c)(4) (i) and (ii)	____	____	____	____
B-1e	Detailed plans for ground-water monitoring program	270.14(c)(5)	____	____	____	____
B-1f	Description of detection monitoring program (if applicable)	270.14(c)(6)	____	____	____	____
B-1g	Description of compliance monitoring program and characterization of contaminated ground water (if applicable)	270.14(c)(7) and (c)(7)(ii)	____	____	____	____
B-1h	ACL demonstration (if any)	270.14(c)(7)(iv)	____	____	____	____
B-1i	Corrective action program (if applicable)	270.14(c)(8)	____	____	____	____
B-1j	Description of liner and leachate collection systems (if applicable)	270.17(b)(1) 270.21(b)(1)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

B. Ground-Water Pathway (continued)

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
B-2.	Additional Information					
B-2a	Existing map showing location of all known wells within three miles; number and location of drinking water wells	270.10(j)	____	____	____	____
B-2b	Discussion of ground-water uses within three miles of unit	270.10(j)	____	____	____	____
B-2c	Regional map showing areas of ground-water recharge and discharge	270.10(j)	____	____	____	____
B-2d	Net precipitation using net seasonal rainfall or other available data	270.10(j)	____	____	____	____
B-2e	Unless otherwise reported to EPA, available well data indicating a release, and information on any affected public or private water supplies, including populations served	270.10(j)	____	____	____	____
B-2f	Any known food chain contamination due to prior release from the unit to ground water	270.10(j)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

C. Surface Water Pathway

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
C-1.	Information in Part B Application					
C-1a	Location information related to 100 yr flood plain including variance demonstrations	270.14(b)(11) (iii) thru (v)	____	____	____	____
C-1b	System for control of run-on from each peak discharge of 25 yr storm	270.21(b)(2)	____	____	____	____
C-1c	System for control of run-off from 24 hr, 25 yr storm	270.21(b)(3)	____	____	____	____
C-1d	Procedures/equipment to prevent overtopping	270.17(b)(2), 264.221(f)	____	____	____	____
C-1e	Structural integrity of dikes	270.17(b)(3)	____	____	____	____
C-2.	Additional Information					
C-2a	Discussion of surface water uses within three miles of the unit, including a map showing the location of all surface water bodies and downstream drinking water intakes	270.10(j)	____	____	____	____
C-2b	Velocities of streams and rivers passing through and adjacent to the property	270.10(j)	____	____	____	____
C-2c	Description of any system used to monitor surface water quality, and a summary of the data	270.10(j)	____	____	____	____
C-2d	Description of known releases to surface water; the extent of contamination; remedial action, if any; and if known, severity of impact	270.10(j)	____	____	____	____
C-2e	Any known food chain contamination resulting from prior release from the unit to surface water	270.10(j)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

D. Air Pathway

Numbers	Information Requirement	Req. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
D-1.	Information in Part B Application					
D-1a	Documentation of procedures to prevent accidental ignition or reaction	270.14(b)(9) 270.21(f) and (g), 270.21(h) and (i)	____	____	____	____
D-1b	Plans to control wind dispersal of particulate matter at landfills	270.21(b)(5)	____	____	____	____
D-1c	A wind rose showing prevailing windspeed and direction	270.14(b)(19)(v)	____	____	____	____
D-2.	Additional Information					
D-2a	Summary of air monitoring data and a description of current monitoring system, if any	270.10(j)	____	____	____	____
D-2b	Population within a four mile radius of the unit	270.10(j)	____	____	____	____
D-2c	Describe any known releases to air; the extent of contamination; remedial action, if any; and severity of impact, if known	270.10(j)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

B. Subsurface Gas Pathway

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
B-1.	Information in Part B Application					
	[Note: None in addition to General Information Requirements]					
B-2.	Additional Information					
B-2a	Any past disposal of municipal-type wastes in the unit; approximate quantities and dates of disposal, if known	270.10(j)	____	____	____	____
B-2b	Map location of any underground conduits within the site and known underground conduits within 1000 feet of property boundary	270.10(j)	____	____	____	____
B-2c	Descriptions of any monitoring or control mechanisms for subsurface gas release; summarize resulting data	270.10(j)	____	____	____	____
B-2d	Description of any known releases; extent of contamination; remedial action taken, if any; and the severity of impact, if known	270.10(j)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

F. Contaminated Soil Pathway

Numbers	Information Requirement	Req. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
F-1.	**Information in Part B Application**					
	[Note: None in addition to General Information Requirements]					
F-2.	**Additional Information**					
F-2a	If soil sampling has been done, a map showing areas of soil contamination, and a summary of analytical results	270.10(j)	____	____	____	____
F-2b	Description of the types of major releases that resulted in soil contamination, and any clean-up action	270.10(j)	____	____	____	____
F-2c	Any known food-chain contamination resulting from the use of contaminated soils for raising crops	270.10(j)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

G. Transportation Information

Numbers	Information Requirement	Req. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
G-1.	Information in Part B Application					
G-1a	Traffic pattern, volume, and controls; access road characteristics	270.14(b)(10)				
G-2.	Additional Information					
G-2a	Description of the types and capacities of vehicles used to transport waste	270.10(j)				
G-2b	Identification of normal transport routes for hazardous waste into the site and within one mile of the facility entries	270.10(j)				
G-2c	Description of procedures for clean-up of transportation-related spills or leaks	270.10(j)				
G-2d	Description of any transportation accidents releasing hazardous wastes on-site, or in the immediate vicinity	270.10(j)				

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

H. Management Practices Information

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
H-1.	**Information in Part B Application**					
H-1a	Outline of programs to train employees to safely operate and maintain facility, including emergency response activities	270.14(b)(12) 264.16	____	____	____	____
H-2.	**Additional Information**					
H-2a	Summary of existing records on worker illness or injury, related to the operation of the unit; include summaries of Workmen's Compensation claims, or hospital records	270.10(j)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

I. Potential for Human Exposure

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
I-1.	Groundwater Pathway					
I-1a	Description of how the units' location affects the potential for and possible magnitude of human exposure from releases to groundwater	270.10(j)	____	____	____	____
I-1b	Description of the design and operating features that affect the potential for releases to groundwater and the magnitude of these releases	270.10(j)	____	____	____	____
I-2.	Surface Water Pathway					
I-2a	Description of how the units' location affects the potential for and possible magnitude of human exposure from releases to surface water.	270.10(j)	____	____	____	____
I-2b	Description of the design and operating features that affect the potential for releases to surface water and the magnitude of these releases.	270.10(j)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

I. Potential for Human Exposure (Continued)

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
I-3.	Air					
I-3a	Description of how the units' location affects the potential for and possible magnitude of human exposure from releases to the air.	270.10(j)	____	____	____	____
I-3b	Description of the design and operating features that affect the potential for releases to the air and the magnitude of these releases.	270.10(j)	____	____	____	____
I-3c	Description of wastes indicative of air releases and management of these wastes.	270.10(j)	____	____	____	____
I-3c(1)	Description of any waste characteristics (e.g., incompatibility, reactivity, ignitability, volatility) indicative of potential for releases to the air.	270.10(j)	____	____	____	____
I-3c(2)	Description of special handling, treatment, or mixing procedures used to prevent violent reactions, fires, explosions, or extensive evaporation of volatile constituents.	270.10(j)	____	____	____	____
I-4.	Subsurface Gas Releases					
I-4a	Description of how the units' location affects the potential for and possible magnitude of human exposure from subsurface gas releases.	270.10(j)	____	____	____	____
I-4b	Description of the design and operating features that affect the potential for subsurface gas releases and the magnitude of these releases	270.10(j)	____	____	____	____

EXPOSURE INFORMATION REPORT (EIR) REQUIREMENT CHECKLIST

I. Potential for Human Exposure (Continued)

Numbers	Information Requirement	Reg. Cite	Provided (Y/N)	Complete (Y/N)	Not Applicable	Location in Part B or EIR/Comment
I-5.	Releases to Soil					
I-5a	Description of how the units' location affects the potential for and possible magnitude of human exposure from releases to soil.	270.10(j)	____	____	____	____
I-5b	Description of the design and operating features that affect the potential for releases to soil and the magnitude of these releases.	270.10(j)	____	____	____	____
I-6.	Transportation-Related Releases					
I-6a	Description of how methods and routes of transportation of waste on-site and in the immediate vicinity of the facility affect the potential for human exposure from transportation-related releases.	270.10(j)	____	____	____	____
I-7.	Worker-Management Practices					
I-7a	Analysis of worker data and discussion of the potential for off-site migration and public exposure resulting from any releases related to worker-management practices.	270.10(j)	____	____	____	____
I-7b	Description of training programs in place for the workers to ensure the safe handling of wastes and minimize the potential for releases from normal operation of the units.	270.10(j)	____	____	____	____

Attachment III. Levels of ATSDR Assistance*

1. Health Consultation: Immediate or short-term consultation by ATSDR to provide health advice and/or health effects information regarding a specific site.

2. Health Assessment: Initial multi-disciplinary reviews by ATSDR of all readily available data to evaluate the nature and magnitude of any threat to human health at a site. These evaluations will adapt EPA's risk assessment for the characterization of potential health threats at a site or sites, and may include literature searches, information summarization, and evaluation of existing environmental data, pilot samples, testing for food chain contamination, and similar activities.

3. Pilot Study: A preliminary or short-term medical, laboratory, or epidemiologic study on a limited human population to decide if additional, large-scale studies are warranted. The study populations can include those living at, or near, a site and those not residing at, or near, a site (control or reference population).

4. Epidemiologic Study: Long-term study by ATSDR involving a comprehensive protocol designed to add knowledge of the health effects of a specific substance or substances at a site or sites.

5. Health Registry: A site-specific or adverse health effects-specific registry established and maintained to track specific diseases and illnesses and long-term health effects to persons exposed to toxic substances.

* These levels of assistance are taken from the EPA/ATSDR MOU for CERCLA; definitions of these ATSDR activities may change in the EPA/ATSDR MOU for RCRA.