## ENVIRONMENTAL PROTECTION AGENCY

**40 CFR Parts 261, 271, and 302**

**[FRL 2940-6]**

## Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Notification Requirements; Reportable Quantity Adjustments; Proposed Rule

**AGENCY:** Environmental Protection Agency (EPA).

**ACTION:** Proposed rule.

**SUMMARY:** The EPA is proposing to amend its hazardous waste identification regulations under Subtitle C of the Resource Conservation and Recovery Act (RCRA) by expanding the Toxicity Characteristic to include additional chemicals and by introducing a new extraction procedure to be used in the Toxicity Characteristic. EPA is also proposing to incorporate the changes made pursuant to this rule into the lists of hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Today's action is necessary both to define further the scope of the hazardous waste regulations and to meet a specific mandate of the Hazardous and Solid Waste Amendments of 1984 (HSWA). This amendment will bring additional wastes under regulatory control, providing for further protection of public health and the environment.

**DATES:** Comments on this proposed rule must be submitted on or before August 12, 1986. A public hearing has been scheduled for July 14, 1986 at 9:30 a.m., in Washington DC. Requests to present oral testimony must be received 10 days before each public hearing.

**ADDRESSES:** One original and three copies of all comments on this proposed rule, identified by the docket number F-86-TC-FFFFF, should be sent to the following address: EPA RCRA Docket (S-212), U.S. Environmental Protection Agency (WH-562), 401 M Street SW., Washington DC 20460. The EPA RCRA docket is located in the sub-basement area at the above address, and is open from 9:30 a.m. to 3:30 p.m., Monday through Friday, excluding Federal holidays. To review docket materials, the public must make an appointment by calling Mia Zmud at 475-9327 or Kate Blow at 382-4675. A maximum of 50 pages of material may be copied from any one regulatory docket at no cost. Additional copies cost $.20/page. Documents identified in Section IX of the Supplementary Information section of this preamble are available in the docket. The public hearing will be held on July 14, 1986 at the following location: Vista International Hotel, 1400 M Street, NW., Washington, DC 20460. The hearing will begin at 9:30 a.m., with registration at 9:00 a.m., and will run until 4:00 p.m. unless concluded earlier. Anyone wishing to make a statement at the hearing should notify, in writing, Ms. Geraldine Wyer, Public Participation Officer, Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460. Persons wishing to make oral presentations must restrict them to 15 minutes and are encouraged to have written copies of their complete comments for inclusion in the official record.

**FOR FURTHER INFORMATION CONTACT:** For general information contact the RCRA Hotline, Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (800) 424-9346 toll-free or (202) 382-3000.

For information on specific aspects of this proposed rule contact: Todd A. Kimmell, Office of Solid Waste (WH-562B), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (202) 382-4770.

**SUPPLEMENTARY INFORMATION:**

### I. Background

Under section 3001 of the Resource Conservation and Recovery Act (RCRA), EPA was charged with identifying those wastes which pose a hazard to human health and the environment if improperly managed. It further called on EPA to identify such wastes through development of lists of hazardous waste and through characteristics of hazardous wastes. These two means of identifying hazardous wastes employ fundamentally different approaches.

To list a waste as hazardous, EPA conducts a detailed industry study, placing particular emphasis on the hazardous constituents contained in specific wastes from the industry being studied (See 40 CFR 261.11(a)(3)). This process involves literature reviews, engineering analyses, surveys and questionnaires, and site visits, including sampling and analysis of wastes. As such, the listing process may require from 1 to 3 years or more, depending on the complexity of the industry being investigated.

The process of identifying wastes as "hazardous" by reason of a characteristic is fundamentally different. Characteristics are those properties which, if exhibited by a waste, identify the waste as a hazardous waste. It is a generic process whereby EPA identifies properties that might be possessed by a waste which would cause the waste, *if improperly managed,* to cause harm to human health or the environment. The Agency then determines a reasonable mechanism by which such harm might occur, develops a quantitative model to identify hazard levels, and whenever possible, test methods for use in determining if a specific waste possesses hazardous levels of the property. Once EPA promulgates a characteristic it becomes self implementing. Any solid waste which exhibits the characteristic is a hazardous waste, and when treated so that it no longer exhibits the characteristic, is no longer subject to RCRA regulation as a hazardous waste.

Solid wastes which do not exhibit a characteristic, however, are not necessarily non-hazardous. Characteristics are established at levels at which there is a high degree of certainty that a waste which exhibits these properties needs to be managed in a controlled manner (i.e., is a hazardous waste). The Agency realizes that not all wastes which exhibit properties at levels below the characteristic are safe for disposal as nonhazardous waste. The Agency may therefore, upon evaluation of specific wastes from specific industries, decide to list such wastes as hazardous based on the criteria defined in 40 CFR 261.11(a)(3). This reflects the Agency's philosophy, first articulated in May of 1980, that the characteristics define broad classes of wastes that are clearly hazardous, while the listing process defines some wastes that may pass the characteristic, but are nonetheless hazardous wastes (45 FR 33111).

In carrying out the RCRA mandate, EPA identified a number of characteristics which, if exhibited by a waste, would indicate that the waste is a hazardous waste and should be managed as such. One of these characteristics, the Extraction Procedure (EP) Toxicity Characteristic (EPTC) (40 CFR 261.24), was intended to identify wastes which pose a hazard due to their potential to leach significant concentrations of specific toxic species.

The EPTC is the only characteristic which directly relates to the toxicity of a waste. This characteristic entails use of a leaching test, the EP, which is used in determining if an unacceptably high level of ground water contamination might result from improper waste management. The EP results in a liquid extract which is analyzed for eight metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver), four insecticides (endrin, lindane, methoxychlor and toxaphene), and two herbicides (2,4-D and 2,4,5-TP). Regulatory thresholds were established for these 14 species taking into account the attenuation and dilution expected to occur during migration of the leachate to the ground water, through use of a generic dilution/attenuation factor of 100 (Ref. 26).

At the time of promulgation, EPA recognized two major shortcomings of the EPTC. The first was that the only benchmarks for establishing toxicity levels of specific chemicals, which were both scientifically recognized and which addressed chronic exposure, were the National Interim Primary Drinking Water Standards (DWS). The Agency considered incorporating other standards, such as the Water Quality Criteria that were being developed under the Clean Water Act. Preliminary drafts of these criteria, however, received substantial negative comment from the scientific community. The Agency thus put off expansion of the EPTC pending development of acceptable standards. The second shortcoming was that the EP was optimized to evaluate the leaching of elemental rather than organic constituents. Hence, the leaching of organics needed to be investigated.

In addition to addressing the leaching of organics, EPA believes that other aspects of the EPTC can be improved. For example, ground water modeling and knowledge of leaching and fate and transport mechanisms have advanced to the point that mathematical models can be used to identify species-specific dilution/attenuation factors, rather than relying on the generic 100 times level now employed in the EPTC. Also, the EP protocol is known to suffer a number of operational shortcomings that, while not critical, warrant attention. These shortcomings and their solutions are detailed in further sections of this preamble.

Congress also recognized the shortcomings of the EPTC, and amended RCRA in 1984 (section 3001 (g) and (h)), directing EPA to make changes in the EP to insure that it accurately predicts leaching potential, and to identify additional characteristics of hazardous waste, including measures or indicators of toxicity. EPA intends to address both of these mandates through expansion of the EPTC to include additional chemicals, and through the introduction of an improved leaching test to replace the current EP protocol.

EPA is also planning to add another facet to the hazardous waste characteristics. Specifically, EPA is working on a mechanism by which to identify wastes as hazardous by virtue of their ability to mobilize other toxicants. This component would primarily affect solvent-containing wastes, and will complement a regulation EPA promulgated on December 31, 1985 that redefined the universe of solvents considered listed hazardous wastes to include certain solvent mixtures (50 FR 53315). EPA indicated that this was an interim measure which would be modified or superseded when further work was completed. More detail regarding the approach the Agency is considering is provided in section II(E).

EPA is today proposing to amend the Extraction Procedure Toxicity Characteristic by (1) expanding the characteristic to include 38 additional compounds, (2) applying compound-specific dilution/attenuation factors generated from a ground water transport model, and (3) introducing a second generation leaching procedure, the Toxicity Characteristic Leaching Procedure (TCLP), that has been developed to address the mobility of both organic and inorganic compounds, and to solve the operational problems of the EP protocol.

It is important to point out that while this proposed rule fulfills the Congressional mandate to add additional characteristics of hazardous waste, considerably more work is now underway within EPA to look at additional constituents that could and should be added to the proposed rule, and to explore other characteristics that will deal with toxicity.

On January 14, 1986 (51 FR 1602), the Agency proposed the framework for a regulatory program to implement the congressionally mandated land disposal prohibitions. The action proposed procedures to establish treatment standards for hazardous waste and procedures by which EPA will determine whether to allow continued land disposal of specific hazardous wastes.

In implementing these procedures, the Agency has proposed to employ the TCLP to estimate the leaching hazard posed by waste placed in Subtitle C facilities. The same subsurface transport model is used in both the land disposal regulation and this proposed regulation. However, minor modifications to account for disposal in a non-hazardous versus a hazardous waste landfill have been made in the transport equation for use in this proposed rule. In addition, different risk levels are used to establish the regulatory level for carcinogens, and a different confidence interval for the ground water transport simulation is used to establish the dilution/attenuation factors. However, to the extent that commenters have provided us with their views on the model either in the context of the land disposal restrictions program or its delisting programs, those comments need only be referenced in response to this proposed rule. More information on the differences between the models is provided in Section V of this preamble.

## II. Development to Toxicity Characteristic

### *A. Introduction*

In establishing a scientifically justifiable approach for arriving at threshold concentrations, EPA wanted to assure a high degree of confidence that a waste which releases toxicants at concentrations above the regulatory threshold level would pose a hazard to human health.

The existing EPTC uses the National Interim Primary Drinking Water Standards (DWS) as toxicity thresholds for individual pollutants, and combines these with a generic dilution/attenuation factor (100 times) to yield the regulatory threshold. The new approach, described below, uses chronic toxicity reference levels, combined with a compound-specific dilution/attenuation factor (derived from application of a ground water transport equation), to calculate the regulatory level concentrations for individual toxicants.

### *B. Chronic Toxicity Reference levels*

Implementation of the Toxicity Characteristic level setting approach described below, requires the initial input of a toxicity limit to establish a regulatory level for each contaminant. Limits set for protection against chronic toxicity effects are the reference standard of choice since this level will usually be protective for both chronic and acute effects. The first step in developing regulatory levels is therefore the development of a measure of "acceptable" chronic exposure for individual toxicants in drinking water.

EPA, under other statutory mandates, has investigated the adverse health effects due to specific chemicals with a view toward controlling exposure through different media. Human health criteria and standards have been proposed or promulgated for certain substances in particular media. Since these have received Agency and public review and evaluation, EPA is proposing to use such standards as the starting point for the back calculation model, where such standards are available. EPA used the DWS for the 8 elements and 6 pesticides as the basis of the Extraction Procedure Toxicity Characteristic.

Drinking water standards are based upon toxicity, treatment technologies, costs, and other feasibility factors such as availablity of analytical methods. In developing DWS's, the intital step is the identification of non-enforceable health limits. The assessment process for establishing these health goals includes evaluation of the quality and weight-of-evidence of supporting toxicological studies, absorption rates of specific toxicants, the possibility that a compound or element is nutritionally essential at certain levels, route of exposure, and exposure medium apportionment.

For non-carcinogens, these health limits are denoted as Reference Doses (RfD's). The RfD is an estimate of the daily dose of a substance which will result in no adverse effect even after a lifetime of such exposure. It is thus a chronic toxicity limit. The establishment of a chronic toxicity reference level for carcinogens requires setting a specific risk level which is then used to calculate the Risk Specific Dose (RSD). The RSD is the daily dose of a carcinogen over a lifetime which will result in an incidence of cancer equal to the specific risk level. An RSD established at the $10^{-5}$ risk level translates to a probability of one in one hundred thousand that an individual might contract some form of cancer in his or her lifetime.

In developing toxicity levels for carcinogens, EPA is further proposing a weight-of-evidence approach which involves categorizing carcinogens according to the quality and adequacy of the supporting toxicological studies. This approach was proposed by EPA in its Carcinogen Risk Assessment guidelines published in the **Federal Register** on November 23, 1984 (49 FR 46294).

In order to account for toxicant exposure from other sources (i.e., air and food), EPA is also proposing to limit the RfD value to some fraction, as is done in developing drinking water standards. The fraction of the toxicity level used in these standards is compound-specific, and is apportioned according to exposure assessment data, if adequate data exist, or by use of an arbitrary value of 20 percent if adequate exposure assessment data do not exist. EPA is proposing a similar approach for the Toxicity Characteristic.

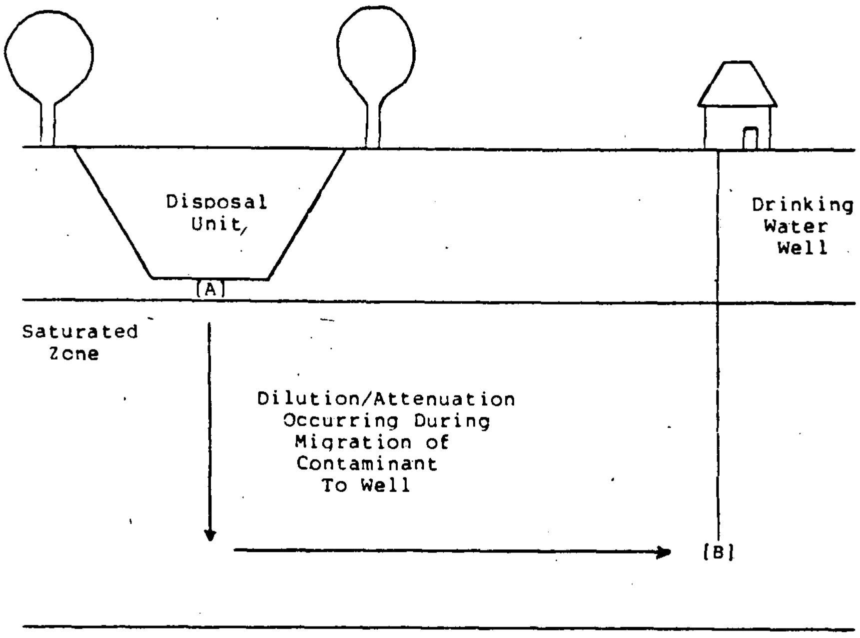
Note, however, that EPA is not proposing this approach for the carcinogens, as it appears that a small reduction in the RSD would still be well within the margin of uncertainty of the estimated RSD. Rather, EPA is proposing to use 100 percent of the RSD value. Section VIII(A) of this preamble provides detailed information as to the identification of chronic toxicity reference levels.

One area that the Agency solicits comment on is whether, as an alternative to using the DWS's, the Agency should consider using the RfD or RSD values as the starting point for the back calculation model, even when DWS's are available.

### *C. Dilution/Attenuation Factor*

After a toxicity level has been identified, the degree of attenuation and dilution that a compound is expected to undergo during transport through the ground water to an underground drinking water source is determined. The ground-water transport equation EPA is intending to use to estimate dilution and attenuation, estimates the reduction in toxicant concentration that would occur as toxicants are transported in ground water over a specified distance from the disposal unit to the point of exposure (i.e., drinking water well), as depicted in the following figure (Figure 1):

Figure 1: Illustration of Dilution/Attenuation



[A] Refers to the concentration of the contaminant in the leachate at the bottom of the disposal unit.

[B] Refers to the concentration of the contaminant in the drinking water well, which is calculated using a ground water transport equation, and is expected to be lower than the concentration at [A] due to attenuation and dilution.

This equation relies on compound specific hydrolysis and soil absorption data, coupled with parameters describing a generic underground environment (e.g., ground water flow rate, soil porosity, ground water pH), to calculate the degree of attenuation and dilution a compound would be expected to undergo as it migrates to an underground drinking water source. Values for environmental parameters have been selected based on review of subsurface geological conditions at existing landfills across the continental United States. Boundary conditions and interrelationships between the above parameters have been established based on a sensitivity and an uncertainty analysis.

Originally, EPA had also hoped to develop dilution/attenuation factors for metal species through use of a second model, since these species generally behave differently in the ground water environment than do the organic compounds. Unfortunately, this model could not be fully developed in time for today's proposal. Accordingly, while EPA is continuing to work on modeling metal transport, EPA is retaining the present EP Toxicity Characteristic levels for the elemental toxicants.

Details of the ground water transport equation to be used for organic compounds are provided in section VIII(B). Note that in the **Federal Register** of January 14, 1986, the Agency proposed to use the same basic ground water transport equation for use in the Land Disposal Restrictions Rule (51 FR 1602). The proposed Land Disposal Restrictions Rule equation, however, contains minor differences to account for the additional engineering controls (e.g., landfill caps), required of Subtitle C hazardous waste facilities, and the higher standard of confidence required under HSWA for determining that a hazardous waste is suitable for land disposal. As noted previously, different risk levels are used to establish the characteristic regulatory threshold for carcinogens, and a different confidence interval is used for the ground water transport simulation to establish the dilution/attenuation factors. While section VIII(B) provides additional information concerning the equation proposed for use in the Toxicity Characteristic, considerably more detail concerning this equation is provided in the preamble section to the proposed Land Disposal Restrictions Rule (51 FR 1602, January 14, 1986).

Since many aspects of the ground water transport equation are similar between the two rules, commenters need not repeat relevant comments that have already been made in response to the Land Disposal Restrictions Rule. These earlier comments may be referenced, although all relevant comments will be considered in developing the Toxicity Characteristic final rule. Comment specific to EPA's use of the equation for this rule, should however, be submitted.

### *D. Proposed Toxicants and Regulatory Levels*

In order to establish a Toxicity Characteristic regulatory level for individual compounds, adequate and verified data must exist for EPA to (1) identify a toxicity level (i.e., DWS, RfD, or RSD), and (2) calculate a dilution/attenuation factor through application of the ground water transport equation. As discussed previously, EPA will retain the 100 times factor used in the current EP Toxicity Characteristic for the elemental drinking water toxicants. Due to the Agency's continuing efforts to develop an adequate ground water transport equation for the metals, addition of elemental and anionic toxicants to the Toxicity Characteristic is being delayed. The Agency expects to propose Toxicity Characteristic thresholds for nickel and thallium during the period between proposal and promulgation of this rule.

In selecting additional organic toxicants to incorporate in today's proposal, the Agency identified those Appendix VIII compounds for which there existed a promulgated or proposed drinking water standard, or an RfD or RSD. The compounds identified as a result of these efforts were then examined to determine if adequate fate and transport data were available to establish a compound-specific dilution/attenuation factor.

These efforts have resulted in the identification of a total of 52 compounds for the Toxicity Characteristic. This includes the existing 14 EPTC compounds, and 38 compounds whose thresholds are driven by their toxicity, as shown in the following table (Table 1):

TABLE 1: PROPOSED TOXICITY CHARACTERISTIC CONTAMINANTS AND REGULATORY LEVELS

| HWNO | Contaminants | CASNO | Regulatory level (mg/l) |
|---|---|---|---|
| D018 | Acrylonitrile | 107-13-1 | 5.0 |
| D004 | Arsenic | 7440-38-2 | 5.0 |
| D005 | Barium | 7440-39-3 | 100 |
| D019 | Benzene | 71-43-2 | 0.07 |
| D020 | Bis(2-chloroethyl) ether. | 111-44-4 | 0.05 |
| D006 | Cadmium | 7440-43-9 | 1.0 |
| D021 | Carbon disulfide | 75-15-0 | 14.4 |
| D022 | Carbon tetrachloride | 56-23-5 | 0.07 |
| D023 | Chlordane | 57-74-9 | 0.03 |
| D024 | Chlorobenzene | 108-90-7 | 1.4 |
| D025 | Chloroform | 67-66-3 | 0.07 |
| D007 | Chromium | 1333-82-0 | 5.0 |
| D026 | o-Cresol | 95-48-7 | 10.0 |
| D027 | m-Cresol | 108-39-4 | 10.0 |
| D028 | p-Cresol | 106-44-5 | 10.0 |
| D016 | 2,4-D | 94-75-7 | 1.4 |
| D029 | 1,2-Dichlorobenzene | 95-50-1 | 4.3 |
| D030 | 1,4-Dichlorobenzene | 106-46-7 | 10.8 |
| D031 | 1,2-Dichloroethane | 107-06-2 | 0.40 |
| D032 | 1,1-Dichloroethylene | 75-35-4 | 0.1 |
| D033 | 2,4-Dinitrotoluene | 121-14-2 | 0.13 |
| D012 | Endrin | 72-20-8 | 0.003 |
| D034 | Heptachlor (and its hydroxide). | 76-44-2 | 0.001 |
| D035 | Hexachlorobenzene | 118-74-1 | 0.13 |
| D036 | Hexachlorobutadiene. | 87-68-3 | 0.72 |
| D037 | Hexachloroethane | 67-72-1 | 4.3 |
| D038 | Isobutanol | 78-83-1 | 36 |
| D008 | Lead | 7439-92-1 | 5.0 |
| D013 | Lindane | 58-89-9 | 0.06 |
| D009 | Mercury | 7439-97-6 | 0.2 |
| D014 | Methoxychlor | 72-43-5 | 1.4 |
| D039 | Methylene chloride | 75-09-2 | 8.6 |
| D040 | Methyl ethyl ketone | 78-93-3 | 7.2 |
| D041 | Nitrobenzene | 98-95-3 | 0.13 |
| D042 | Pentachlorophenol | 87-86-5 | 3.6 |
| D043 | Phenol | 108-95-2 | 14.4 |
| D044 | Pyridine | 110-86-1 | 5.0 |
| D010 | Selenium | 7782-49-2 | 1.0 |
| D011 | Silver | 7440-22-4 | 5.0 |
| D045 | 1,1,1,2-Tetrachloroethane. | 630-20-6 | 10.0 |
| D046 | 1,1,2,2-Tetrachloroethane. | 79-34-5 | 1.3 |
| D047 | Tetrachloroethylene | 127-18-4 | 0.1 |
| D048 | 2,3,4,6-Tetrachlorophenol. | 58-90-2 | 1.5 |
| D049 | Toluene | 108-88-3 | 14.4 |
| D015 | Toxaphene | 8001-35-2 | 0.07 |
| D050 | 1,1,1-Trichloroethane. | 71-55-6 | 30 |
| D051 | 1,1,2-Trichloroethane. | 79-00-5 | 1.2 |
| D052 | Trichloroethylene | 79-01-6 | 0.07 |
| D053 | 2,4,5-Trichlorophenol. | 95-95-4 | 5.8 |
| D054 | 2,4,6-Trichlorophenol. | 88-06-2 | 0.30 |
| D017 | 2,4,5-TP (Silvex) | 93-76-5 | 0.14 |
| D055 | Vinyl chloride | 75-01-4 | 0.05 |

There is one group of chemicals for which the Agency considers use of the health criteria/ground water transport approach to setting threshold concentrations as being inappropriate in some cases. These are solvents. Solvents need to be managed in a controlled manner not only because of inherent toxicity, but also because they can mobilize hazardous constituents from codisposed non-hazardous waste. Since solvents exhibit this property, the Agency is working to identify such wastes through use of a solvent override.

The Agency intends to set regulatory levels for solvents based on the total amount of solvent observed in the TCLP extract. Thus, wastes whose TCLP extract contains more than a specified amount of total solvent would be identified as a hazardous waste even if none of the health criteria based thresholds for the individual solvents are exceeded. The Agency is also exploring the possibility of developing a solvent power test which would be designed to determine the actual ability of a waste to mobilize hazardous constitutents for non-hazardous wastes. The Agency solicits ideas, data and comments on these and other approaches.

The next section presents a discussion regarding some of the analytical constraints EPA faced in establishing regulatory levels. Section VIII(C) provides tables presenting each compound and the data that EPA has used to calculate the regulatory level. EPA anticipates that the list of toxicants to be included in the Toxicity Characteristic will be periodically expanded as more information on the Appendix VIII compounds is developed.

### *E. Analytical Constraints*

As illustrated in Table 1 (and further in section VIII(C)), the regulatory levels for the proposed compounds span about 5 orders of magnitude (i.e., from the low parts per billion to 100 parts per million). This is not so much a function of the individual dilution/attenuation factors, but rather due to the great range in toxicity levels of the individual toxicants. Since many of the toxicity levels for the carcinogens (and some of the non-carcinogens) (see section VIII(A)) are very low, depending on the magnitude of the dilution/attenuation factor, the calculated level will also be very low. This presents a problem for the Agency since some of these calculated thresholds are below the analytical level measurable using currently available methodology. This affects 7 of the compounds (See section VIII(C)).

EPA believes that the appropriate way to deal with this problem is to establish technology based regulatory levels.[1] The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions is the quantitation limit. The quantitation limit thus represents the lowest level achievable by good laboratories within specified limits during routine laboratory operating conditions. The quantitation limit is determined through interlaboratory studies, such as performance evaluation studies.

If data are unavailable from interlaboratory studies, quantitation limits are estimated based upon the detection limits and an estimate of a higher level which would represent a practical and routinely achievable level with relatively high certainty that the reported value is reliable. EPA estimated this level to be 5 to 10 times the detection limit in their final rule on National Interim Primary Drinking Water Standards for Volatile Synthetic Organic Chemicals (50 FR 46880, November 13, 1985). EPA believes that setting the quantitation limit at 5 times the detection limit is a fair expectation for most regulatory and commercial laboratories. Public comment is specifically requested on the use of 5 times the detection limit as a general rule as to what levels can be expected to be measured routinely by commercial laboratories with reliability.

Use of either detection limits or quantitation limits would allow for regulatory levels that fall below the analytically measurable level to be periodically updated as advances are made in analytical methodology. EPA is proposing the use of the quantitation limits because the determination that a compound is present (in the extract above a specified value) conclusively demonstrates the presence of a hazard. EPA is seeking comment, however, on both approaches.

The tables in section VIII(C) indicate the quantitation limits for each of the elements and compounds, as well as the appropriate EPA SW-846 analytical method numbers (Ref. 27). (Analytical

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[1] Such levels could be set at the analytical detection limit or, as an alternative, they could be set at the limits of accurate quantitation (i.e., quantitation limit). In general, EPA defines the method detection limit as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the true value is greater than zero. The specifications of such a concentration are limited by the fact that detection limits are a variable affected by the performance of a given measurement system. Detection limits are not necessarily reproducible over time in a given laboratory, even when the same analytical procedures, instrumentation and sample matrix are used. Differences between detection and quantitation limits are expected since the detection limits represent the lowest achievable level under ideal laboratory conditions, whereas the quantitation limit represents the lowest achievable level under practical and routine laboratory conditions.

methods for the Toxicity Characteristic compounds are discussed more fully in section IV(D) of this preamble.) The quantitation limits used are based on the presence of these compounds in a water matrix. Since TCLP extracts would also be aqueous in nature, EPA is proposing to use the quantitation limit as observed in water. EPA recognizes, however, that while these quantitation limits would be attainable for most wastes, other wastes will produce an extract that is qualitatively different, and may not allow quantitation to the same low level as water. This, however, will be waste specific and difficult to predict beforehand. While specifying a higher quantitation limit is an option, EPA is reluctant to do so due to the degree of environmental protection that might be sacrificed. EPA is, however, working to determine actual quantitation limits on real wastes, which may result in increases in the quantitation limit, and the corresponding regulatory level, for some of the contaminants. EPA solicits comments and suggestions on how to deal with this issue.

Three of the phenolic compounds that are included in today's proposal, ortho-, meta-, and para-cresol, also pose an analytical problem. Specifically, meta- and para-cresol cannot be analytically separated using readily available techniques. In order to overcome this problem, and given that these isomers all act in an additive manner, the Agency is proposing to establish a single level for total o-, m- and p-cresol.

Public comment and information on all aspects of the issues presented in this section are requested to assist EPA in making a final choice of analytical methods and the specific performance requirements in the final rule. Supporting data/information is requested for any comments provided. Specifically, public comment is requested on the following questions:

- Are the proposed analytical methods technically and economically available (see section IV(D) of this preamble)?
- What is the precision/accuracy of the analytical methods at the proposed quantitation levels?
- Are there sufficient qualified laboratories capable of measuring at proposed quantitation levels?

## III. Development of the Leaching Procedure

### *A. Introduction*

The Extraction Procedure (EP) was designed to simulate the leaching that would result when a solid waste is co-disposed with municipal wastes in a sanitary landfill. The EP was intended to be a first order approximation of the leaching action of the low molecular weight carboxylic acids generated in an actively decomposing sanitary landfill. Acetic acid, one of the more dominant carboxylic acids present in municipal waste leachate, is added to deionized distilled water to make up the extracting medium used in the EP. The acetic acid models primarily the leaching of metals from an industrial waste. The impetus behind development of the Toxicity Characteristic Leaching Procedure (TCLP) was the need also to address the leaching of organic compounds (Ref. 26).

In addition, EPA believes that the EP protocol can be improved in certain areas. For example, the EP involves continual pH adjustment (titration) with 0.5 N acetic acid to a pH of 5.0±0.2. This can involve more than 6 hours of operator attention and can be difficult for some waste types, particularly oily wastes. In developing the TCLP, EPA felt that elimination of the need for continual pH adjustment would be a desirable improvement. As another example, the EP involves separating the initial liquid from the solid phase of the waste, as well as separation of the liquid (extract) derived from the leaching test. These steps, involving pressure filtration through a 0.45 um filter, can be difficult and time consuming for certain waste types, and warrant simplification. In addition, other minor changes in the EP protocol, such as shortening the duration of the test and accounting for the loss of waste materials to the sidewalls of sample containers, were felt to be of use in lowering the cost of the test and improving the overall precision of the method. Thus, the Agency believes that development of a second generation extraction procedure was of value even if the EP were found to be acceptable for organics.

### *B. Objectives*

EPA's intent, then, was to develop an improved leaching test method suitable for use in evaluating wastes containing organic toxicants. It is important to note that the purpose of the EP, as well as this new method, is as a means of determining whether a waste, if mismanaged, has the potential to pose a significant hazard to human health or the environment due to its propensity to leach toxic compounds. EPA believes that the EP adequately accomplished this goal for the currently regulated toxicants.

When the EP was developed, the Agency had little empirical data upon which to base its assumptions regarding accuracy (Ref. 26). Hence, while the few data that were available regarding accuracy were used in developing the EP, it was primarily based on what was reasonable, as well as what would provide a reproducible (precise) test protocol. While improved reproducibility is one objective of the TCLP, the major objective was to accurately model the mobility of constituents from wastes, particularly organic constituents. Other objectives were that the test be relatively inexpensive to conduct; that, if possible, it yield an extract amenable to evaluation with biological toxicity tests; and that it also model the mobility of inorganic species. This last objective would permit EPA to expand the toxicity characteristic to encompass organics, yet require only one leaching test for both organics and inorganics.

### *C. Disposal Environment and Model*

The specific environment modeled by both the current EP and the TCLP is co-disposal of industrial waste with refuse in a sanitary landfill. The Agency's concern was that potentially hazardous waste, if not brought under the control of the RCRA hazardous waste system, might be sent to sanitary landfills, with a resulting high level of leaching activity. This concern has not changed. Although the Agency believes that fewer industrial solid wastes are being disposed in this manner as compared to a few years ago, the Agency also believes that the co-disposal scenario still represents a reasonable worst-case mismanagement scenario. In addition, the Agency believes that the predicted degree of contaminant migration, as indicated by the TCLP, could reasonably occur in the course of other types of land management of wastes (see section VIII(D)).

Hence, the experiments used to develop the TCLP were set up to conform as closely as possible with the co-disposal model. Specific features of this model were that the landfill is composed of 5 percent industrial solid waste and 95 percent municipal waste, and that the character of the leaching fluid that the waste will be exposed to is predominantly a function of the decomposing refuse in the landfill. In expanding the Toxicity Characteristic, the models and assumptions used in developing the EP have been retained.

### *D. Leaching Procedure*

The work undertaken to develop and evaluate the new leaching test was carried out in three phases, and involved 11 wastes and close to 100 organic and inorganic components which leached from these wastes.

Briefly, the research involved leaching these wastes in a pilot-scale field facility with sanitary landfill leachate, measuring the concentration of the compounds which leached from the wastes, and attempting to duplicate these concentrations in a laboratory test, the TCLP (Ref. 6 and 7).

A TCLP has ben developed as a result of this work. EPA believes that this test method is reasonably accurate in terms of modeling a field-scale co-disposal scenario for both organics and inorganics. In addition, it appears that many of the operational problems associated with the EP protocol have been overcome in the process of developing the TCLP. The test has also been subjected to ruggedness and precision evaluations, and a limited multi-laboratory collaborative evaluation, and is currently being evaluated in a more comprehensive collaborative evaluation.

Section VIII(D) of this preamble provides detailed information with respect to the TCLP development and evaluation program. The regulation section provides the actual TCLP protocol, as Appendix II to Part 261. A more detailed discussion pertaining to the TCLP is provided in a background document that EPA has prepared (Ref. 33).

### *E. Leaching Procedure Issues*

In an effort to identify and resolve any potential problems associated with the TCLP prior to proposal, and also to inform the public of EPA's activities in this area, EPA held a number of meetings at which various aspects of the procedure were reviewed and draft procedures circulated. These included public discussions at meetings of the Association of Official Analytical Chemists and the American Society for Testing and Materials (ASTM).

As a result of these meetings and as a result of the Agency's own efforts in these areas, a number of issues have been identified and some minor changes to the TCLP protocol have also been made. Following is a discussion of these issues, and how they have been addressed in the proposed TCLP.

#### 1. Overall Issues

a. *Accuracy of TCLP.* As indicated previously, EPA was directed by the HSWA to make the EP more accurate. EPA's experimental program to develop the TCLP was intended to provide an accurate extraction method, in terms of ability to model a field co-disposal situation. One of the issues associated with the TCLP is whether the method is adequately accurate in this respect.

In an effort to better quantify how well the TCLP compares to the field model, the distributions of the actual and absolute percent differences between concentrations observed in the field model and those observed in the acetate buffer system chosen for the TCLP (see section VIII(D)), have been examined. Results of these comparisons indicate that roughly half of the 95 individual target compounds (from the 11 wastes examined in both Phases I and II), were within −32 percent and +76 percent of their respective field lysimeter target concentrations. Roughly three-fourths of the 95 individual target compounds were within −80 percent and +86 percent of their respective field lysimeter target concentrations (Ref. 25).

The standard deviation of the total distribution (which is skewed) in this case is 182 percent. These preliminary numbers indicate that the acetate buffer system duplicates field lysimeter target concentrations for approximately three-fourths of the target compounds within one standard deviation of the distribution. This is particularly significant since the laboratory test duration is 18 hours, whereas the field lysimeter experiments were run for approximately 3 months. EPA believes that the accuracy of the TCLP is adequate in terms of indicating the potential for wastes to pose a hazard if mismanaged.

b. *Use of TCLP for sewage sludge disposal.* EPA expects to propose in September 1986 sewage sludge management standards under Section 405(d) of the Clean Water Act. Once the Section 405(d) standards are promulgated, EPA is considering exempting sewage sludge from RCRA regulation. The section 405(d) standards will tailor EPA's control strategy to the management of specific risks to human health and the environment from each of the sludge use and disposal practices. The Agency solicits comments on this potential approach to regulating sewage sludge.

c. *Extent of experimentation.* Another issue related to accuracy is whether EPA has examined enough contaminants and waste types in its TCLP development program. The TCLP was developed based on data from 11 wastes and 95 target compounds which leached from these wastes (Ref. 6 and 7). The amount of work involved here is substantial. EPA is aware, however, of one waste type, specifically wastes of moderate to high alkalinity, that was not adequately represented by the 11 wastes, and has included provisions in the TCLP to insure that the potential environmental damage that may be caused by such a waste was not underestimated. (These changes are detailed further in this section).

Additional testing aimed at evaluating the need to modify the TCLP extraction fluid to alter its solubilizing potential is not believed to be necessary. In addition to the work described in section VIII (D), the Agency had earlier conducted two studies that evaluated the effect that changes in extraction fluid composition would have on solubilization of organics (Ref. 19 and 24). These studies examined the effect of adding acetic acid, carbohydrates, protein, tannic acid, citrate, thiosulfate, and a surfactant to the leaching medium. Both studies showed little change in toxicant solubility and extraction efficiency with the addition of these various solubilizing agents. This agrees well with the work done to develop the TCLP (Ref. 6 and 7), which also showed that leaching seems to be unaffected by minor changes to primarily aqueous extraction media. Thus, EPA believes that further testing is unlikely to result in a significant change in extraction fluid composition.

d. *Mismanagement scenario.* RCRA requires EPA to identify those wastes which pose a potential hazard to human health or the environment *if mismanaged.* In determining what form of mismanagement to model in developing the TCLP, the Agency considered several alternatives. These included segregated management, co-disposal with municipal refuse, co-disposal with industrial waste in a Subtitle D landfill, and co-disposal with industrial waste in a Subtitle C landfill which suffers some form of containment system failure.

For wastes which are not defined as hazardous (e.g., do not exhibit the proposed toxicity characteristic), the Agency has concluded that disposal in a Subtitle C (hazardous waste) landfill is not a reasonable mismanagement option. In the absence of regulation, there is no reason to expect that waste would go to the more expensive Subtitle C facilities. The Agency believes that it is reasonable to base its regulations on adverse effects when in a non-Subtitle C environment.

For the three remaining options, segregated management, co-disposal with municipal refuse, and co-disposal with industrial refuse in a Subtitle D landfill, the Agency believes that, in general, each is a plausible mismanagement scenario. Industrial facilities dedicated to the management of only one waste, or the waste from only one generator, are likely to pose less of a hazard than would general sanitary or industrial landfills, since the design and operation problems are simpler and the operator has much more information on the properties of the wastes before and while the facility is in operation. To insure that industrial wastes are adequately managed, EPA has proposed to employ the more protective sanitary landfill scenario.

The Agency believes that sanitary landfills may pose more of a potential hazard than industrial landfills. Many States have required some additional protection (*e.g.*, more stringent siting requirements) at industrial landfills. The Agency, however, solicits comments on the choice of the sanitary landfill scenario, and specifically requests any evidence that another disposal scenario may represent the worst-case plausible mismanagement.

The scenario selected for the TCLP, as well as for the current EP, was co-disposal with municipal waste in a sanitary landfill. EPA selected this co-disposal scenario since Subtitle D sanitary landfills have traditionally accepted non-hazardous industrial wastes. A recent survey conducted for the Office of Solid Waste (Ref. 14) concluded that ". . . in general, Subtitle D landfills accept industrial wastes but not organic solvents or liquids." Wastes do have the potential to be subject to more aggressive conditions that might be better modeled through the use of strong inorganic acids, alkalies, or solvents.

The survey noted above, however, found that Subtitle D facilities generally take only small amounts of organic solvent wastes (*i.e.*, <1 to 2 percent of the total waste accepted). In addition, EPA will consider listing specific wastes as hazardous, when their normal management or their potential for mismanagement suggests more aggressive conditions. The Agency solicits comments on the fate of industrial wastes, the 5% industrial waste, 95% municipal waste assumption used in developing the leaching procedure, and the level of solvents which can be found at Subtitle D landfills.

The Agency recognizes that not all industrial waste, or even wastes from all industries, go to Subtitle D sanitary landfills. The Agency believes, however, that this scenario is a reasonable worst-case and that *some* industrial wastes go to such facilities. In addition, it could be a serious administrative problem to define hazardous waste characteristics based on waste-specific or industry-specific disposal scenarios (including different leaching media) for the many different wastes generated. Even if different toxicity characteristics could be created, difficult enforcement issues would result. For example, if the Agency discovered an uncontrolled waste situation (e.g., waste disposed in an open pit) it might be difficult to determine what characteristic test should apply to the waste because there may be very little available information about how the waste was generated. Moreover, even where some information existed about the source of the waste, the Agency believes that the existence of varied toxicity tests would encourage disputes about which test should apply to a particular waste.

It is therefore reasonable to use a Subtitle D sanitary landfill as a general model of how industrial wastes might be disposed. The Agency, however, solicits comments on whether this scenario is appropriate for all wastes. Commenters identifying a different scenario for particular wastes should explain why the Subtitle D sanitary landfill model is inappropriate and what disposal scenario would be appropriate for those wastes, including a discussion of what leaching medium is suggested by that scenario. In response to this information, the Agency may develop special management standards for a class or classes of wastes.

As an additional matter, the Agency believes that the predicted degree of contaminant concentration in leachate could reasonably occur in the course of other types of land based waste management (e.g., surface impoundments). The TCLP, as well as the EP, basically involve mixing the waste with an aqueous leaching media, and seeing if certain contaminants can migrate from the waste to a significant degree. If such mobility is demonstrated, EPA believes that the waste in question poses a potential hazard to ground water, and that proper management controls need to be instituted to preclude unacceptable contamination of ground water. This applies to the leaching of both organics and inorganics.

First, as discussed previously, minor changes to primarily aqueous media do not generally affect the leaching of organic compounds. For inorganics, the acidity afforded by the TCLP leaching fluid accounts for the possibility that wastes could be subjected to mild acidic conditions occurring in other types of land disposal environments.

Wastes do have the potential to be subjected to more aggressive conditions that might be better modeled through the use of strong inorganic acids, alkalies, or solvents. The survey referred to earlier (Ref. 14) found that Subtitle D facilities generally take only small amounts of organic solvent wastes (e.g., <1 to 2 percent of the total waste accepted). In addition, EPA will consider listing specific wastes as hazardous, when their normal management or their potential for mismanagement dictates more aggressive conditions.

*e. Treatment of highly alkaline wastes.* As mentioned previously, highly alkaline wastes were not adequately represented by the 11 wastes used in the TCLP development program. EPA is concerned that the potential hazard posed by these wastes may be underestimated by the acetate buffer system initially chosen for the TCLP (See section VIII(D)). Specifically, EPA believes that an increase in the leaching of inorganic and some organic species may be observed as the alkalinity of wastes becomes exhausted due to continuous contact with an acidic leaching medium. Note that this can occur well after the 20 to 1 liquid to solid ratio selected for the EP and TCLP. Data from the TCLP development program (on a moderately alkaline waste), and from subsequent studies on wastes of moderate to high alkalinity (Ref. 8), demonstrated that the leaching rate of heavy metals was relatively constant, and in some cases increased slightly, over liquid to solid ratios as high as 30 to 1. Constituents from non-alkaline wastes generally experience a decrease in leaching rate during this time period (Ref. 6 and 7). The TCLP acetate buffer leaching fluid may therefore not adequately account for the leaching of heavy metals from wastes of moderate to high alkalinity.

To address this problem, EPA determined that an increase in the acidity of the leaching medium for the alkaline wastes would adequately account for the increased leaching of these species that could eventually occur in landfills. To define this second leaching fluid, the basis behind the EP's maximum amount of acetic acid (i.e., 2 milliequivalents of acid per gram of waste) was used in defining a second leaching fluid to be used when evaluating highly alkaline wastes. Data gathered at EPA's Boone County Field Site over a period of 7 years indicated that the leachate generated by decomposing municipal waste contains approximately 0.14 equivalents of acidity per kilogram of dry refuse. Applying this data to the hypothetical co-disposal environment, EPA concluded that 1 gram of industrial waste could potentially be acted upon by 2 milliequivalents of acid. For a hundred gram sample (the EP's minimum sample size), this translated to a total of 200 milliequivalents of acid (Ref. 26). The acetate buffer system originally chosen for the TCLP supplies only 70 milliequivalents of acid for a hundred gram sample.

As indicated above, steady or increased leaching of inorganic species was demonstrated to occur up to and after the 20 to 1 liquid to solid ratio (Ref. 8). While this data demonstrates that the 70 milliequivalent acetate buffer system is not aggressive enough for most of the inorganic species investigated, it supports the use of a 200 milliequivalent acetic acid solution for only some of the inorganic species. The Agency is, however, proposing use of the 200 milliequivalent acetic acid solution for alkaline wastes to be protective of human health and the environment when such leaching does occur. The Agency believes this action is justified given the conservative nature of the Hazardous and Solid Waste Amendments of 1984. In addition, as indicated in the report on Phase I of the TCLP development effort (Ref. 6), municipal waste leachates, both those generated in lysimeters and real leachates, have been observed in other studies to contain higher concentrations of carboxylic acids (measured as total organic carbon, of which approximately 70 percent is made up of carboxylic acids (Ref. 6)), than those measured in the municipal waste leachate used in the TCLP development program.

Hence, EPA is proposing a two leaching fluid system for the TCLP. As explained above, the Agency has chosen to base the strength of the alkaline waste leaching medium on the basis behind the EP's limit on the amount of acetic acid used. This will involve a 2 milliequivalent of acid per gram of waste leaching fluid for wastes of moderate to high alkalinity and a 0.7 milliequivalent per gram of waste leaching fluid for other wastes. A simple test of waste alkalinity is proposed as a means of determining the appropriate leaching fluid. For highly alkaline wastes (i.e., alkalinity> 0.7 milliequivalents/gm), the more acidic leaching fluid would be used. Note that EPA is not proposing this dual leaching fluid system for the evaluation of volatile compounds, since these compounds are expected to be unaffected by slight changes in acidity. More detail is provided in Section VIII (D) and in the background document supporting the TCLP (Ref. 33).

*f. Use of a pre-screen test.* One concern that was raised with the TCLP was that the protocol for dealing with volatile compounds is likely to be considerably more expensive than the protocol for the non-volatiles. Similarly, since this proposal involves additional analytes, the analytical costs associated with the TCLP protocol will also increase over that of the EP. For these reasons, EPA is proposing to establish a pre-screen test for the TCLP protocol. This pre-screen consists of a total analysis of the waste itself (using SW-846 methods, Ref. 27)), to determine if the waste contains sufficient amounts of specific compounds for the regulatory level to be exceeded, assuming that all the compound leaches from the waste. If based on such an analysis one can be certain that the regulatory level cannot be exceeded, then the TCLP does not have to be performed.

This pre-screen is being offered as a cost saving alternative, and is not mandatory. It will be especially useful to those generators who wish to demonstrate that their waste does not contain sufficient amounts of certain compounds, and therefore, that further analysis would be unnecessary. Perhaps a prime example of this is wastes resulting from a combustion process, like ashes from incineration. Since these wastes would likely be devoid of volatile components running the TCLP for volatiles would be unnecessary.

2. Technical Issues

*a. Use of extraction devices.* The EP protocol contains a descriptive definition of what was considered to be acceptable agitation. Two types of extraction equipment are described which EPA has determined meet this definition. One is a stirrer type extractor which uses small fan-like blades to mix the extraction fluid with the waste. The other type involves rotary action in which closed bottles containing the waste/extraction fluid mixture are tumbled in an end over end fashion (Ref. 27). This lack of specificity in agitation conditions is a major source of variability.

Today's proposal eliminates this source of variability by specifying a single means of agitation (i.e., rotary tumbler), and a fixed agitation rate (30±2 rpm). The rotary of tumbler type of extractor was selected for several reasons. It is widely recognized as a reproducible means of contacting the liquid and solid, and has been standardized by ASTM in their draft method D3987 (Ref. 1). Also, a factor in this determination was that the Agency's Science Advisory Board (SAB), in reviewing the TCLP development program, recommended that EPA develop one device and one set of operating conditions (Ref. 29). Although EPA recognized that this would require laboratories to purchase additional equipment, EPA has opted to propose the use of rotary agitation only.

Another related issue deals with the extractor vessel. As discussed in section VIII (D), EPA has developed a zero-headspace extraction vessel (ZHE) for use when extracting wastes with volatile organic compounds. This device can accommodate liquid/solid separation within the device, and obviates the need for an outside pressure filtration apparatus. One issue associated with use of this device is that, due to its 500 ml internal capacity, it can only accommodate a maximum sample size of 25 grams for a 100 percent solids sample. (A device of the normal 2 liter capacity was impractical due to its large size and weight.) For a waste of less than 100 percent solids, the maximum sample size the device can accommodate is tied to the percent solids of the waste. The device can only accommodate the minimal 100 gram sample size for wastes that are 25 percent solids or less.

Another problem associated with the extractor is that while EPA is proposing to require the zero-headspace extractor when dealing with volatiles, EPA is requiring use of regular extraction bottles when dealing with metals and other non-volatile components. Regular extraction bottles are much less expensive and easier to use than the zero-headspace vessel. The problem is that while EPA originally intended the zero-headspace extractor to be allowed to be used for metals and non-volatiles as well, certain features of the device, and other constraints, have led EPA to allow its use only when dealing with volatiles.

The problem touches upon the SAB's concern that, in the interest of precision, one device and one set of operating conditions should be specified (See section VIII(D)). There are actually two factors here which differ between regular extraction bottles and the zero-headspace vessel which could affect precision. The first is that since regular extraction bottles will provide for at least some headspace, agitation is likely to be slightly greater than with the zero-headspace vessel.

The second factor is that the two devices involve different types of liquid/solid separation techniques. Whereas the ZHE requires piston-applied pressure, use of bottles involves conventional air pressure filtration. These two means of applying pressure to accomplish liquid/solid separation are capable of producing different results for some waste types.

*b. Particle size reduction.* The EP protocol requires particle size reduction in those cases where the waste cannot pass through a 9.5 mm sieve, or has a surface area of less than 3.1 $cm^2/gm$. The TCLP continues with this requirement. One difference, however, deals with particle size reduction for monolithic type wastes. The EP allows the alternative of using the Structural Integrity Procedure (SIP), which amounts to pounding the monolithic waste with hammer-like blows and then conducting the extraction on the resulting sample, whether in one piece or in many pieces. The proposed TCLP does not allow use of the SIP (i.e., requires particle size reduction) for several reasons. The first reason again has to do with precision and the Science Advisory Board's comment to limit the new procedure to one device and set of operating conditions. Secondly, the Agency believes that given the uncertainties concerning the long term environmental stability of solidified wastes, an environmentally conservative approach is warranted. The SIP was originally developed as a means of assessing the degree to which a cementitious process stabilized a waste to the extent that the waste would remain as a monolithic block even after disposal. Such stabilization processes decrease leaching potential through reduction of surface area, and thus the area of potential leachate contact. Many processes also provide for chemical stabilization by binding heavy metals in insoluble hydroxide and other complexes.

The Agency believes that physical stabilization alone is not enough to insure that components do not leach in significant quantities from wastes. There are two types of actions which may act to reduce the physical integrity of stabilized wastes. First, the action of heavy landfill equipment, which the SIP is designed to simulate, will act to reduce the monolithic blocks into smaller pieces. Secondly, and more important, is the effect of natural weathering forces, such as wet/dry and freeze/thaw cycles (Ref. 10). The SIP does not account for such weathering. The Agency is currently investigating the effects of natural weathering on monolithic wastes, and may propose the use of additional predictive methodology at some later date. In the interim, by not allowing use of the SIP, the Agency insures that generators do not rely on physical stabilization alone.

An unrelated issue regarding particle size reduction also involves the treatment of volatile compounds. While EPA is attempting to prevent loss of volatiles (through introduction of the ZHE), if a waste containing volatiles requires particle size reduction, it is likely that some portion of these volatiles will be lost before the waste is introduced into the ZHE.

Herein lies a problem that may require a trade-off. Is it more important to reduce particle size or to prevent the loss of volatiles? EPA believes that particle size reduction is more important and has addressed this problem in the draft TCLP protocol by specifying that, where possible, particle size reduction be conducted to the extent possible on the sample as it is being taken.

The protocol does recognize, however, that there will be situations where volatile containing samples requiring particle size reduction cannot be reduced under these conditions. In this case, the protocol specifies that the sample should first be refrigerated to reduce the vapor pressure of the volatiles, and then that the particle size should be reduced with minimal exposure to the atmosphere to, at least, minimize the loss of volatiles. Another alternative is to require extractions under both conditions. Comments and alternative suggestions regarding this issue are solicited.

*c. Quality assurance requirements.* The quality assurance requirements of the EP are relatively straightforward. They require a minimum of one blanket per sample batch, and the method of standard addition (MSA) to be run for all samples. The Agency has received comments that requiring MSA for all extractions, which is very expensive, is unnecessary for all situations. This issue is particularly significant in determining the quality assurance requirements for the TCLP, given the increased number of analytes. In addition, the EP protocol is felt to need clarification and expansion in addressing other aspects of quality assurance, such as sample holding times.

The reader is referred to section 9 of the draft TCLP protocol, which appears as Appendix II to Part 261 in the regulation section of this proposed rule for review of the quality assurance requirements. One change that deserves mention here is in the requirement for the method of standard addition (MSA). Recognizing that MSA is expensive and not always necessary, EPA is proposing to require MSA only under certain conditions (See Proposed Appendix II to Part 261). This change recognizes that MSA is necessary only when the measured concentration of a constituent is close enough to the threshold, that matrix interferences could yield a wrong decision regarding the determination of hazard, or when there is evidence that severe matrix interference may be present.

## IV. Other Aspects of Proposal

### *A. Testing Frequency and Recordkeeping*

Under the framework being proposed today, the determination of whether a waste is a hazardous waste depends on whether the concentrations of constituents in the TCLP extract exceed the applicable regulatory levels. Since this determination is critical, EPA is evaluating whether to require periodic waste testing.

EPA has identified three general approaches to testing requirements, which are discussed in detail below. First, EPA could require generators to evaluate their wastes as to whether they exceed applicable regulatory levels, but not specifically require testing to make this determination. This approach is consistent with the current application of the RCRA hazardous waste characteristics. Second, EPA could require testing of wastes at a frequency specified by regulation. Third, EPA could require the generator to test, documenting the determination of the appropriate testing frequency based on guidance provided by the Agency.

As indicated above, existing regulations (40 CFR 262.11) require generators of solid wastes to determine whether their waste is hazardous. If the solid waste is not specifically excluded from regulation, and it is not listed as a hazardous waste in Subpart D of 40 CFR Part 261, then the generator must determine whether the waste is hazardous by any of the hazardous waste characteristics included in Subpart C of 40 CFR Part 261. This determination may be made by either testing the waste or by the application of knowledge of the waste in light of the materials or the processes used in its generation. Under 40 CFR 262.40, generators are required to keep records on how the hazard determination was made. Thus, although generators are held responsible for determining whether their wastes are hazardous, they are not specifically required to perform testing.

Although this approach would place the least burden on the regulated community, EPA is concerned that this approach may not promote voluntary compliance and that it could hamper Agency enforcement efforts against those members of the regulated community that do not comply voluntarily with the regulations.

Another possible approach is to require periodic testing, specifying in the regulations both the method and the frequency of testing. Thus, testing might be required on a semiannual, or annual basis. This approach would make enforcement of the regulations easier and would likely induce a higher level of voluntary compliance since the regulations would be highly specific regarding what constitutes an acceptable testing program and what actions and inactions would constitute violations.

There are, however, several problems with such an approach. First, there are problems inherent in specifying an appropriate testing frequency. Based on data from the Office of Solid Waste's Industry Studies Program and data from the Office of Water's Effluent Guidelines Program, it is clear that many waste streams are extremely variable in concentrations of chemical constituents from one plant to another, even when the same general process is employed. Variability exists not only from one generator to another, but also spatially and temporarily within a single plant or process. This variability can be caused by plant start-ups and shut-downs, changes in raw materials, changes in product specifications, seasonal changes, or meteorological events. While these factors tend to indicate the desirability of requiring testing at frequent specified intervals, the process-specific nature of this variability (among others) makes it difficult to identify a generically appropriate testing interval. For example, an appropriate frequency for a continuous process might be too infrequent for a batch process.

The third possible approach is to require generators to perform testing on their wastes, but not to specify a testing frequency in the regulations. Rather, generators would be required to determine an appropriate testing frequency based on guidance developed by the Agency and to document, in their records, this frequency determination. The advantage of this approach is that process-specific factors could be taken into account in determining the appropriate testing interval. Thus, although there would be some additional burden on generators to determine, based on the guidance, the appropriate frequency for testing tailored to specific factors relating to his process, there would be less of a chance of requiring unnecessarily frequent testing. This approach does, however, present greater enforcement difficulties than does the approach of specifying generic periodic testing intervals.

Even if testing is specifically required, a problem still remains as to how to assure that the waste sample subjected to testing is representative of both the batch and the process from which they are derived. This problem arises not only in the context of the Toxicity Characteristic program, but also in connection with other waste sampling requirements. EPA is currently developing a guidance manual on representative sampling that will address these concerns and anticipates publishing that guidance in late 1986.

EPA is proposing to retain the requirement that generators evaluate their wastes as to whether they exceed applicable regulatory thresholds, but not specifically to require periodic testing. EPA is, however, requesting comments on the approaches discussed above, as well as other possible alternatives to these approaches.

### *B. Relationship To Multiple EP and Oily Waste EP*

As a result of its waste listing program, EPA has listed a number of wastes as being hazardous on the basis that these wastes typically or frequently contain hazardous constituents at significant levels, or that they typically or frequently exhibit one or more of the characteristics of hazardous wastes. In recognition, however, that individual wastes may not actually be hazardous, due perhaps to a different process or the use of different raw materials, EPA has established a "delisting program," where generators could demonstrate to EPA that the particular waste in question does not constitute a hazardous waste. Although no waste to date has been listed because it exhibits the EPTC, the delisting program has been applying the EP protocol to this determination for the metal contaminants (with the application of a more conservative dilution/attenuation factor).

Given that the delisting process involves a more waste specific approach, a number of situations have arisen which have led EPA to modify the EP to address specific situations. The use of multiple extractions with simulated acid rain have been used to predict any long-term effects acid rain might have on stabilized wastes (the Multiple Extraction Procedure or MEP), and the Oily Waste EP (OWEP) has been used to predict the leaching of metals from wastes which contain significant amounts of oily materials. The OWEP was adopted because of the Agency's concern that the oil present in the wastes may (1) degrade, thus permitting the metals to be leached from the residue, or (2) migrate itself, and transport metals present in the organic phase to the ground water.

The Agency has a number of studies underway to better define the situations when such modifications are required. Pending completion of such studies the Agency will continue to employ the MEP and OWEP only in the listing and delisting programs where situation specific decisions can be made.

### *C. Analytical Methods*

The analytical methods proposed to be used for TCLP extracts are shown in section VIII(C) (See Table C-2), and also appear in the regulation section of this proposal as required methods. These are SW-846 methods (Ref. 27).

Analyzing the TCLP extract for phenolic compounds and phenoxy acid herbicides poses a potential analytical problem. The leaching fluid used in the new leaching procedure is 0.1 M with respect to acetate. Due to potential interference from the acetate ion, the routinely used analytical methods used for these compounds (i.e., GC/MS-SW-846 method 8270) may not be sufficient. EPA is presently investigating these methods to ascertain whether they are sufficient, or, whether it may be necessary to modify these methods. One modification being investigated is whether it may be possible to remove the acetate ion from the extract before determination of the phenolics and herbicides.

EPA is also investigating the use of high pressure liquid chromatography (HPLC) using electrochemical and fluorescence detection. HPLC with fluorescence detection was used in developing the improved leaching procedure, and has been shown to produce acceptable results (Ref. 6 and 7). A GC/MS method would be preferable since use of the HPLC method could add significantly to analytical costs. Should the presence of the acetate ion present substantial problems to GC/MS, it is likely that HPLC may be specified.

These methods are currently being evaluated. The Agency solicits comments and data on these or other methods which may be appropriate. On completion of these studies and evaluation of data received, a method for the phenolics will be selected and proposed for use with TCLP extracts prior to promulgation of this rule.

### *D. Notification Requirements*

The Agency has decided not to require persons who generate, transport, treat, store, or dispose of these hazardous waste to notify the Agency within 90 days of promulgation that they are managing these wastes. The Agency views the notification requirement to be unnecessary in this case since we believe that most, if not all, persons who manage these wastes have already notified EPA and received an EPA identification number. In the event that any person who generates, transports, treats, stores, or disposes of these wastes has not previously notified and received an identification number, that person must get an identification number pursuant to 40 CFR 262.12 before he can generate, transport, treat, store, or dispose of these wastes.

### V. Relationship to Other Regulatory Authorities

As has been pointed out previously, the Toxicity Characteristic threshold setting approach is modeled along the same lines as that used in the January 14, 1986 proposed standards for implementing the Land Disposal Restrictions regulations (51 FR 1603). However, since the Toxicity Characteristic proposes to use a Subtitle D disposal model, a slightly broader confidence interval for the Monte Carlo simulation, and an order of magnitude higher risk level for the carcinogens, the regulatory thresholds may be different than those proposed for banning wastes from land disposal.

The reason for the different thresholds in the Toxicity Characteristic relates to the nature of characteristics and the relationship between characteristics and listings, as discussed previously in this preamble. Characteristics are designed to be self implementing hazardous waste definitions in which waste and management specific factors are not considered. For that reason, characteristics are established at levels at which the Agency has a very high level of certainty that a waste which exhibits these properties, needs to be managed in a controlled manner (i.e., is a hazardous waste). The Agency realizes that not all waste which exhibit properties at levels below the characteristic are safe for disposal as nonhazardous waste. Rather, for those wastes having properties lower than the characteristic levels, and which are demonstrated to pose a hazard to human health or the environment, the Agency undertakes waste specific evaluations under the auspices of its listing program. Wastes which are determined to require controlled management after consideration of the factors identified in 40 CFR 261.11(a)(3), (e.g., the nature of the toxic constituents, toxicant mobility under various environmental management scenarios, volume of waste generated, potential methods of management), are then specifically listed as hazardous wastes and subjected to the appropriate RCRA management controls.

For the land disposal restrictions program, the screening levels identified through the equation are levels which EPA is very certain are protective at Subtitle C land disposal facilities. Wastes not meeting the screening levels are not banned outright from land disposal, but rather subject to case-by-case evaluations taking into account the specific characteristics of individual facilities. This case-by-case determination is initiated by petitions for exmption from the land disposal restrictions. The evlauation of these petitions will be based on results of modeling similar to that used to set screening levels, but with site-specific rather than conservative generic factors included.

In addiiton, the HSWA requires a very high standard of proof for a showing that a hazardous waste is suitable for land disposal. For this reason, the Agency believes it is appropriate to use a higher level of confidence and a lower cancer risk level in the modeling for the land disposal restrictions decisions, than is used for the Toxicity Characteristic. However, the Agency requests comment on whether the risk level and confidence level used in the Toxicity Characteristic should be the same as for the screening levels used in the proposed land disposal restrictions rule.

Whenever a waste or waste stream is determined to be hazardous under section 3001 of RCRA, it automatically becomes a hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). CERCLA section 103 requires that persons in charge of vessels or facilities from which hazardous substances have been released in quantities that are equal to or greater than the reportable quantities (RQs), immediately notify the National Response Center (at (800) 424–8802 or (202) 426–2675) of the release. (See 50 FR 13456, April 4, 1985).

The term "hazardous substance" includes all substances designated in § 302.4(a) of the April 4, 1985 final rule (50 FR 13474), as well as unlisted hazardous wastes exhibiting the characteristics of Ignitability, Corrosivity, Reactivity, and Extraction Procedure Toxicity (ICRE). (See § 302.4(b) of the April 4, 1985 final rule).

There are currently only 14 substances listed under CERCLA as ICRE wastes on the basis of the EP Toxicity Characteristic, most of which are also specifically designated as hazardous substances under 40 CFR 302.4(a). Under today's proposed rule, an additional 38 compounds, which are also specifically designated as hazardous substances under 40 CFR 302.4(a), would be incorporated under the newly defined Toxicity Characteristic. Accordingly, EPA proposes in this rulemaking to amend Table 302.4 of 40 CFR 302.4, to remove "Characteristic of EP Toxicity" and replace it with "Toxicity Characteristic," and to list the additional Toxicity Characteristic contaminants along with their final RQs from Table 302.4.

The CERCLA program will also use the TCLP procedure to help determine when waste taken off-site must be managed as a hazardous waste. To the extent that the TCLP is applicable or relevant and appropriate, the CERCLA program will apply the TCLP in a manner that is consistent with the National Contingency Plan (NCP) (50 FR 47912, November 20, 1985) and policy on CERCLA compliance (50 FR 47946, November 20, 1985) with other environmental statutes.

As indicated earlier in this preamble, under section 405 of the Clean Water Act (CWA), EPA establishes guidelines for the disposal and use of sewage sludge. The regulation of sewage sludge is necessarily a complex matter because these sludges fall within the jurisdiction of several Federal environmental programs. Under section 1004(27) of RCRA, the definition of "solid waste" specifically includes "sludge from a waste treatment plant." In defining "sludge," section 1004(26A) includes wastes from a "municipal wastewater treatment plant." Under section 102 of the Marine Protection, Research and Sanctuaries Act, EPA regulates the ocean dumping of sludge, including sewage sludge.

Where such overlapping jurisdiction exists, EPA seeks to integrate and coordinate its regulatory actions to the extent feasible. Thus, consistent with section 1006 of RCRA, the Agency's strategy for the development of a comprehensive sewage sludge management regulation will result in the establishment of a separate regulation. Once this regulation is in place, all sewage sludge use and disposal practices will be covered under appropriate provisions of section 405 of the CWA. If appropriate, sewage sludge that would be defined as a hazardous waste will be exempted from coverage under provisions of Subtitle C of RCRA, once this separate sewage sludge regulation, which will provide an equivalent level of protection, is issued.

## VI. State Authority

### *A. Applicability of Rules in Authorized States*

Under section 3006 of RCRA, EPA may authorize qualified States to administer and enforce the RCRA program within the State. (See 40 CFR Part 271 for the standards and requirements for authorization.) Following authorization, EPA retains enforcement authority under sections 3008, 7003 and 3013 of RCRA, although authorized States have primary enforcement responsibility.

Prior to the HSWA, a State with final authorization administered its hazardous waste program entirely in lieu of EPA administering the Federal program in that State. The Federal requirements no longer applied in the authorized State, and EPA could not issue permits for any facilities in the State which the State was authorized to permit. When new, more stringent Federal requirements were promulgated or enacted, the State was obliged to enact equivalent authority within specified time frames. New Federal requirements did not take effect in an authorized State until the State adopted the requirements as State law.

In contrast, under newly enacted section 3006(g) of RCRA, 42 U.S.C. 6926(g), new requirements and prohibitions imposed by the HSWA take effect in authorized States at the same time that they take effect in nonauthorized States. EPA is directed to carry out those requirements and prohibitions in authorized States, including the issuance of permits, until the State is granted authorization to do so. While States must still adopt HSWA-related provisions as State law to retain final authorization, the HSWA applies in authorized States in the interim.

Today's rule would be promulgated pursuant to sections 3001 (g) and (h) of RCRA, provisions added by HSWA. Thus, it would be added to Table 1 in section 271.1(j) which identifies the Federal program requirements that are promulgated pursuant to HSWA and that take effect in all States, regardless of their authorization status. States may apply for either interim or final authorization for the HSWA provisions identified in Table 1, as discussed in the following section of this preamble.

### *B. Effect on State Authorizations*

As noted above, EPA will implement today's proposed rule, when promulgated, in authorized States until they modify their programs to adopt these rules and the modification is approved by EPA. Since the rule will be promulgated pursuant to HSWA, a State submitting a program modification may apply to receive either interim or final authorization under section 3006(g)(2) or 3006(b), respectively, on the basis of requirements that are substantially equivalent or equivalent to EPA's. The procedures and schedule for State program modifications under section 3006(b) are described in 40 CFR 271.21. The same procedures should be followed for section 3006(g)(2).

Applying § 271.21(e)(2), States that have final authorization must modify their programs within a year of promulgation of EPA's regulations if only regulatory changes are necessary, or within two years of promulgation if statutory changes are necessary. These deadlines can be extended in exceptional cases (40 CFR 271.21(e)(3)).

States with authorized RCRA programs may already have requirements similar to those in today's proposed rule. These State regulations have not been assessed against the Federal regulations being proposed today to determine whether they meet the tests for authorization. Thus, a State is not authorized to carry out these requirements in lieu of EPA until the State program modification is approved. States with existing rules may continue to administer and enforce their standards as a matter of State law. In implementing the Federal program, EPA will work with States under cooperative agreements to minimize duplication of efforts.

States that submit official applications for final authorization less than 12 months after promulgation of EPA's regulations may be approved without including standards equivalent to those promulgated. Once authorized, however, a State must modify its program to include standards substantially equivalent or equivalent to EPA's within the time periods discussed above.

## VII. Economic and Regulatory Impacts

### *A. Regulatory Impact Analysis*

#### 1. Executive Order 12291

Executive Order 12291 requires regulatory agencies to conduct a Regulatory Impact Analysis (RIA) for any major rule. A major rule is one likely to result in (1) an annual effect on the economy of $100 million or more, (2) a major increase in costs or prices for consumers, individual industries, Federal, State or local government agencies, or geographic regions, or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or the ability of United States-based enterprises to compete in domestic or export markets.

EPA conducted an RIA to compare several regulatory alternatives, as explained in the following sections. The RIA provides an analysis based on the guidelines contained in the Office of Management and Budget's "Interim Regulatory Impact Analysis Guidance" (Ref. 21) and EPA's "Guidelines for Performing Regulatory Impact Analyses" (Ref. 28).

Based on the results of this analysis the Agency has concluded that this proposed regulation is a major rule with an annual cost to the economy of $151 million and an annual benefit of $1,625 million. The benefits, however, may be an overestimate since it is assumed that all contaminated aquifers would be cleaned up. Thus, the savings attributed to not having to clean up those aquifers would not accrue with a resultant decrease in benefits. Due to the case-by-case nature of these cleanup decisions, it was not possible to quantify this overestimation.

The purpose of section VII(A1) is to summarize the methodologies and findings of the RIA. Section VII(A)(2) discusses the basic approach taken in the RIA, and provides the regulatory alternatives examined. Section VII(A)(3) lists the industries projected to be affected by the proposed actions, and section VII(A)(4) discusses the methodologies employed in the economic impacts, benefit, and cost analyses. Finally, section VII(A)(5) reviews and compares the results of the benefit and cost estimations. The full draft RIA is available as part of one of the background documents supporting this proposed regulation (Ref. 22).

This proposed rule was submitted to the Office of Management and Budget for review, as required by Executive Order 12291.

#### 2. Basic Approach/Regulatory Alternatives

EPA is proposing to expand its list of contaminants under the EP Toxicity Characteristic to include a total of 52 contaminants. As explained earlier, and in sections VIII (A), (B) and (C), regulatory levels for these contaminants have been established by multiplying the chronic toxicity reference level for the contaminant, by its compound specific dilution/attenuation factor. Since EPA was in the process of refining both its chronic toxicity reference levels for some of the compounds, and its ground water transport model, many of the actual levels proposed today could not be used in estimating regulatory impact. Since the ground water transport model was in the process of being refined, straight dilution/

attenuation factors of 10, 100, and 1,000 were applied to estimated chronic toxicity reference levels, to arrive at three levels of regulation. Thus, including the status quo (i.e., no regulation), a total of four regulatory alternatives were examined.

This approach was taken as it would provide minimum and maximum estimates of regulatory impact, and also because it provided EPA with comparative cost and benefits estimates for three levels of regulation. Since the regulatory levels for the elemental drinking water standards are being retained, and since the TCLP is expected to be roughly equivalent to the EP, this RIA also assumes that the universe of waste regulated as a result of the elemental drinking water standards is unchanged. Benefits and costs were determined, then, for the following regulatory alternatives:

*Alternative 1.* Includes all currently unregulated wastes which would produce a TCLP extract containing any of the contaminants at a level greater than or equal to 100 times the chronic toxicity reference level.

*Alternative 2.* Same as above except this alternative evaluates a level greater than or equal to 10 times the chronic toxicity reference level.

*Alternative 3.* Same as above except this alternative evaluates a level greater than or equal to 1,000 times the chronic toxicity reference level.

*Alternative 4.* Status quo (i.e., no regulation).

The proposed regulation, since it employs compound specific attenuation factors, does not exactly mirror any of the alternatives studied. Rather, it falls between alternatives 2 and 3, with 40 compounds having a dilution/attenuation factor of 14.4, and 12 compounds with factors ranging from 18 to 150 (See section VIII(C). As will be seen from the discussion which follows, alternatives 1 and 2 both yield almost identical results for both costs and benefits. Thus, basing the conclusions on the results of alternatives 1 or 2 are not expected to result in any significant difference.

Benefits and costs for each regulatory alternative are compared to those of the baseline status quo. The status quo is assumed not to require industry to incur additional waste management costs. However, this RIA assumes that society will incur the costs of not regulating these wastes. The "social" costs of the status quo are assumed to be the benefits that would occur if the wastes were regulated. They vary with the projected number of affected facilities.

Note that no original research, sampling, or analyses were conducted as part of this RIA. In addition, as in all RIAs, a number of assumptions were made in order to predict impact. Assumptions about potentially affected wastes were based primarily on technical judgment, review of available literature and data, and EPA guidance. The determination of whether wastes would be hazardous under this proposed rule was based primarily on the solubility of individual contaminants rather than actual testing or data. Consequently, EPA believes that the estimates of projected impact indicated in the following paragraphs, are conservative (i.e., overstated) and should be viewed in a relative sense. In addition, although EPA expects to have better impact estimates (and some additional actual data) when this proposed regulation is promulgated, the very nature of predicting impact based on assumptions and technical judgment dictates that impact estimates still be viewed in a relative sense.

3. Affected Industries

Since the proposed action is chemical specific rather than industry-specific, it affects a wide range of industries. The following table (Table 2) shows the affected industries by Standard Industrial Classification (SIC) code, and gives the number of potentially affected facilities:

TABLE 2.—DIRECTLY AFFECTED INDUSTRIES

| Industry | SIC code No. | Description | Affected facilities [1] |
|---|---|---|---|
| Plastics materials and resins. | 2821 | Manufacturing of synthetic resins, plastics materials and nonvulcanizable elastomers. | 823 |
| Synthetic rubber. | 2822 | Manufacturing synthetic rubber by polymerization or copolymerization. | 2 |
| Medicinals and botanicals. | 2833 | Manufacturing bulk organic and inorganic medicinal chemicals and botanical drugs. | 1 |
| Soap and other detergents. | 2841 | Manufacturing soap and synthetic organic detergents, inorganic alkaline detergents, and crude and refined glycerin. | 2 |
| Surface active agents. | 2843 | Producing surface active preparations as wetting agents, emulsifiers, and penetrants. | 22 |
| Paints and allied products. | 2851 | Manufacturing paints, varnishes, and allied paint products. | 2 |
| Cyclic crudes and intermediates. | 2865 | Manufacturing coal tar crudes and cyclic organic intermediates, dyes, color lakes, and toners. | 185 |
| Industrial organic chemicals. | 2869 | Manufacturing industrial organic chemicals not elsewhere classified. | 214 |
| Agricultural chemicals. | 2879 | Formulation and preparation of pest control chemicals, including insecticides, fungicides, and herbicides. | 7 |
| Petroleum refining. | 2911 | Producing gasoline, kerosene, fuel oils, lubricants, and other petroleum derived products. | 2 |
| Nonferrous wire drawing and insulating. | 3357 | Drawing, drawing and insulating, and insulating wire and cable of nonferrous metals. | 5 |
| Total |  |  | 1,265 |

[1] Based on Alternative 2 (10×dilution/attenuation factor).

Most of the plants that produce and use the proposed chemicals appear in the organic chemical industries. Any facility that is projected to generate a waste which could produce a TCLP extract containing any contaminant at concentrations greater than the regulatory level (i.e., the solubility of the contaminant exceeds the level), is assumed to be a hazardous waste. (Those wastes currently regulated by RCRA are not included in the analysis.) The number of affected facilities may include plants that produce or use more than one of the chemicals. The actual number of plants affected may therefore be less than the total shown.

The RIA addresses primarily the impact of the expansion of the Toxicity Characteristic on the industrial sector. It is apparent, however, that since sewage sludges are defined as solid wastes under RCRA, today's proposal will also have an impact on the municipal sector. Given that there are some 15,000 municipal generators of sewage sludge across the United States, the impact could be significant. While less than 10 percent of these facilities accept sufficient industrial waste to cause any concern, these facilities generate most of the sewage sludge across the United States.

The existing and proposed regulations do not differ in their treatment of metals. Thus, any impact of the proposed regulation on the municipal sector would be due solely to the additional organic compounds. Due to this concern, EPA has begun a testing program to evaluate these sludges. To date, eight sewage sludges from facilities receiving significant industrial input have been tested with the TCLP, and all were found not to exceed any of the Toxicity Characteristic levels (organics or inorganics). Although more sewage sludge is being tested, EPA expects that only sludge containing very high levels of the organic toxicants proposed for addition (which would most likely be introduced through industrial input), would be defined as hazardous. Very few sewage sludges are expected to be hazardous wastes.

Hence, most of the impact of the proposed rule on the municipal sector will be the requirement to evaluate sludges against the Toxicity Characteristic levels. This, as explained earlier in the preamble, does not necessarily mean that all sewage sludges will be tested using the TCLP. Rather, as with the current EPTC, the vast majority of sewage sludge generators will perform that hazard determination using their knowledge of the sludge they generate. EPA believes that most of the municipal facilities receive such small amounts of industrial input, that they will be able to support a determination of non-hazardousness without having to test sludges using the TCLP.

To assess more fully the regulation's impact on the municipal sector, the Agency will be collecting additional data during the period between proposal and promulgation. To help the Agency in its impact estimates, EPA is requesting that data on municipal sewage sludges generated with the EP, the TCLP, or total analyses be sent to the Agency. Although it is not necessary to indicate the source of the sewage sludge, EPA solicits information such as the extent of industrial input to the generating facility, the type of industry involved, the amount of sludge generated by the facility annually, the type and extent of sludge generation and treatment (e.g., primary, secondary, tertiary, filtration, etc.), and the disposal method used.

### 4. Methodology Employed

*a. Economic impacts methodology.* A Partial Equilibrium Multimarket (PEM) model was used to estimate economic impacts. The basis of this model is the partial equilibrium framework, in which only a manageable number of markets is modeled. Economic impacts, or equilibrium changes, in non-modeled markets are assumed to be insignificant.

Input, directly affected, and output markets ideally would be linked together by a vertical market structure. A majority of the expected market changes would be modeled by the structure in which markets are linked to each other through the purchase of inputs or the sale of outputs. As changes occur in one market, resource reallocations by buyers and sellers prompt changes in other markets. Limited data availability imposes constraints on such a modeling effort. Thus, the economic impacts model, used quantitatively, projects economic impacts only in the identifiable directly affected markets.

As described in the full RIA, directly affected markets have been identified at the four-digit SIC level. Since different products are included within a four-digit SIC code, products unaffected by the proposed regulation may unavoidably be included in this analysis.

The directly affected markets are linked together by means of the PEM model. Data requirements include an original equilibrium, supply functions, demand functions, and the initial impacts caused by the proposed regulatory alternatives. Several assumptions make this data collection effort more manageable. Within this economic impacts model, all supply functions are treated as being perfectly elastic. This assumption limits the interaction between directly affected markets. A demand shift in an output market does not change input price and does not change production costs of a directly affected product. What this simplification implies cannot be assessed because of limited data. In the long run, however, all supply functions tend to become more elastic (or flatten), making the importance of this assumption less significant.

Demand functions are assumed to incorporate changes in equilibrium. As defined by Just, Heath, and Schmitz (Ref. 15), these general equilibrium demand functions define the relationship between price and quantity, given all changes in output markets. For example, a price increase and quantity decrease in an output market ordinarily will shift demand for a directly affected product. With a general equilibrium demand function, a shift in demand function does not have to be defined.

Market changes caused by the proposed regulation are straightforward. Initial equilibrium changes occur as increased production costs and cause supply functions in the directly affected markets to shift up. Owing to the assumptions listed above, these new prices and quantities now represent a new equilibrium since input prices do not change and demand for directly affected products does not shift. Changes in the unmodeled input market are only changes in quantity traded. Changes in unmodeled output markets are an increase in price and a decrease in quantity traded.

The PEM model simplifies the analysis in several ways. Most importantly, it allows measurement of all social costs in the directly affected markets. Also, it allows the economic impacts to be solved in several steps rather than simultaneously. The projected economic impacts are then used to define benefits and costs.

*b. Benefits estimation methodology.* Regulation of wastes containing any one of the selected chemicals is anticipated to result in a reduced risk of contamination of ground water that serves as a supply of drinking water for many communities. If the contaminating chemical is a carcinogen, consumption of drinking water may result in an excess incidence of cancer cases in the population. Ingestion of noncarcinogenic chemicals in drinking water at a level above the RfD may be correlated with toxic, reproductive, or genetic effects, depending on the particular chemical. If people avoid drinking contaminated ground water, switching to an alternative water source imposes substantial costs on the affected communities. Often, if a chemical has been detected in the ground water, the contaminated aquifer is cleaned up (to the extent possible) and the landfill treated, which also results in additional costs to the community.

Estimates are made for each chemical of the health effects and switching and cleanup costs (corrective costs) attributable to the presence of that chemical in the ground water. Regulation of the waste is assumed to prevent these estimated health effects and corrective costs completely. The estimated benefits attributable to the regulation are the health effects and corrective costs avoided by its implementation.

Four steps are used to determine benefits: (1) Estimate quantity and concentration of chemical in landfill, (2) estimate concentration of chemical in leachate (i.e., TCLP extract), (3) estimate chemical concentration at drinking water well, and (4) estimate health effects and corrective costs attributable to that ground water contamination.

The unregulated wastes are assumed to be disposed in a landfill each year for 20 years (the average lifetime of a landfill). The amount of the chemical contaminant that leaches through the landfill, and the leaching duration, is determined using a leachate concentration model. From the bottom of the landfill, the contaminant is transported through the aquifer to the community well. The concentration of the contaminant at the well varies over time and is tracked over 100 years with a ground water transport model. The health and corrective costs attributable to the contaminated well are then estimated by a health and corrective costs model.

Two methods—the Base Case Method (Alternative 1) and an Alternate Method (use of a ground water transport model) were employed to estimate the concentration of the chemical in the leachate at the well. The estimated benefits presented in the next unit are calculated using the Base Case Method. This method assumes (1) that the landfill receives predominantly domestic refuse, with only 5 percent of the landfill holding industrial waste, (2) that the character of the leaching fluid to which wastes are exposed is primarily a function of the non-industrial material in the landfill, (3) that the landfill is located over an aquifer that is a source of drinking water, (4) that the soil below the landfill has limited attenuative capacity, (5) that the nearest drinking water wells are 150 meters (500 ft) downgradient from the landfill, and (6) that as constituents migrate from the landfill through the unsaturated and saturated zones to the source of drinking water, they are attenuated by a factor of 100.

*c. Cost estimation methodology.* The current disposal costs, or baseline, must be established if the increased disposal costs incurred by waste generators due to the proposed regulation are to be estimated. Current disposal costs are a function of the disposal alternatives in use. Where the waste is not a listed hazardous waste, current disposal practices are identified by examining the technical literature, by analogy to similar wastes for which disposal practice is known, or by assumption.

Some baseline disposal alternatives may understate the actual treatment and disposal applied to that waste, because no effort has been made to determine which wastes may be affected by State and local regulations that are more stringent than Federal regulations. This may also occur because firms voluntarily may be applying more thorough treatment and disposal than required by regulation. The result of this potential understatement of baseline treatment and disposal alternatives is that the estimated increase in disposal costs to comply with the characteristic approach will be greater than the actual increase.

For currently landfilled wastes not listed as hazardous but subject to the regulation, disposal practice after regulation will become more stringent and costs will increase. Disposal costs are assumed to remain the same for wastes currently incinerated or deepwell injected. Solvent wastes and a few other wastes are assumed to be incinerated.

Using model plant information, estimates of the incremental disposal and operating and maintenance costs associated with the implementation of the alternatives are projected. These estimated costs are then compared to the cost of contracting with commercial disposal services to estimate properly the minimum costs incurred by the affected facilities. These costs are annualized to reflect an accurate measure of the increased production costs associated with this proposal. Estimates of percentage cost change are generated for use in the product/consumption model. Under the assumption of full-cost pricing, these percentage estimates are determined by dividing the annualized incremental costs by the value of shipments in affected SIC industries.

The economic impacts model is used to derive all costs or welfare losses borne by consumers of directly affected products. Consumers suffer a welfare loss because they lose consumer surplus, or the value placed on consumption in excess of the amount required to purchase a product. Economic theory allows the estimation of total consumer costs through impacts in the directly affected markets. Thus, input and output market data are not required.

Consumer surplus losses represent the only recurrent or annual costs. Changes in waste disposal methods in response to a regulation are represented by an upward shift in the supply function. The higher production costs that result create a new equilibrium and a consumer surplus loss. The new equilibrium will have lower production at a higher cost than the initial equilibrium. A real resource cost is the value of the additional costs incurred to produce the new lower level of output. A dead-weight loss is the loss in surplus value consumers placed on those units that will no longer be produced.

Extension of the above analysis to a multimarket situation is straightforward. Since impacts in input and output markets need not be considered, total welfare costs are developed by assuming welfare costs in the directly affected markets.

Consumer surplus costs represent annual costs. Within this analysis all baseline data are presented for the year 1982. Consumer surplus losses will continue to be incurred, however, for an unknown number of years. To develop cost estimates for future years, costs are first estimated for 1982 and then assumed to be constant for all subsequent years. This simplifying assumption is necessary since time constraints preclude the projection of market trends.

Implementation costs, consisting of transaction costs and employment losses, represent losses in welfare that will be incurred only once. Transaction costs represent the value of resources that would be expended to determine if a waste stream is to be regualated. These costs are based on an estimated cost of sampling and analyzing each waste stream by affected facilities.

Employment losses occur since goods and services are forgone when individuals are employed. Losses are based on the projected change in production and employment-to-output ratios for each directly affected market. These losses are not valued in dollar terms because projecting the length of time for which an employee is unemployed is difficult. Similarly, the value to place on time, individual job skills, age, education, and personal dislike of being unemployed are not valued in dollar terms.

### 5. Results

*a. Aggregate benefits.* Continued use of current practices for managing wastes producing TCLP extracts containing the selected chemicals in excess to regulatory levels is expected to result in the deterioration of environmental quality. This deterioration may elevate risks to human health and reduce the quality of environmental resources, such as drinking water. The major route by which environmental quality is expected to be affected is through the leaching of contaminated wastes into ground water. Over 50 percent of the U.S. population uses ground water for drinking water. Further, contaminated ground water can enter surface water, reducing its quality. The capacity of both ground water and surface water to assimilate toxic chemicals is limited.

If people drink contaminated ground water, a wide range of health effects may occur, from simple gastrointestinal problems to cancer and birth defects. The focus is on the possible excess cancer cases if the selected chemicals are not regulated. It is assumed that contaminated water would continue to be used as a drinking water source until the concentration reached taste or odor thresholds of the average person. When that threshold is attained, it is assumed they would switch to alternative water sources.

When a landfill is recognized as a source of ground water contamination, it is also assumed that the municipality would take action to prevent further leaching of the chemicals. Estimates were developed for a representative community and aggregated to obtain national totals. This aggreation process is not very precise, so the reader is cautioned to interpret the results presented carefully. The benefits and costs for each regulatory alternative are summarized in the following table (Table 3).

TABLE 3.—BENEFIT-COST ASSESSMENT

| Benefits-Costs | Regulatory alternative | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Monetized benefits:[a] | | | |
| Avoided cost of alternative water source: | | | |
| Present value ($$10^6$)[b] | 3,218 | 3,317 | 3,174 |
| Annualized ($$10^6$/Yr) | 378 | 390 | 373 |
| Avoided cost of aquifer cleanup: | | | |
| Present value ($$10^6$)[b] | 11,897 | 12,316 | 11,719 |
| Annualized ($$10^6$/Yr) | 1,398 | 1,447 | 1,377 |
| Monetized costs: | | | |
| Real resource cost: | | | |
| Present value ($$10^6$)[b] | 1,285 | 1,287 | 1,186 |
| Annualized ($$10^6$/Yr) | 151 | 151 | 139 |
| Deadweight consumer surplus cost: | | | |
| Present value ($$10^6$)[b] | 1.2 | 1.2 | 1.0 |
| Annualized ($$10^6$/Yr) | 0.1 | 0.1 | 0.1 |
| Transaction cost ($$10^6$)[c] | 1.2 | 1.2 | 1.2 |
| Net monetized benefits:[d] | | | |
| Present value ($$10^6$)[b] | 13,830 | 14,345 | 13,706 |
| Annualized ($$10^6$/Yr) | 1,625 | 1,685 | 1,610 |
| Nonmonetized benefits:[a] | | | |
| Avoided cancer cases | 54 | 54 | 53 |
| Avoided person-years of exposure above the chronic threshould ($10^6$) | 4.8 | 4.8 | 0 |
| Nonmonetized costs: | | | |
| Employee dislocations | 407 | 407 | 372 |

[a] Benefits are based on Alternative 1.

[b] 20-Year cost discounted at 10 percent.

[c] One-time cost incurred first year.

[d] Monetized benefits minus monetized costs excluding transaction costs.

These estimates of the health effects and corrective costs attributable to a waste are developed for a typical community. The estimates of the aggregate benefits of the proposed regulation are obtained by assuming that health effects and corrective costs would be avoided by all the communities affected by the proposed regulation. Since the aggregation process used assumes that each waste affects a single typical community, it is somewhat arbitrary. Again, the reader is cautioned to interpret results with care.

*b. Aggregate costs.* Benefits of the regulatory alternatives would be accompanied by costs. As described previously, total costs of the regulatory alternatives includes real resource costs, dead-weight consumer surplus losses, dead-weight producer surplus losses (capital value losses), employee dislocation costs, and transaction costs. Two of these welfare costs have not been projected in this analysis. Employee dislocations have been quantified, but their social costs have not been evaluated. Capital value losses incurred by owners of affected capital also have not been evaluated.

*c. Benefit-cost comparison.* Most public policy alternatives have benefits and costs. Policy evaluation can be difficult because these benefits and costs typically accrue to different individuals. Harberger (Ref. 11) has argued that:

> when evaluating the net benefits or costs of a given action (project, program, or policy), the costs and benefits accruing to each member of the relevant group (e.g., a nation) should normally be added without regard to the individuals to whom they accrue.

This principle dates to Kaldor (Ref. 16) and Hicks (Ref. 12), who argued that a change should be instituted if a potential gain exists so that those who bear the cost could be compensated fully for their loss by the beneficiaries, and the beneficiaries would still be better off than before. Following the Kaldor-Hicks principle, this RIA evaluates benefits and costs to society at large without regard to their incidence.

Table 3 summarizes the benefits and costs of the regulatory alternatives. The difference between the monetized benefits (i.e., avoided corrective costs) and monetized costs (i.e., real resource and dead-weight consumer surplus costs) is compared using the annualized method. This difference is positive for all regulatory alternatives. Thus, each alternative would provide an improvement in economic welfare.

An evaluation of the regulatory alternatives will allow a comparison of the different regulatory levels for the proposed contaminants. Moving from Alternative 2 to 1, respectively leads to virtually no changes in health benefits, but does increase the net monetized benefits by $61 million per year. This suggests that Alternative 2 is preferable to Alternative 1. Moving from Alternative 3 to 1 leads to substantial reduction in health benefits, and yields a decrease in net monetized benefits of $14 million per year.

As explained earlier, this RIA compares the benefits and costs of several regulatory alternatives that were determined by mulitplying estimated chronic toxicity reference levels for the selected compounds, by assumed dilution/attenuation factors of 10, 100 and 1,000. This was necessary, as the toxicity reference levels and the model-generated dilution/attenuation factors that were proposed today could not be generated in time for this analysis. Hence, while this analysis provides estimates of the range of regulatory impacts due to the proposed rule, it does not directly provide an estimate of the impact of the proposed rule. The final RIA which will accompany the promulgation of this rule will analyze the benefits and costs based on the final regulation.

### *B. Regulatory Flexibility Act*

Under the Regulatory Flexibility Act, 5 U.S.C. 601–612 whenever an Agency is required to issue for publication in the **Federal Register** any proposed or final rule, it must prepare and make available for comment a Regulatory Flexibility Analysis which describes the impact of the rule on small entities (i.e., small business, small organizations, and small government jurisdictions), unless the Agency's Administrator certifies that the rule will not have significant economic impact on a substantial number of small entities.

The Agency has examined the proposed rule's potential impact on small businesses, and has concluded that this regulation will not have a significant impact on a substantial number of small entities. Again, for the reasons stated in the above section, this analysis does not directly provide an estimate of the impact of the proposed rule on small businesses.

More than 20 percent of the small firms in an industry is considered a substantial number of affected firms. This analysis uses a worst-case approach and assumes that all affected facilities belong to small firms. Three standard measures suggested by EPA guidance are used in determining a significant impact on small firms within an industry. These are (1) when annualized compliance cost as a percentage of total costs of production is greater than 5 percent, (2) when capital costs of compliance represent a significant portion of capital available to small entities, and (3) when annualized compliance cost as a percentage of sales for small firms is more than 10 percentage points higher than annualized compliance costs as a percentage of sales for large firms. For the purposes of this analysis, the costs associated with the first regulatory alternative are used in assessing the significance of impacts on the small firms within affected industries.

In determining the ratios needed for the third measure, annual compliance costs for each industry are apportioned into two groups. One group is used with the receipts for large firms and the other is used with receipts for small firms. The proportion going to each group is equal to the percentage of small and large firms above and below the size standard of 50 employees. EPA has elected not to adopt the Small Business Administration's definition of small business, which is fewer than 500 employees for most SICs, because it would include the majority of plants in the regulated community. Using a threshold value which includes a majority of the total population obscures any differential impacts on smaller firms. The Agency considers a threshold value of fewer than 50 employees to be a more sensitive index of impacts on small businesses.

For the other two measures, the entire cost for the industry is compared to the aggregate data for small firms as a worst case. This will provide an extreme estimate of the number of industries that have small firms that might experience a significant impact. A "significant portion of capital available to small entities" depends on the average annual portion of new capital expenditures spent on pollution abatement in the last 10 years. If capital costs as a percentage of new capital expenditures are more than 10 percentage points larger than the average percentage that has been spent in the last 10 years, than the capital costs are determined to be significant.

Under this analysis, no SICs are impacted significantly by any of the three measures described. Accordingly, I certify that this proposed regulation will not have a significant economic impact on a substantial number of small entities. This regulation therefore does not require a Regulatory Flexibility Analysis.

### *C. Paperwork Reduction Act*

The proposed rule contains information collection requirements subject to OMB review under the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 et. seq. Specifically, under 40 CFR 262.40, generators are required to keep records on how the hazard determination was made for the wastes they generate. EPA believes that these information collection requirements are insignificant and has not prepared documentation pursuant to the Paperwork Reduction Act. If necessary, such documentation will be prepared for the promulgated rule.

## VIII. Additional Information

### *A. Chronic Toxicity Reference Levels*

#### 1. Introduction

When the EP Toxicity Characteristic (EPTC) was promulgated in May of 1980, the only standards which existed for establishing toxicity levels, and which addressed chronic exposure, were the National Interim Primary Drinking Water Standards (NIPDWS). These addressed 8 metals, 4 insecticides and 2 herbicides, and hence, EP toxicity thresholds were limited to these 14 contaminants. Today, however, chronic toxicity levels have been established for a number of additional toxicants. This Section provides details on the chronic toxicity reference levels which are being proposed for use in expanding the Toxicity Characteristic.

#### 2. Non-Carcinogenic Constituents

Establishing regulatory levels for individual contaminants requires the initial input of a health reference level. Determination of the appropriate level is dependent upon the nature of the toxic effect of the constituent, specifically whether or not the constituent is a carcinogen. Substances which do not cause cancer exert toxicity through mechanisms which exhibit physiological thresholds. Thus a reserve capacity, assumed to exist within an organism, must be depleted or overwhelmed before toxic effects are evident. Simply put, for each non-carcinogen there is some low level of exposure which has no effect on humans. Protection against a chronic toxic effect for a non-carcinogen is achieved by keeping exposure levels at or below the reference dose.

For non-carcinogenic constituents, the Agency is proposing to use Reference Doses (RfDs) as the starting point for establishing chronic toxicity regulatory levels. An RfD is an estimate of a lifetime daily exposure of a substance to the general human population, which appears to be without an appreciable risk of deleterious effects. Conceptually, the RfD is closely related to the term Acceptable Daily Intake. ADIs were first used by the Food and Drug Administration (FDA) in 1954 as specific guidelines and recommendations on the use of "safe" levels of chemicals, such as food additives or food contaminants, for human consumption (Ref. 18). Since their initial use by the FDA, ADIs have been used by other public health agencies in establishing "safe" levels for toxic chemicals. The Food and Agricultural Organization, World Health Organization, and EPA have used ADIs in the process of establishing allowable pesticide residues in foodstuffs (i.e., tolerances). The National Academy of Science and EPA have estimated ADIs for purposes of establishing safe levels of contaminants in drinking water (Ref. 30).

The experimental method for estimating the RfD is to measure the highest test dose of a substance which causes no statistically or biologically significant effect in an appropriately conducted animal bioassay test. This experimental no-observed-adverse-effect-level (NOAEL) is an estimate of the animal population's physiological threshold. The RfD is derived by dividing the NOAEL by a suitable scaling or uncertainty factor.

NOAELs are usually obtained through a chronic study or a 90-day subchronic study. Other available toxicological data, such as metabolism and pharmacokinetics, are used to validate the judgmental choice of a particular dose level as the NOAEL. Confidence in the NOAEL, and therefore in the RfD, is dependent on the quality of the experiment, the number and type of animals tested at each level, the number and range of dose levels, the duration of the study (i.e., chronic vs subchronic), and the nature of the biological endpoint measured (i.e., the severity of the observed effects). The longer the duration of the study, the smaller is the uncertainty factor applied to the NOAEL. Selection of the appropriate uncertainty factor involves scientific judgment and the application of general guidelines (Ref. 30). The derivation of RfDs used for establishing regulatory levels has been evaluated and verified by an Agency workgroup (Ref. 30, 31, and 32).

Table A-1 presents the proposed non-carcinogens and their RfDs. The RfDs in this table are calculated by assuming that a 70 Kg person ingests the compound in 2 liters of drinking water per day.

TABLE A-1.—NON-CARCINOGENS AND RFDS (MG/L)

| Compounds | RfD |
|---|---|
| Carbon disulfide | 4 |
| Chlorobenzene | 1 |
| o-Cresol | [1] 2 |
| m-Cresol | [1] 2 |
| p-Cresol | [1] 2 |
| 1,2-Dichlorobenzene | 3 |
| Isobutanol | [1] 10 |
| Methyl ethyl ketone | 2 |
| Nitrobenzene | 0.02 |
| Pentachlorophenol | 1 |
| Phenol | 4 |
| Pyridine | 0.075 |
| 2,3,4,6-Tetrachlorophenol | [1] 0.4 |
| Toluene | 10 |
| 2,4,5-Trichlorophenol | 4 |

[1] Preliminary estimate of RfD.

For some of the contaminants addressed in today's proposed rule, insufficient toxicological data exists for establishing an RfD. EPA is using preliminary data for isobutanol, ortho-, meta-, and para-cresol, and 2,3,4,6-tetrachlorophenol while appropriate testing continues. The Agency will revise these RfD's and repropose the regulatory levels if necessary. Note also that the Agency intends to propose regulatory levels for nickel and thallium during the period between proposal and promulgation of this rule. The chronic toxicity levels for nickel and thallium are expected to be 0.15 and 0.002 mg/l, respectively.

### 3. Carcinogenic Constituents

The use of the RfD is appropriate only for non-carcinogenic toxic endpoints. In the absence of chemical specific information on mechanism of action or kinetics, EPA science policy suggests that no threshold dose exists for carcinogens. No matter how small the dose, some risk remains.

The dose-response assessment for carcinogens usually entails an extrapolation from an experimental high dose range and observed carcinogenic effects in an animal bioassay, to a dose range where there are no observed experimental data, by means of a pre-selected dose-response model. The slope of the dose-response curve is determined by this model. EPA's Carcinogen Assessment Group has estimated the carcinogenic potency (i.e., the slope of risk versus exposure) for humans exposed to low dose levels of carcinogens. These potency values indicate the upper 95 percent confidence limit estimate of excess cancer risk for individuals experiencing a given exposure over a 70 year lifetime. In practice, a given dose multiplied by the slope of the curve gives an upper limit estimate of the number estimated to develop cancer. The slope can be used to calculate the upper limit of the dose which gives rise to a given risk level (e.g., one response in a hundred thousand). By specifying the level of risk (no matter how small) one can estimate the lifetime dose corresponding to it. The upper limit of the dose of a carcinogen corresponding to a specific risk level is called the Risk Specific Dose (RSD). To arrive at a starting health limit for a carcinogen, a risk level or range of concern must be specified. EPA proposes to specify a risk level of concern on a weight-of-evidence basis, as described below.

In November 1984, EPA proposed Guidelines for Carcinogen Risk Assessment (49 FR 46294), which described a scheme to characterize carcinogens based on the experimental weight of evidence. This scheme is based on considerations of the quality and adequacy of the experimental data and the kinds of responses induced by a suspect carcinogen. The classification scheme is generally an adaptation of a similar system developed by the International Agency for Research on Cancer (Ref. 13).

EPA's classification of weight-of-evidence system comprises five groups. Group A indicates human carcinogens. This classification is based on sufficient evidence from epidemiological studies of a causal association between human exposure to the substance and cancer. Group B indicates probable human carcinogens. The evidence of human carcinogenicity from epidemiological studies for substances within this group ranges from almost sufficient to inadequate. This group is subdivided into two categories ($B_1$ and $B_2$) on the basis of the strength of the human evidence. Where there is limited epidemiologic evidence of carcinogenicity, the carcinogen is categorized as $B_1$. Where there is no evidence or inadequate evidence from human studies, the carcinogen is categorized as $B_2$. Group C comprises possible human carcinogens. This group includes agents with limited evidence of animal carcinogenicity. It includes a wide variety of animal evidence. Group D includes agents which cannot be classified because no data or insufficient data are available. Group E includes chemicals for which there are adequate negative animal bioassays. This category indicates no evidence of carcinogenicity in humans.

The Agency regards agents classified in Group A or B as suitable for quantitative risk assessment. The method for quantitation of Group C substances is best judged on a case-by-case basis, since some Group C agents do not have a data base of sufficient quality and quantity to perform a quantitative carcinogenicity risk assessment.

Since carcinogens differ in the weight of evidence supporting the hazard assessment, EPA believes that establishment of a single across-the-board risk level is not appropriate. The Agency proposes to set a reference risk level as a point of departure, along with a risk range keyed to the weight of evidence approach. The dose for known and probable human carcinogenic agents (Classes A and B) would thus be determined at the $10^{-5}$ risk level.

For the Class C carcinogens (agents with less firm evidence of human carcinogenicity), a risk level of concern of $10^{-4}$ is being proposed. For those Class C carcinogens for which there is insufficient data to perform a quantitative risk assessment, the dose is calculated on the basis of the lowest threshold effect, with an additional uncertainty factor of ten (e.g., NOAEL/1000). This approach is similar to the approach taken by the Agency on November 13, 1985 in its proposed regulations on enforceable standards for volatile organic chemicals in drinking water (50 FR 46880). The Agency solicits comments on the proposed risk levels and the criteria for distinguishing among the Class C carcinogens for this purpose.

Some agents appear to cause cancer by only one route of exposure or entry. Conclusions about route specificity can only be addressed in circumstances where adequate data exists on carcinogenicity for more than one route of exposure. Where carcinogenicity findings are available from only one route of exposure, the substance is judged to represent a cancer hazard by all routes, unless it can be scientifically demonstrated that the material cannot gain access to target sites by the alternative routes of interest. Where the data from one or more routes are limited, the Agency will evaluate each case on its merits, placing particular emphasis on the scientific evidence.

For a few substances (notably metals), the data base demonstrating that cancer is produced by one route of exposure but not by another is substantial and convincing. An example of a substance whose carcinogenic response is characterized as route-specific is chromium and some of its salts. These substances cause cancer by inhalation but not by other conventional routes of entry. The Agency will regulate such substances as carcinogens only by the relevant route and as non-carcinogens by all other routes.

Table A-2 presents those proposed Toxicity Characteristic contaminants that are carcinogens, the class of the carcinogen, and the Risk Specific Dose.

TABLE A-2.—CARCINOGENIC CONTAMINANTS AND RSD (MG/L) [1]

| Contaminant | Carcinogen class | Risk level | Risk specific dose (RSD) |
|---|---|---|---|
| Acrylonitrile | B | $10^{-5}$ | 2E-3 |
| Bis (2-chloroethyl) ether. | B | $10^{-5}$ | 3E-4 |
| Chlordane | C | $10^{-4}$ | 2E-3 |
| Chloroform | B | $10^{-5}$ | 5E-3 |
| 2,4-Dinitrotoluene | B | $10^{-5}$ | 1E-3 |
| Heptachlor | B | $10^{-5}$ | 1E-4 |
| Hexachlorobenzene. | B | $10^{-5}$ | 2E-4 |
| Hexachlorbutadiene. | C | $10^{-4}$ | 5E-2 |
| Hexachloroethane | C | $10^{-4}$ | 3E-1 |
| Methylene chloride | B | $10^{-5}$ | 6E-1 |
| 1,1,1,2-Tetrachloroethane. | C | $10^{-4}$ | 7E-1 |
| 1,1,2,2-Tetrachloroethane. | C | $10^{-4}$ | 2E-2 |
| Tetrachloroethylene. | B | $10^{-5}$ | 7E-3 |
| 1,1,2-Trichloroethane. | C | $10^{-4}$ | 6E-2 |
| 2,4,6-Trichlorophenol. | B | $10^{-5}$ | 2E-2 |

[1] Does not include those carcinogenic contaminants for which Drinking Water Standards have been established or proposed (See next section).

### 4. Use of Existing Agency Health Standards

Under the existing EP Toxicity Characteristic, EPA uses the existing

National Interim Primary Drinking Water Standards, established for eight elemental contaminants and six pesticides, as toxicity thresholds. Today's rule retains these thresholds for the elemental toxicants but proposes compound specific dilution/attenuation factor based thresholds for the organic compounds.

EPA has also been working to establish Drinking Water Standards for additional organic compounds. Final standards for drinking water, the Maximum Contaminant Levels (MCLs), are enforceable and are based upon health, treatment technologies, costs, and other feasibility factors such as the availability of analytical methods. The MCLs are set following an analysis based on health considerations as guided by the Safe Drinking Water Act. This intermediate analysis results in proposed Recommended Maximum Contaminant Levels (PMCLs), which are non-enforceable health based limits. Included in the analysis of the health considerations for determining PMCLs are not only the quality and weight-of-evidence of the supporting toxicological studies, but also examination of absorption rates of specific toxicants, the possibility of nutritionally essential levels for some elements, the existence of route-specific toxicity, the demonstration of other environmental exposures, and finally, the apportionment of the permissible limit of constituent into media specific amounts. In general, final MCLs for non-carcinogens are based on 20% of the relevant RfDs, to account for exposure from other sources (e.g., food and air). Final MCLs for carcinogens are based on risk levels that range from $10^{-4}$ to $10^{-6}$.

Since the above factors have been evaluated for each of the other contaminants in today's rule, PMCL standards derived under the Safe Drinking Water Act can be used as toxicity thresholds. On November 13, 1985 EPA proposed MCLs for eight synthetic volatile organic chemicals (50 FR 46880). EPA is also proposing to use these contaminants and their proposed MCLs, which appear in Table A-3, as toxicity thresholds for the Toxicity Characteristic. After public review and evaluation EPA will promulgate final standards. Should the final MCLs differ from the proposed MCLs, EPA will base regulatory levels for the Toxicity Characteristic on these revised final standards.

TABLE A-3.—PROPOSED MCL'S FOR VOLATILE ORGANIC COMPOUNDS (MG/L)

| Contaminant | Proposed MCL |
|---|---|
| Benzene | 0.005 |
| Carbon tetrachloride | 0.005 |
| 1,4-Dichlorobenzene | 0.75 |
| 1,2-Dichloroethane | 0.005 |
| 1,1-Dichloroethylene | 0.007 |
| 1,1,1-Trichloroethane | 0.2 |
| Trichloroethylene | 0.005 |
| Vinyl chloride | 0.001 |

5. Apportionment of Health Limits

The reference dose for humans is the maximum daily dose of a substance that should not be exceeded to assure no adverse health effects over a lifetime of exposure. If exposure occurs by multiple routes, some tolerance level can be established for each route so that the sum of exposures by the individual routes does not exceed the reference dose.

The concept of apportionment of a chemical by medium and by route of exposure is not new. The National Research Council's Safe Drinking Water Committee, calculated a suggested no-adverse-response-level (SNARL) for chronic exposure to a non-carcinogen in drinking water, while incorporating an "arbitrary assumption" that 20 percent of the intake of the chemical was from drinking water (Ref. 20). EPA, in setting PMCLs for chemicals in drinking water, has followed the suggestion of the NRC, and selected a fraction of the RfD, usually 20 percent for synthetic organic chemicals if no empirical data suggest some other fraction is more appropriate (50 FR 46880, Nov. 13, 1985). EPA is proposing to apportion non-carcinogenic contaminants according to the scheme outlined on the following pages.

In evaluating carcinogens, the National Research Council's Safe Drinking Water Committee estimated cancer risks assuming that tap water exposure was both 1 and 20 percent of the total daily intake (Ref. 20). The Agency is however, not proposing to apportion the RSD for carcinogens. For such substances, the RSD is estimated by a procedure which introduces unavoidable uncertainties. The procedure used is deliberately conservative, so that a difference in dose of a factor of two is still well within the margin of uncertainty of the estimated RSD.

Moreover, for carcinogens, the determination of risk is the daily dose averaged over a lifetime. Small variations around the daily dose have little effect on the lifetime risk, providing that the average is not affected. For this reason, a two-fold reduction in the RSD is relatively insignificant. For non-carcinogens, it is possible that not applying a 50 percent reduction (the indirect effect of which is to permit an approximate doubling of the RfD), may cause the level to be exceeded on some or even many days of exposure. Exceeding the level for non-carcinogens may therefore have significant health consequences for some individuals. Thus, there is justification for treating non-carcinogens differently from carcinogens with respect to apportionment.

In the process to developing drinking water standards, EPA considers the contribution from other sources of exposure, such as air and food. When sufficient data are available, the PMCL is determined by subtracting the known contribution of the constituent in food and air from the RfD. Such data is often not available. In these cases, the amount permitted in drinking water is calculated by an estimation of the percentage of exposure attributable to the exposure route of concern. In the absence of adequate exposure data, apportionment is established at 20 percent for synthetic organic chemicals. For inorganic chemicals, an adequate data base generally exists. The actual contribution from other sources can be factored into the PMCL. Where actual data is sparse, however, a 10 percent contribution is estimated for inorganics in drinking water, since sources other than drinking water are more likely carriers for inorganics.

Apportionment has also been used in the risk evaluation procedure developed for EPA's Office of Emergency and Remedial Response to evaluate and manage the risks for specific remedial action sites under the CERCLA (Superfund) law. In this procedure, concentrations are generally apportioned equally in environmental media (e.g., air and water), as an initial basis for calculating a rate of release. If there are significant cost and feasibility differences in controlling exposures via the different pathways, unequal apportionment is selected. This option is appropriate under the CERCLA statute since cost-effectiveness is an integral part of the decision-making process (Ref. 5).

Many of the chemicals EPA regulates are ubiquitous in the environment and may be associated with exposures from other media (e.g., water, food, air). Although available scientific and technical information as well as past decisions will be considered in reaching decisions on the apportionment of RfDs, sufficient information is not generally available on exposure to reliably quantify the proportion of the RfD that should be allotted for each chemical. When adequate exposure data does not exist, the Agency is proposing to limit population exposure to a 50% fraction of the RfD to reflect consideration of potential and actual exposure from other media.

EPA proposes to apportion reference doses according to the scheme shown in Figure A-1.

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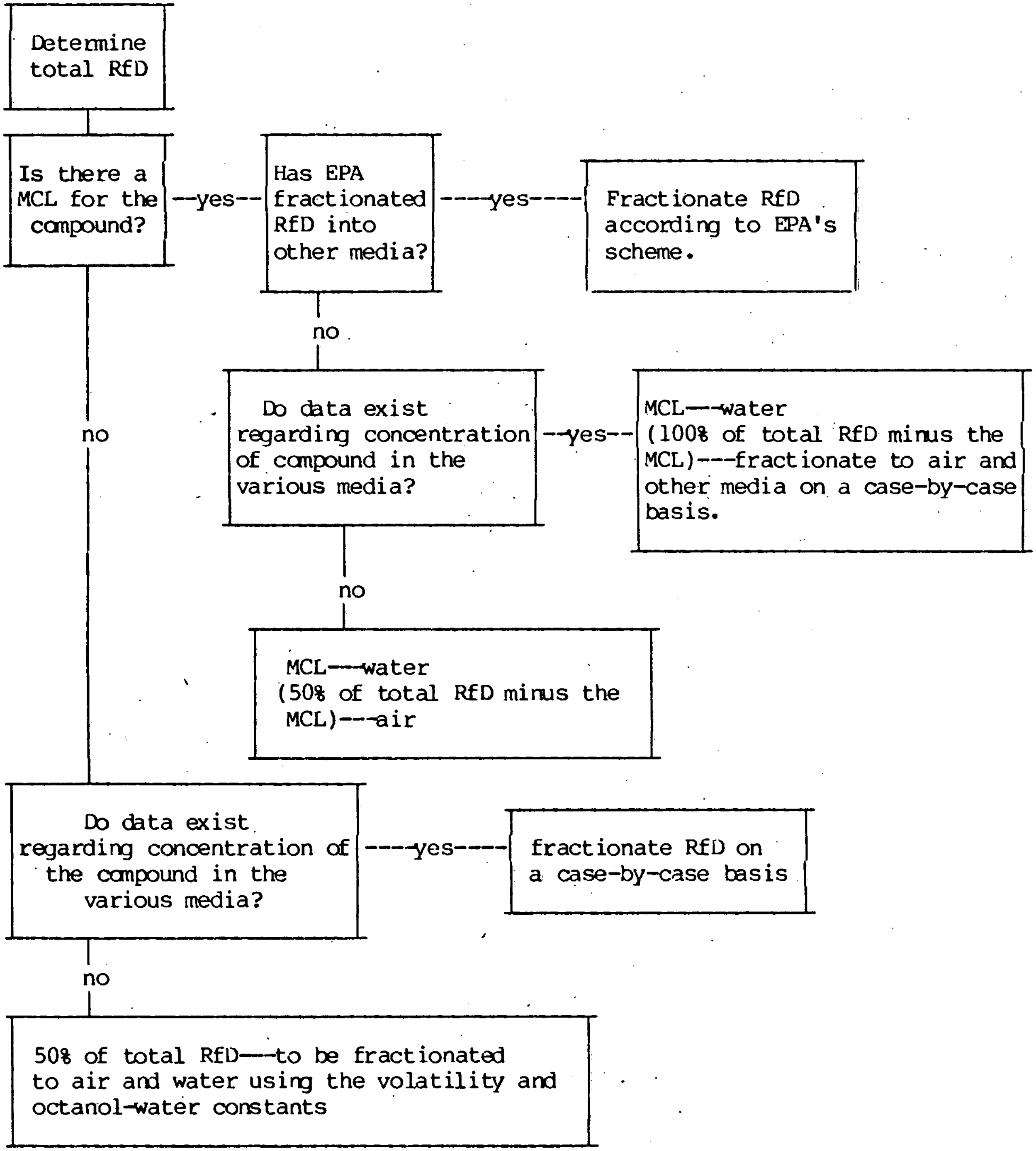
Figure A-1

Flow Chart for Apportionment of RfD



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Basically, this scheme indicates that, if the Agency has adequate data to assess exposure from various routes, then such data will be used to apportion. If on the other hand, adequate data does not exist, EPA will use 50 percent of the RfD and subtract from this 50% the fraction of the RfD allotted to water, using the remainder for air.

EPA proposes to estimate environmental partitioning to air and water according to a simplified scheme using Henry's Law Constant ($H_c$) and the octanol-water partition coefficient ($k_{ow}$) for individual contaminants. Henry's Law constant estimates the ratio of a substance between the vapor and dissolved (aqueous) state. The $k_{ow}$ estimates the distribution of a compound between water and octanol, where octanol is intended to represent an organic (lipid) component. Each distribution constant ($H_c$ and $k_{ow}$) is subdivided into two equal parts according to its range of values, as shown in Table A-4. Each contaminant to be apportioned is classified as having a high or low value according to the general size of its distribution constants, as shown in Table A-5. A relationship between $H_c$ and $k_{ow}$ and the distribution between air and water has been devised using a matrix, as shown in Table A-6.

TABLE A-4.—RANGES AND CLASSIFICATION OF HENRY'S LAW CONSTANTS ($K_H$) and Octanol-Water Partition Coefficients ($k_{ow}$)

| | | |
|---|---|---|
| $k_H$ | High in Air $>10^{-5}$ | Low in Air $<10^{-5}$. |
| $K_{ow}$ | Low in water $>500$ | High in water $<500$. |

TABLE A-5.—HENRY'S LAW CONSTANTS AND OCTANOL-WATER PARTITION COEFFICIENTS FOR NON-CARCINOGENIC CONTAMINANTS

| Contaminant | Henry's law constant (atm m³ mol) | Relative concentration in air | Octanol-water coefficient (Kow) | Relative concentration in water |
|---|---|---|---|---|
| Carbon disulfide | 1.68E-02 | High | 1.45E+02 | High. |
| Chlorobenzene | 3.46E-03 | High | 7.41E+02 | Low. |
| Cresols | 5.05E-06 | Low | 1.41E+02 | High. |
| 1,2-Dichlorobenzene | 1.88E-03 | High | 3.80E+03 | Low. |
| Isobutanol | 1.23E-05 | High | 5.50E+00 | High. |
| Methyl ethyl ketone | 2.61E-05 | High | 2.00E+00 | High. |
| Nitrobenzene | 2.40E-05 | High | 7.94E+01 | High. |
| Pentachlorophenol | 4.62E-06 | Low | 1.15E+05 | Low. |
| Phenol | 5.02E-06 | Low | 1.49E+00 | High. |
| Pyridine | 1.95E-07 | Low | 4.79E+00 | High. |
| 2,3,4,6-Tetrachlorophenol | 4.53E-06 | Low | 2.14E+04 | Low. |
| Toluene | 5.93E-03 | High | 6.61E+02 | Low. |
| 2,4,5-Trichlorophenol | 2.84E-05 | High | 7.24E+03 | Low. |

TABLE A-6.—DISTRIBUTION MATRIX BETWEEN WATER AND AIR USING $K_{ow}$ and $k_H$ Air [1]

| | Low | High |
|---|---|---|
| Water: | | |
| Low | Air:water 50:50 | Air:water 80:20. |
| High | Air:water 20:80 | Air:water 50:50. |

[1] Determined by comparing actual or computed $k_H$ and $k_{ow}$ to ranges in Table A-5.

To construct the matrix, EPA assumed that a compound with equal ranges of $k_{ow}$ and $H_c$ (i.e., high-high or low-low), will distribute between air and water into equal parts. For compounds that exhibit a high range for $H_c$ and a low range for $k_{ow}$, EPA assumes that the distribution would be in a ratio of 80 to 20, air to water. As an example, given that 50 percent of the total RfD is available for apportionment into water and air, and if Table A-5 indicates a high $H_c$ and a high $k_{ow}$, the fractionation of the total RfD is 25 percent of the total RfD into each medium. If the contaminant exhibits a low $H_c$ and a high $k_{ow}$, then 10 percent of the total RfD will distribute to air and 40 percent to water.

EPA believes that the approach outlined above is reasonable in light of the difficulty in obtaining exposure data for many compounds within the statutory time limit. The Agency solicits comments on this general approach. The Agency is also considering a simpler scheme which examines relative concentrations between water and air using Henry's Law constant only.

Table A-7 presents all 52 compounds included for toxicity, their respective health based toxicity thresholds, and the results of any apportionment.[1] The Tables in section VIII(C) contain further information used in establishing the proposed regulatory thresholds.

TABLE A-7.—SUMMARY OF CHRONIC TOXICITY REFERENCE LEVELS

| Contaminant | chronic toxicity reference level (mg/l) | Basis | Apportionment (percent) | Resulting value (mg/l) |
|---|---|---|---|---|
| Acrylonitrile | 2E-3 | RSD [1] | | 2E-3 |
| Arsenic | 0.05 | DWS [2] | | 0.05 |
| Barium | 1.0 | DWS | | 1.0 |
| Benzene | 0.005 | PMCL [3] | | 0.005 |
| Bis(2-chloroethyl) ether. | 3E-4 | RSD | | 3E-4 |
| Cadmium | 0.01 | DWS | | 0.01 |
| Carbon disulfide | 4 | RfD [4] | 25 | 1.0 |
| Carbon tetrachloride. | 0.005 | PMCL | | 0.005 |
| Chlordane | 2E-3 | RSD | | 2E-3 |
| Chlorobenzene | 1 | RfD | 10 | 0.1 |
| Chloroform | 5E-3 | RSD | | 5E-3 |
| chromium | 0.05 | DWS | | 0.05 |
| o-Cresol | 2 | RfD | 40 | 0.7 |
| m-Cresol | 2 | RfD | 40 | 0.7 |
| p-Cresol | 2 | RfD | 40 | 0.7 |
| 2,4-D | 0.1 | DWS | | 0.1 |
| 1,2-Dichlorobenzene. | 3 | RfD | 10 | 0.3 |
| 1,4-Dichlorobenzene. | 0.75 | PMCL | | 0.75 |
| 1,2-Dichloroethane | 0.005 | PMCL | | 0.005 |
| 1,1-Dichloroethylene. | 0.007 | PMCL | | 0.007 |
| 2,4-Dinitrotoluene | 1E-3 | RSD | | 1E-3 |
| Endrin | 2E-3 | DWS | | 2E-3 |
| Heptachlor | 1E-4 | RSD | | 1E-4 |
| Hexachlorobenzene | 2E-4 | RSD | | 2E-4 |
| Hexachlorobutadiene. | 5E-2 | RSD | | 5E-2 |
| Hexachloroethane | 0.003 | RSD | | 0.003 |
| Isobutanol | 10 | RfD | 25 | 2.5 |
| Lead | 0.05 | DWS | | 0.05 |
| Landane | 0.004 | DWS | | 0.004 |
| Mercury | 0.002 | DWS | | 0.002 |
| Methoxychlor | 0.1 | DWS | | 0.1 |
| Methylene chloride | 0.06 | RSD | | 0.06 |
| Methyl ethyl ketone | 2 | RfD | 25 | 0.5 |
| Nitrobenzene | 0.02 | RfD | 25 | 0.004 |
| Pentachlorophenol | 1 | RfD | 25 | 0.25 |
| Phenol | 4 | RfD | 40 | 1.6 |
| Pyridine | 0.075 | RfD | 40 | 0.03 |
| Selenium | 0.01 | DWS | | 0.01 |
| Silver | 0.05 | DWS | | 0.05 |
| 1,1,1,2-Trichloroethane. | 0.7 | RSD | | 0.7 |
| 1,1,2,2-Trichloroethane. | 2E-2 | RSD | | 2E-2 |
| Tetrachloroethylene | 7E-2 | RSD | | 7E-2 |
| 2,3,4,6-Tetrachlorophenol. | 0.4 | RfD | 25 | 0.1 |
| Toluene | 10 | RfD | 10 | 1.0 |
| Toxaphene | 0.005 | DWS | | 0.005 |
| 1,1,1-Tetrachloroethane. | 0.2 | PMCL | | 0.2 |
| 1,1,2-Tetrachloroethane. | 6E-3 | RSD | | 6E-3 |
| Trichloroethylene | 0.005 | PMCL | | 0.005 |
| 2,4,5-Trichlorophenol. | 4 | RfD | 10 | 0.4 |
| 2,4,6-Trichlorophenol. | 2E-2 | RSD | | 2E-2 |
| 2,4,5-TP (Silvex) | 0.01 | DWS | | 0.01 |
| Vinyl chloride | 0.001 | PMCL | | 0.001 |

[1] RSD=Risk Specific Dose.
[2] DWS=National Interim Primary Drinking Water Standard.
[3] PMCL=Proposed Maximum Contaminant Level.
[4] RfD=Reference Dose.

### *B. Ground Water Transport Equation*

#### 1. Introduction

Under the framework presented in this proposal, EPA will establish regulatory levels for individual chemical constituents contained in hazardous wastes. These levels are expressed as

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[1] As explained in other sections of this preamble, 11 compounds are also proposed for inclusion in the Toxicity Characteristic based on their solvent properties.

maximum acceptable concentrations for individual constituents in extracts of wastes. The extract concentration is assumed to be the same as the leachate concentration entering the ground water since the scenario assumes the bottom of the landfill lies directly over the saturated zone. EPA has developed a quantitative ground water modeling procedure to evaluate potential impacts on ground water and to establish regulatory levels for individual constituents. The proposed regulatory level-setting procedure involves a back-calculation from a point of potential exposure to a point of release from a hypothetical sanitary landfill. Specifically, the model assesses the long-term chemical flux or leaching of toxicants to the ground water from a waste disposed in a Subtitle D sanitary landfill. The beginning point of the back-calculation is a measurement point at a specified distance directly downgradiant from the disposal unit.

This procedure incorporates the toxicity, mobility, the persistence of constituents, and also the long-term uncertainties associated with land disposal.

The toxicity of constituents is considered by specifying a regulatory level at the point of measurement (i.e., drinking water well) and back-calculating to the maximum acceptable leachate concentration that will not exceed the specified standard. The mobility of constituents is considered through application of the TCLP, and for organics, through incorporation of sorption as a delay mechanism. The inclusion of sorption in the ground water transport model is important only for organic constituents which degrade.

The persistence of constituents is incorporated into the ground water model for organics by considering hydrolysis. Metals do not degrade, so no degradation is assumed. Speciation of metals in ground water is an important factor in the extent to which metals migrate. The Agency is studying the use of the MINTEQ speciation model in order to permit calculating element specific dilution/attentuation factors. The Agency has not been able to complete these studies yet, and therefore will continue to employ a standard attenuation factor of 100. Once development of the fate and transport equation approach for the elemental species is completed, element specific factors will be proposed.

The proposed ground water model accounts for most of the major physical and chemical processes known to influence movement and transformation of chemicals in simple, homogenous and isotropic porous media under steady flow conditions. The mechanisms considered include advection, hydrodynamic dispersion in the longitudinal, lateral, and vertical dimensions, adsorption, and chemical degradation. Mechanisms not considered in the model include biodegradation, effects of sinks and sources, and dilution of constituents within drinking water wells.

2. Model Assumptions

The analytical solution described below is based on a number of key assumptions pertaining to the features of ground water flow and the properties of the porous medium. These assumptions include the following:

a. Saturated soil conditions (no attenuation of chemicals in the unsaturated zone).

b. Flow regions of infinite extent in the longitudinal direction, semi-infinite extent in the lateral direction.

c. All aquifer properties are homogeneous, isotropic and of constant thickness.

d. Groundwater flow is uniform and continuous in direction and velocity.

e. First-order decay is limited to hydrolysis and the byproducts of hydrolysis are assumed to be non-hazardous.

f. Sorption behaves linearly.

g. Infinite source—supplies a constant mass flux rate.

h. Ground water recharge is accounted for.

i. The ground water is initially free of contamination.

j. The receptor well is directly in line with the source and the ground water flow.

The effect of the first assumption is to presume that a waste is placed directly at the top of the saturated zone. Since EPA has found that a significant number of hazardous waste landfills are located within a few feet of an aquifer, and since Subtitle D facilities are generally sited in similar environments, this assumption is believed to be reasonable. This worst-case assumption predicts that no attenuation occurs during the migration of constituents in leachates to the underlying aquifer.

The second assumption of infinite and semi-infinite flow regions in the longitudinal and lateral direction, respectively, is appropriate for all simplified analytical ground water flow models. (The term semi-infinite refers to the fact that once a leachate reaches an aquifer, although theoretically it can disperse in the lateral direction to an infinite degree, for all practical purposes there is a point at which further dispersion has little effect on the concentration of contaminants within a plume. Although further dispersion would still be greater than zero, its effect is insignificant.) Aquifers have finite areal extent, however, and may be confined by impermeable layers. If an aquifer is confined by an impermeable layer in the longitudinal or lateral fields, this assumption will underestimate downgradient concentrations.

The assumption of homogeneous and isotropic aquifer properties is rarely encountered in the field, but the availability of data and the generic nature of this analysis requires the use of a homogeneous and isotropic approximation. Also, this assumption is usually employed if the solution of the problem is obtained by analytical techniques.

A uniform flow velocity, the fourth assumption, presumes that the water volume entering from the source is not large enough to affect the natural ground water gradient. This assumption is appropriate for simplified analytical solutions. In situations where the ground water flow system contains sinks or sources (e.g., pumping or injection wells), drastic changes in the velocity distribution will occur. Under this situation that steady-state down gradient contaminant concentrations may be underestimated.

Hydrolysis of first-order kinetics, the fifth assumption, is the only mechanism for transformation considered in the proposed model. While other transformation mechanisms, such as biodegradation and oxidation are also important, the Agency's present understanding of these mechanisms does not yet permit a kinetic representation of these processes within the system modeled. The effects, relative importance, and interactions of these processes in the ground water environment are not well understood and are under investigation.

In general, all transformations are dependent upon both the chemical constituent and the prevailing environmental properties. For hydrolysis, ground water pH and temperature must be known. The Agency's analysis to date has identified more than 20,000 measurements for pH and temperature from which distribution functions can be assigned for purposes of evaluating variation and uncertainty. Similar data describing microbial populations, metabolizable carbon sources, etc., are not generally available. The Agency believes that given this limited understanding of the factors influencing biodegradation and oxidation in the ground water environment, prudence dictates that these processes not be included in the model. By including only hydrolysis in the model, the Agency is being conservative.

The seventh assumption of an infinite source represents a worst case. To ensure that waste disposal is protective of human health and the environment in all possible situations (which do not address the total amount of waste disposed), the Agency believes it is prudent to adopt this conservative assumption.

The assumption of dilution of the contaminant plume by ground water recharge accounts for a process known to occur in the environment. Ground water recharge leads to further dilution of the contaminant plume as it moves downgradient from the facility. EPA recognizes that it is difficult to develop precise estimates of ground water recharge for incorporation into a generic mode. Data is available, however, from which rough estimates can be developed.

The assumption of placement of a well in the exact position to receive the highest concentration of a contaminant represents an absolute worst case. The Agency believes this assumption is appropriate for use in the model since it is possible that some drinking water wells are directly in line with Subtitle D land disposal units.

### 3. Cumulative Frequency Distribution

Through use of a Monte Carlo computer simulation, the ground water transport equation results in a cumulative frequency distribution. The cumulative frequency distribution provides estimates of the likelihood or probability that the target concentration level (e.g., reference dose), would not be exceeded, given the range and distribution of the values that may be expected for each of the various environmental parameters known to affect such concentrations. For the purposes of this regulation, EPA is proposing to use the 85th cumulative percentile. EPA believes that using the 85th percentile will provide a reasonable balance between the need to identify the majority of truly hazardous waste as hazardous, while at the same time minimizing the false identification of non-hazardous waste as hazardous. Note, however, that EPA is considering the use of both the 80th and the 90th percentile for this regulation. For non-degrading compounds, the 80th and 90th percentiles produce dilution/attenuation factors of 22 and 10, respectively.

The regulatory levels being proposed today are based on the 85th cumulative frequency percentile. As indicated previously, this does not necessarily mean that EPA is unconcerned about wastes which may exceed levels based on some higher percentile (e.g., 90 percent). Specific wastes which the Agency finds not to be hazardous using the regulatory levels based on the 85th percentile, but which could exceed thresholds based on some higher percentile, and which are determined to pose a hazard to ground water, may be specifically listed by the Agency as hazardous wastes under §§ 261.31 or 261.32.

### 4. Further Information

The Agency has proposed to use the same basic ground water transport equation and health effects thresholds for use in the Land Disposal Restrictions Rule (51 FR 1603), proposed on January 14, 1986. Differences in the equations have been introduced for the proposed Land Disposal Restrictions Rule, to account for the additional engineering controls required (e.g., landfill caps), when managing wastes as hazardous in a Subtitle C hazardous waste facility, and the higher standards of confidence required under the HSWA for determining that a waste is suitable for land disposal.

While this proposal outlines the equation's proposed use in the Toxicity Characteristic, considerably more detail concerning this equation is provided in the preamble section to the proposed Land Disposal Restrictions Rule. The reader is referred to that preamble, and the reference noted therein, for further information on the equation and the data used in running it. The computer printouts obtained as a result of running the equation on the compounds will be included in the Toxicity Characteristic docket.

## *C. Tables of Proposed Contaminants and Data Used to Develop Regulatory Levels*

TABLE C-1.—TOXICITY CHARACTERISTIC CONTAMINANTS AND LEVELS

| HWNO[1] and contaminant | Casno[2] | Regulatory level (mg/1) |
|---|---|---|
| D018—Acrylonitrile | 107-13-1 | 5.0 |
| D004—Arsenic | 7440-38-2 | 5.0 |
| D005—Barium | 7440-39-3 | 100 |
| D019—Benzene | 71-43-2 | 0.07 |
| D020—Bis(2-chloroethyl)ether | 111-44-4 | 0.05 |
| D006—Cadmium | 7440-43-9 | 1.0 |
| D021—Carbon disulfide | 75-15-0 | 14.4 |
| D022—Carbon tetrachloride | 56-23-5 | 0.07 |
| D023—Chlordane | 57-74-9 | 0.03 |
| D024—Chlorobenzene | 108-90-7 | 1.4 |
| D025—Chloroform | 67-66-3 | 0.07 |
| D007—Chromium | 1333-82-0 | 5.0 |
| D026—o-Cresol | 95-48-7 | 10.0 |
| D027—m-Cresol | 108-39-4 | 10.0 |
| D028—p-Cresol | 106-44-5 | 10.0 |
| D016—2,4-D | 94-75-7 | 1.4 |
| D029—1,2-Dichlorobenzene | 95-50-1 | 4.3 |
| D030—1,4-Dichlorobenzene | 106-46-7 | 10.8 |
| D031—1,2-Dichloroethane | 107-06-2 | 0.40 |
| D032—1,1-Dichloroethylene | 75-35-4 | 0.1 |
| D033—2,4-Dinitrotoluene | 121-14-2 | 0.13 |
| D012—Endrin | 72-20-8 | 0.003 |
| D034—Heptachlor (and hydroxide) | 76-44-8 | 0.001 |
| D035—Hexachlorobenzene | 118-74-1 | 0.13 |
| D036—Hexachlorobutadiene | 87-68-3 | 0.72 |
| D037—Hexachloroethane | 67-72-1 | 4.3 |
| D038—Isobutanol | 78-83-1 | 25 |
| D008—Lead | 7439-92-1 | 5.0 |
| D013—Lindane | 58-89-9 | 0.06 |
| D009—Mercury | 7439-97-6 | 0.2 |
| D014—Methoxychlor | 72-43-5 | 1.4 |
| D039—Methylene chloride | 75-09-2 | 8.6 |
| D040—Methyl ethyl ketone | 78-93-3 | 7.2 |
| D041—Nitrobenzene | 98-95-3 | 0.13 |
| D042—Pentachlorophenol | 87-86-5 | 3.6 |
| D043—Phenol | 108-95-2 | 14.4 |
| D044—Pyridine | 110-86-1 | 5.0 |
| D010—Selenium | 7782-49-2 | 1.0 |
| D011—Silver | 7440-22-4 | 5.0 |
| D045—1,1,1,2-Tetrachloroethane | 630-20-6 | 10.0 |
| D046—1,1,2,2-Tetrachloroethane | 79-34-5 | 1.3 |
| D047—Tetrachloroethylene | 127-18-4 | 0.1 |
| D048—2,3,4,6-Tetrachlorophenol | 58-90-2 | 1.5 |
| D049—Toluene | 108-88-3 | 14.4 |
| D015—Toxaphene | 8001-35-2 | 0.07 |
| D050—1,1,1,-Trichloroethane | 71-55-6 | 25 |
| D051—1,1,2-Trichloroethane | 79-00-5 | 1.2 |
| D052—Trichloroethylene | 79-01-6 | 0.07 |
| D053—2,4,5-Trichlorophenol | 95-95-4 | 5.8 |
| D054—2,4,6-Trichlorophenol | 88-06-2 | 0.30 |
| D017—2,4,5-TP (Silvex) | 93-76-5 | 0.14 |
| D055—Vinyl chloride | 75-01-4 | 0.05 |

[1] Hazardous Waste Identification Number.
[2] Chemical Abstracts Registry Number.

TABLE C-2.—METHODS AND QUANTITATION LIMITS FOR TOXICITY CHARACTERISTIC CONTAMINANTS

| Contaminant | Vol.[1] | SW-846 methods[2] | Detection limit (mg/1)[3] | Quantitation limit (mg/1)[4] |
|---|---|---|---|---|
| Acrylonitrile | V | 5030/8240 | 1.0 | 5.0 |
| Arsenic | | 7060, 7061 | 0.005 | 0.025 |
| Barium | | 6010, 7080, 7081 | 0.01 | 0.05 |
| Benzene | V | 5030/8240 | 0.01 | 0.05 |
| Bis(2-chloroethyl)ether | | 3510/8270 | 0.01 | 0.05 |
| Cadmium | | 6010, 7130, 7131 | 0.01 | 0.05 |
| Carbon disulfide | V | 5030/8240 | 1.0 | 5.0 |
| Carbon tetrachloride | V | 5030/8240 | 0.01 | 0.05 |
| Chlordane | | 8080 | 0.0005 | 0.0025 |

TABLE C-2.—METHODS AND QUANTITATION LIMITS FOR TOXICITY CHARACTERISTIC CONTAMINANTS—Continued

| Contaminant | Vol.[1] | SW-846 methods [2] | Detection limit (mg/1) [3] | Quantitation limit (mg/1) [4] |
|---|---|---|---|---|
| Chlorobenzene | V | 5030/8240 | 0.01 | 0.05 |
| Chloroform | V | 5030/8240 | 0.01 | 0.05 |
| Chromium | | 6010, 7190, 7191 | 0.02 | 0.10 |
| o-Cresol | | 3510/8270 | 0.10 | 0.50 |
| M-Cresol | | 3510/8270 | 0.10 | 0.50 |
| P-Cresol | | 3510/8270 | 0.10 | 0.50 |
| 2,4-D | | 8150 | 0.005 | 0.025 |
| 1,2-Dichlorobenzene | | 3510/8270 | 0.025 | 0.125 |
| 1,4-Dichlorobenzene | | 3510/8270 | 0.025 | 0.125 |
| 1,2-Dichloroethane | V | 5030/8240 | 0.01 | 0.05 |
| 1,1-Dichloroethylene | V | 5030/8240 | 0.01 | 0.05 |
| 2,4-Dinitrotoluene | | 3510/8270 | 0.025 | 0.125 |
| Endrin | | 8080 | 0.0001 | 0.0005 |
| Heptachlor (and its hydroxide) | | 8080 | 0.0001 | 0.0005 |
| Hexachlorobenzene | | 3510/8270 | 0.025 | 0.125 |
| Hexachlorobutadiene | | 3510/8270 | 0.025 | 0.125 |
| Hexachloroethane | | 3510/8270 | 0.025 | 0.125 |
| Isobutanol | V | 5030/8240 | 1.0 | 5.0 |
| Lead | | 6010, 7420, 7421 | 0.08 | 0.40 |
| Lindane | | 8080 | 0.0001 | 0.0005 |
| Mercury | | 7470, 7471 | 0.0004 | 0.002 |
| Methoxychlor | | 8080 | 0.0005 | 0.0025 |
| Methylene chloride | V | 5030/8240 | 0.025 | 0.125 |
| Methyl ethyl ketone | V | 5030/8240 | 0.01 | 0.05 |
| Nitrobenzene | | 3510/8270 | 0.025 | 0.125 |
| Pentachlorophenol | | 3510/8270 | 0.01 | 0.05 |
| Phenol | | 3510/8270 | 0.025 | 0.125 |
| Pyridine | | 3510/8270 | 1.0 | 5.0 |
| Selenium | | 6010, 7740, 7741 | 0.01 | 0.05 |
| Silver | | 6010, 7760, 7761 | 0.01 | 0.05 |
| 1,1,1,2-Tetrachloroethane | V | 5030/8240 | 0.01 | 0.05 |
| 1,1,2,2-Tetrachloroethane | V | 5030/8240 | 0.01 | 0.05 |
| Tetrachloroethylene | V | 5030/8240 | 0.01 | 0.05 |
| 2,3,4,6-Tetrachlorophenol | | 3510/8270 | 0.10 | 0.50 |
| Toluene | V | 5030/8240 | 0.01 | 0.05 |
| Toxaphene | | 8080 | 0.005 | 0.025 |
| 1,1,1-Trichloroethane | V | 5030/8240 | 0.01 | 0.05 |
| 1,1,2-Trichloroethane | V | 5030/8240 | 0.01 | 0.05 |
| Trichloroethylene | V | 5030/8240 | 0.01 | 0.05 |
| 2,4,5-Trichlorophenol | | 3510/8270 | 0.05 | 0.25 |
| 2,4,6-Trichlorophenol | | 3510/8270 | 0.05 | 0.25 |
| 2,4,5-TP (Silvex) | | 8150 | 0.005 | 0.025 |
| Vinyl chloride | V | 5030/8240 | 0.01 | 0.05 |

[1] The "V" indicates the compound to be volatile and requires the use of the Zero-Headspace Extractor.

[2] Test Methods for Evaluating Solid Waste—Physical/Chemical Methods WS-846. Second Edition, U.S. Environmental Protection Agency, July 1982. Methods for phenolic compounds being evaluated.

[3] Detection limits in TCLP extract. Detection limits are approximate.

[4] Quantitation limits are assumed to be 5 times the detection limit.

TABLE C-3.—CHRONIC TOXICITY REFERENCE LEVELS FOR TOXICITY CHARACTERISTIC CONTAMINANTS

| Contaminant | Chronic toxicity reference level (mg/l)[1] | LOG Kow [2] | Kh(atm m³/mol)[3] | Apportionment (percent)[4] | Apportioned reference level (mg/l)[5] |
|---|---|---|---|---|---|
| Acrylonitrile | 0.002(RSD) | | | | 0.002 |
| Arsenic | 0.05(DWS) | | | | 0.05 |
| Barium | 1.0(DWS) | | | | 1.0 |
| Benzene | 0.005(PMCL) | | | | 0.005 |
| Bis(2-chloroethyl)ether | 0.0003(RSD) | | | | 0.0003 |
| Cadmium | 0.01(DWS) | | | | 0.01 |
| Carbon disulfide | 4(RfD) | 2.16 | 1.68E-2 | 25 | 1.0 |
| Carbon tetrachloride | 0.005(PMCL) | | | | 0.005 |
| Chlordane | 0.002(RSD) | | | | 0.002 |
| Chlorobenzene | 1(RfD) | 2.87 | 3.46E-3 | 10 | 0.1 |
| Chloroform | 0.005(RSD) | | | | 0.005 |
| Chromium | 0.05(DWS) | | | | 0.05 |
| o-Cresol | 2(RfD) | 2.15 | 5.05E-6 | 40 | 0.7 |
| m-Cresol | 2(RfD) | 2.15 | 5.05E-6 | 40 | 0.7 |
| p-Cresol | 2(RfD) | 2.15 | 5.05E-6 | 40 | 0.7 |
| 2,4-D | 0.1(DWS) | | | | 0.1 |
| 1,2-Dichlorobenzene | 3(RfD) | 3.56 | 1.88E-3 | 10 | 0.3 |
| 1,4-Dichlorobenzene | 0.75(PMCL) | | | | 0.75 |
| 1,2-Dichloroethane | 0.005(PMCL) | | | | 0.005 |
| 1,1-Dichloroethylene | 0.007(PMCL) | | | | 0.007 |
| 2,4-Dinitrotoluene | 0.001(RSD) | | | | 0.001 |
| Endrin | 0.0002(DWS) | | | | 0.0002 |
| Heptachlor (and hydroxide) | 0.0001(RSD) | | | | 0.0001 |
| Hexachlorobenzene | 0.0002(RSD) | | | | 0.0002 |
| Hexachlorobutadiene | 0.05(RSD) | | | | 0.05 |
| Hexachloroethane | 0.3(RSD) | | | | 0.3 |
| Isobutanol | 10(RfD) | 0.74 | 1.23E-5 | 25 | 2.5 |
| Lead | 0.05(DWS) | | | | 0.05 |
| Lindane | 0.004(DWS) | | | | 0.004 |
| Mercury | 0.002(DWS) | | | | 0.002 |
| Methoxychlor | 0.10(DWS) | | | | 0.1 |
| Methylene chloride | 0.6(RSD) | | | | 0.6 |
| Methyl ethyl ketone | 2(RfD) | 0.3 | 2.61E-5 | 25 | 0.5 |
| Nitrobenzene | 0.02(RfD) | 1.90 | 2.40E-5 | 25 | 0.004 |

TABLE C-3.—CHRONIC TOXICITY REFERENCE LEVELS FOR TOXICITY CHARACTERISTIC CONTAMINANTS—Continued

| Contaminant | Chronic toxicity reference level (mg/l)[1] | LOG Kow[2] | Kh(atm $m^3$/mol)[3] | Apportionment (percent)[4] | Apportioned reference level (mg/l)[5] |
|---|---|---|---|---|---|
| Pentachlorophenol | 1(RfD) | 5.06 | 4.62E-6 | 25 | 0.25 |
| Phenol | 4(RfD) | 1.49 | 4.5E-6 | 40 | 1.0 |
| Pyridine | 0.075(RfD) | 0.68 | 1.95E-7 | 40 | 0.03 |
| Selenium | 0.01(DWS) | | | | 0.01 |
| Silver | 0.05(DWS) | | | | 0.05 |
| 1,1,1,2-Tetrachloroethane | 0.7(RSD) | | | | 0.7 |
| 1,1,2,2-Tetrachloroethane | 0.02(RSD) | | | | 0.02 |
| Tetrachloroethylene | 0.007(RSD) | | | | 0.007 |
| 2,3,4,6-Tetrachlorophenol | 0.4(RfD) | 4.33 | 4.53E-6 | 25 | 0.1 |
| Toluene | 10(RfD) | 2.82 | 5.93E-3 | 10 | 1.0 |
| Toxaphene | 0.005(DWS) | | | | 0.005 |
| 1,1,1-Trichloroethane | 0.2(PMCL) | | | | 0.2 |
| 1,1,2-Trichloroethane | 0.06(RSD) | | | | 0.06 |
| Trichloroethylene | 0.005(PMCL) | | | | 0.005 |
| 2,4,5-Trichlorophenol | 4(RfD) | 3.86 | 2.84E-5 | 10 | 0.4 |
| 2,4,6-Trichlorophenol | 0.02(RSD) | | | | 0.02 |
| 2,4,5-TP (Silvex) | 0.01(DWS) | | | | 0.01 |
| Vinyl chloride | 0.001(PMCL) | | | | 0.001 |

[1] DWS = National Interim Primary Drinking Standard.
PMCL = Proposed Maximum Contaminant Level (Proposed standard in drinking water).
RfD = Reference Dose (non-carcinogen).
RsD = Risk Specific Dose (carcinogen).

[2] LOG Octanol Water Partition Coefficient.

[3] Honry's Law Constant.

[4] RfD's are the only Chronic Toxicity Reference Levels which are apportioned (See Section VIII(A)).

[5] Value by which Dilution/Attenuation factor is multiplied (See Tables C-4 and C-5).

TABLE C-4.—DILUTION/ATTENUATION FACTOR FOR TOXICITY CHARACTERISTIC CONTAMINANTS

| | LOG Kow[1] | Hydrolysis rate constants | | | D/A factor[3] |
|---|---|---|---|---|---|
| | | Ka[2] | Kb[2] | Kn[2] | |
| Contaminant: | | | | | |
| Acrylonitrile | 0.07 | >1/Yr | >1/Yr | >1/Yr | 14.4 |
| Arsenic | | | | | 100.0 |
| Barium | | | | | 100.0 |
| Benzene | 2.13 | NHYF[4] | NHYF | NHYF | 14.4 |
| Bis(2-chloroethyl)ether | 1.04 | NH[5] | NH | 8E-5/Hr | 14.4 |
| Cadmium | | | | | 100.0 |
| Carbon disulfide | 2.16 | NH | >10/Yr | NH | 14.4 |
| Carbon tetrachloride | 2.96 | NH | NH | NH | 14.4 |
| Chlordane | [7] 5.48 | NH | >10/Yr | NH | 14.4 |
| Chlorobenzene | 2.87 | NH | 1E-6/Hr | NH | 14.4 |
| Chloroform | 1.96 | NH | 0.23/Hr | 3E-9/Hr | 14.4 |
| Chromium | | | | | 100.0 |
| o-Cresol | 2.15 | NHYF | NHYF | NHYF | 14.4 |
| m-Cresol | 2.15 | NHYF | NHYF | NHYF | 14.4 |
| p-Cresol | 2.15 | NHYF | NHYF | NHYF | 14.4 |
| 2,4-D | 2.70 | NHYF | NHYF | NHYF | 14.4 |
| 1,2-Dichlorobenzene | 3.56 | NH | 1E-5/Hr | NH | 14.4 |
| 1,4-Dichlorobenzene | 3.56 | NLFG[6] | NLFG | NLFG | 14.4 |
| 1,2-Dichloroethane | 1.40 | NH | NH | 7.2E-5/Hr | 75.0 |
| 1,1-Dichloroethylene | 2.13 | NLFG | NLFG | NLFG | 14.4 |
| 2,4-Dinitrotoluene | 2.30 | NLFG | NLFG | NLFG | 14.4 |
| Endrin | [7] 3.54 | >1/Yr | >1/Yr | >1/Yr | 14.4 |
| Heptachlor (and its hydroxide) | [7] 4.61 | NLFG | NLFG | NLFG | 14.4 |
| Hexachlorobenzene | 6.42 | <1/Yr | <1/Yr | <1/Yr | 14.4 |
| Hexachlorobutadiene | 4.24 | NLFG | NLFG | NLFG | 14.4 |
| Hexachloroethane | 4.22 | >1/Yr | >1/Yr | >1/Yr | 14.4 |
| Isobutanol | 0.74 | >1/Yr | >1/Yr | >1/Yr | 14.4 |
| Lead | | | | | 100.0 |
| Lindane | 3.40 | >1/Yr | >1/Yr | >1/Yr | 14.4 |
| Mercury | | | | | 100.0 |
| Methoxychlor | [7] 4.30 | NH | 1.4/Hr | 7.5E-5/Hr | 14.4 |
| Methylene chloride | 1.26 | NH | NH | 1.18E-8/Hr | 14.4 |
| Methyl ethyl ketone | 0.3 | NLFG | NLFG | NLFG | 14.4 |
| Nitrobenzene | 1.90 | NLFG | NLFG | NLFG | 14.4 |
| Pentachlorophenol | 5.06 | NH | >1E-4/Hr | NH | 14.4 |
| Phenol | 1.49 | NHYF | NHYF | NHYF | 14.4 |
| Pyridine | 0.88 | NLFG | NLFG | NLFG | 14.4 |
| Selenium | | | | | 100.0 |
| Silver | | | | | 100.0 |
| 1,1,1,2-Tetrachloroethane | 2.81 | NH | 1.3/Hr | 2.2E-7/Hr | 14.4 |
| 1,1,2,2-Tetrachloroethane | 2.42 | NH | 2.6E+3/Hr | NH | 65.0 |
| Tetrachloroethylene | 3.03 | NLFG | NLFG | NLFG | 14.4 |
| 2,3,4,6-Tetrachlorophenol | 4.33 | NH | 1E-5/Hr | NH | 14.4 |
| Toluene | 2.82 | NHYF | NHYF | NHYF | 14.4 |
| Toxaphene | [7] 5.30 | NH | >10/Yr | NH | 14.4 |
| 1,1,1-Trichloroethane | 2.50 | NH | NH | 1.1E-4/Hr | 150.0 |
| 1,1,2-Trichloroethane | 1.91 | NH | 13/Hr | 4.3E-7/Hr | 20.0 |
| Trichloroethylene | 2.28 | NLFG | NLFG | NLFG | 14.4 |
| 2,4,5-Trichlorophenol | 3.86 | NH | 1E-5/Hr | NH | 14.4 |
| 2,4,6-Trichlorophenol | 3.58 | NH | 1E-5/Hr | NH | 14.4 |
| 2,4,5-TP (Silvex) | 3.45 | NLFG | NLFG | NLFG | 14.4 |
| Vinyl chloride | 1.38 | NH | 1E-5/Hr | 1E-7/Hr | 14.4 |

[1] LOG Octanol Water Partition Coefficient.

[2] Acid base and neutral hydrolysis rate constants.

[3] Dilution/Attenuation Factor derived from ground water transport equation.

[4] NHYF = No Hydrolyzable Functional Group.

[5] NH = Negligible Hydrolysis.

[6] NLFG = No Liable Functional Group.

[7] Estimated value.

TABLE C-5.—REGULATORY LEVELS FOR TOXICITY CHARACTERISTIC CONTAMINANTS

| | Apportioned chronic toxicity reference level (mg/1)[1] | D/A factor[2] | Calculated level (mg/1)[3] | Quantitation limit (mg/1)[4] | Regulatory level (mg/1)[5] |
|---|---|---|---|---|---|
| Contaminant: | | | | | |
| Acrylonitrile | 0.002 | 14.4 | 0.029 | 5.0 | (5.0) |
| Arsenic | 0.05 | 100.0 | 5.0 | 0.025 | 5.0 |
| Barium | 1.0 | 100.0 | 100 | 0.05 | 100 |
| Benzene | 0.005 | 14.4 | 0.072 | 0.05 | 0.07 |
| Bis(2-chloroethyl)ether | 0.0003 | 14.4 | 0.004 | 0.05 | (0.05) |
| Cadmium | 0.01 | 100.0 | 1.0 | 0.05 | 1.0 |
| Carbon disulfide | 1.0 | 14.4 | 14.4 | 5.0 | 14.4 |
| Carbon tetrachloride | 0.005 | 14.4 | 0.072 | 0.05 | 0.07 |
| Chlordane | 0.002 | 14.4 | 0.029 | 0.0025 | 0.03 |
| Chlorobenzene | 0.1 | 14.4 | 1.44 | 0.05 | 1.4 |
| Chloroform | 0.005 | 14.4 | 0.072 | 0.05 | 0.07 |
| Chromium | 0.05 | 100.0 | 5.0 | 0.1 | 5.0 |
| o-Cresol | 0.7 | 14.4 | 10.08 | 0.5 | 10.0 |
| m-Cresol | 0.7 | 14.4 | 10.08 | 0.5 | 10.0 |
| p-Cresol | 0.7 | 14.4 | 10.08 | 0.5 | 10.0 |
| 2,4-D | 0.1 | 14.4 | 1.44 | 0.025 | 1.4 |
| 1,2-Dichlorobenzene | 0.3 | 14.4 | 4.32 | 0.125 | 4.3 |
| 1,4-Dichlorobenzene | 0.75 | 14.4 | 10.8 | 0.125 | 10.8 |
| 1,2-Dichloroethane | 0.005 | 75.0 | 0.40 | 0.05 | 0.40 |
| 1,1-Dichloroethylene | 0.007 | 14.4 | 0.1008 | 0.05 | 0.1 |
| 2,4-Dinitrotoluene | 0.001 | 14.4 | 0.0144 | 0.125 | (0.13) |
| Endrin | 0.0002 | 14.4 | 0.0029 | 0.0005 | 0.003 |
| Heptachlor (and hydroxide) | 0.0001 | 14.4 | 0.0014 | 0.0005 | 0.001 |
| Hexachlorobenzene | 0.0002 | 14.4 | 0.0029 | 0.125 | (0.13) |
| Hexachlorobutadiene | 0.05 | 14.4 | 0.72 | 0.125 | 0.72 |
| Hexachloroethane | 0.3 | 14.4 | 4.32 | 0.125 | 4.3 |
| Isobutanol | 2.5 | 14.4 | 36 | 5.0 | 36 |
| Lead | 0.05 | 100.0 | 5.0 | 0.4 | 5.0 |
| Lindane | 0.004 | 14.4 | 0.0576 | 0.0005 | 0.06 |
| Mercury | 0.002 | 100.0 | 0.2 | 0.002 | 0.2 |
| Methoxychlor | 0.1 | 14.4 | 1.44 | 0.0025 | 1.4 |
| Methylene chloride | 0.6 | 14.4 | 8.64 | 0.125 | 8.8 |
| Methyl ethyl ketone | 0.5 | 14.4 | 7.2 | 0.05 | 7.26 |
| Nitrobenzene | 0.004 | 14.4 | 0.0576 | 0.125 | (0.13) |
| Pentachlorophenol | 0.25 | 14.4 | 3.6 | 0.05 | 3.6 |
| Phenol | 1.0 | 14.4 | 14.4 | 0.125 | 14.4 |
| Pyridine | 0.03 | 14.4 | 0.432 | 5.0 | (5.0) |
| Selenium | 0.01 | 100.0 | 1.0 | 0.05 | 1.0 |
| Silver | 0.05 | 100.0 | 5.0 | 0.05 | 5.0 |
| 1,1,1,2-Tetrachloroethane | 0.7 | 14.4 | 10.08 | 0.05 | 10.0 |
| 1,1,2,2-Tetrachloroethane | 0.02 | 65.0 | 1.3 | 0.05 | 1.3 |
| Tetrachloroethylene | 0.007 | 14.4 | 0.1008 | 0.05 | 0.1 |
| 2,3,4,6-Tetrachlorophenol | 0.10 | 14.4 | 1.44 | 0.5 | 1.5 |
| Toluene | 1.0 | 14.4 | 14.4 | 0.05 | 14.4 |
| Toxaphene | 0.005 | 14.4 | 0.072 | 0.025 | 0.07 |
| 1,1,1-Trichloroethane | 0.2 | 150.0 | 30 | 0.05 | 30 |
| 1,1,2-Trichloroethane | 0.06 | 20.0 | 1.2 | 0.05 | 1.2 |
| Trichloroethylene | 0.005 | 14.4 | 0.072 | 0.05 | 0.07 |
| 2,4,5-Trichlorophenol | 0.4 | 14.4 | 5.76 | 0.25 | 5.8 |
| 2,4,6-Trichlorophenol | 0.02 | 14.4 | 0.288 | 0.25 | 0.3 |
| 2,4,5-TP (Silvex) | 0.01 | 14.4 | 0.144 | 0.025 | 0.14 |
| Vinyl chloride | 0.001 | 14.4 | 0.0144 | 0.05 | (0.05) |

[1] See Table C-3.

[2] See Table C-4.

[3] Apportioned Chronic Toxicity Reference Level multiplied by Dilution/Attenuation Factor.

[4] See Table C-2.

[5] If the quantitation limit is greater than the calculated level, the quantitation limit becomes the (technology based) regulatory level (indicated by level in parenthesis).

### *D. Development and Evaluation of the TCLP*

#### 1. Introduction

This Section provides detailed information on how the TCLP was developed and evaluated. Still more detailed information regarding the TCLP is available in a Background Document that EPA has prepared for the TCLP (Ref. 33).

#### 2. Experimental Design

EPA, through an interagency agreement with the U.S. Department of Energy's Oak Ridge National Laboratory (ORNL), has conducted a research program designed to develop an improved leaching test, the TCLP. The TCLP development program was split up into three phases. Phases I and II, and part of Phase III have been completed. Phase I consisted of an initial data gathering effort in which a number of wastes were leached with a leachate derived from municipal refuse. The wastes were also extracted with a variety of laboratory leaching media and contact procedures. Phase I was designed to narrow the universe of potential candidate leaching procedures. In Phase II, additional wastes were leached and the candidate procedures refined into the draft TCLP. During this phase of testing, public assistance and review of the draft was solicited.

The overall approach employed in Phase I was as follows:

a. Large-scale field lysimeters were filled with domestic and commercial refuse and used to generate a municipal waste leachate (MWL).

b. The MWL was used to leach four industrial solid wastes in large columns.

c. The leachate concentration of a number of organic and inorganic species that were present in each waste were measured over time.

d. A total of 34 laboratory leaching tests were run on the four wastes to assess their accuracy in modeling the results of the lysimeter/column experiments. These tests included both column and batch procedures using four leaching media (i.e, sodium acetate buffer, carbonic acid, water, and actual municipal waste leachate), and four media to waste ratios (i.e., 2.5, 5, 10, and 20 to 1). In addition, the EP and a sequential batch leaching procedure were also investigated.

e. Target Concentrations (TCs), were established for each constituent based on the lysimeter/column leaching curves, by calculating the amount of constituent leached over a specific leaching interval (i.e., an amount of leachate equal to twenty times the weight of the original industrial solid waste—twenty to one liquid to solid ratio).

f. Laboratory leaching test results were compared to the TCs, and the two laboratory tests that best replicated lysimeter results were selected for further evaluation in Phase II.

Phase II of the program involved extensive evaluation and verification of Phase I:

a. Seven wastes were leached in essentially the same experimental arrangement as used in Phase I.

b. Each waste was subjected to the two "best" leaching procedures selected from Phase I, as well as the EP.

c. The single procedure which best satisfied the objectives presented in the body of this preamble was selected as the draft TCLP.

d. the draft TCLP was then circulated to interested members of industry, academia, environmental groups, and other with interest and experience conducting such tests, for comment.

Phase III of the program involved subjecting the draft TCLP to an evaluation of ruggedness and precision. This work has been partially completed and the design and results to date are summarized further in this Section. Another part of Phase III which is currently ongoing is a multi-laboratory collaborative evaluation of the draft TCLP. (The TCLP has evolved to its present form in response to both Agency activities as well as to comments received on the circulated drafts.) The following sections present the experimental program and the results.

### 3. Results of Phase I

The ORNL Phase I report explains in detail the experimental approach and describes the results obtained during the first phase of testing (Ref. 6). Briefly, lysimeter leachate target concentrations were established based on both practical considerations and the need to represent a mid-to-long term leaching interval or exposure period. This was important as the purpose of the leaching test is primarily to evaluate the migratory potential of chronically toxic organic compounds (Ref. 17). (Use of chronic toxicity values are discussed in more detail elsewhere in this preamble.)

The various laboratory procedures tested were then compared as to their ability to reproduce the lysimeter leachate target concentrations. The absolute value of the percentage difference for each target concentration/leaching test concentration pair was determined, averaged for each leaching procedure, and then each procedure was ranked from the lowest to highest difference and evaluated for significance using Duncan's multiple range test. These analyses identified most of the laboratory procedures as being equally predictive of lysimeter leachate target concentrations, particularly where the organics were concerned.

No single procedure will be able to accurately predict leachate concentrations for all compounds in all waste matrices. EPA therefore picked the procedures which seemed to most closely model lysimeter leachate target concentrations using the absolute value of the percentage difference. Factors other than average percentage difference, such as ease and expense of operation, applicability to both organics and inorganics, and applicability to biological testing, were also taken into account. These factors were identified in the body of the preamble as objectives for the TCLP.

On the basis of all these considerations, two procedures, similar in concept and operation to the current EP, were selected for further work in Phase II. Both of these procedures use a 20:1 liquid to solid ratio (i.e., an amount of extraction fluid equal to twenty times the weigth of the solid phase of the waste) and involve a batch-type extraction. One procedure uses a 0.1 N pH 5 sodium acetate buffer solution as the extraction medium, and the other uses carbon dioxide ($CO_2$) saturated deionized distilled water (i.e., carbonic acid).

### 4. Peer Reviews

A number of peer reviews were conducted at various stages of the TCLP development program. The general tone of these reviews was always strongly positive. One such review which deserves attention, primarily because it had profound effect on the way the TCLP development data was analyzed, is a review conducted by the Agency's Science Advisory Board (Ref. 29).

At the end of Phase I, the Environmental Engineering Committee of the Science Advisory Board (SAB) was asked by EPA to review and provide recommendations concerning the development program and the selected methods. Overall, the SAB found that the experimental approach taken reasonably represented an actual landfill. The SAB did, however, question the statistical methodology used to evaluate the Phase I data and recommended that the data be re-evaluated using additional statistical analyses. Their primary concerns were the need to provide more resolution in the data through the use of more powerful statistical tests, the need to indicate the direction of the statistical differences (i.e., were individual laboratory tests generally more or less aggressive than lysimeter targets) and the need to examine the data for possible compound or class-related trends.

### 5. Results of Phase II

The SAB comments resulted in the application of a number of additional statistical tests to both the Phase I and Phase II data, and the Phases I and II combined data (Ref. 7 and 25). Before describing the results of these statistical analyses, it is important to bear in mind that no single leaching procedure will be able to accurately predict leachate concentrations for all compounds in all waste matrices. The idea was to select the procedure which most consistently modeled the field lysimeters. Another consideration was the need to minimize the occurrence of false negative results (i.e., the situation where the leaching test falsely identifies the waste as non-hazardous in this case the leaching test would be less aggressive than field results). While it is important to also minimize the occurrence of false positives, EPA believes that minimizing false negatives is more important, since the consequences of false negative results are more environmentally serious. In addition, other factors, such as ease and expense of operation, applicability to both organics and inorganics, reproducibility, and applicability to biological testing (the original objectives in developing the TCLP), were also considered in selecting the most appropriate leaching medium.

Table D–1 summarizes the results of four of the more important statistical analyses applied to the data comparing lysimeter to laboratory results. This table presents comparisons between three extraction media (i.e., acetate buffer, carbonic acid and EP leaching medium), and includes the results for both organics and inorganics from both phases of testing. Only statistically significant results are presented. A different letter indicates statistical significance at the 5 percent level, an "A" value being closest to the lysimeter results. The results reported in this table come from several references (Ref. 6, 7, and 25). Also, see the TCLP Background Document (Ref. 33).

TABLE D-1.—SUMMARY TABLE—STATISTICAL ANALYSIS OF THE DATA USED TO DEVELOP THE TOXICITY CHARACTERISTIC LEACHING PROCEDURE STATISTICAL SIGNIFICANCE ONLY [1]

| | Inorganics | | | Organics | | | Inorganics and organics | | |
|---|---|---|---|---|---|---|---|---|---|
| | Phase I | Phase II | Phase I+II | Phase I | Phase II | Phase I+II | Phase I | Phase II | Phase I+II |
| Absolute percent D [2]: | | | | | | | | | |
| Acetate | B | A | A | A | A | A | A | A | A |
| Carbonic | A | A | A | A | A | A | A | A | A |
| EP | B | A | A | A | A | A | A | A | A |
| Actual percent D [3]: | | | | | | | | | |
| Acetate | −B | −AB | −B | +A | +A | +A | −A | +A | −A |
| Carbonic | −A | +B | +A | +A | +A | +AB | −A | +B | +B |
| EP | −AB | −A | −B | +A | +A | +B | −A | +A | +AB |
| Multivariate [4]: | | | | | | | | | |
| Acetate | | | | | | | A | A | A |
| Carbonic | | | | | | | A | B | B |
| EP | | | | | | | B | B | B |
| Precision (C.V.) [5]: | | | | | | | | | |
| Acetate | A | A | A | D | B | B | B | B | B |
| Carbonic | A | B | B | B | C | C | A | C | C |
| EP | ND | B | B | ND | C | C | ND | B | B |

[1] A different letter indicates statistical significance at the 5% level, an "A" value being closest to the lysimeter target values.
[2] Absolute value of the percentage difference between laboratory concentration and the lysimeter field results.
[3] Actual value of the percentage difference between laboratory concentration and the lysimeter field results. A negative value indicates the laboratory concentrations to be higher than lysimeter field results.
[4] Ranks based on the Mahalanobis distance (See Ref. 7).
[5] Precision, as coefficient of variation categorized as follows: A=0-19, B=20-39, C=40-59, D=60+, ND=Not Duplicated.

The first test, the absolute percent difference, give a crude indication of accuracy of each of the methods. Looking at Table D-1, the most apparent conclusion is that there is essentially no significant differences among the leaching media as to their ability to duplicate field results. This is especially true for organic compounds. A better means of indicating significant differences in accuracy is believed to be the multivariate analysis, the results of which are also presented. This test indicates that the acetate buffer extraction is significantly more accurate than the other media. In carrying out the multivariate analysis, the results for organics and inorganics were not examined spearately.

The actual percent difference, while also giving an estimate of accuracy, can be used to estimate the aggressiveness of the leaching media relative to the field results. A negative value indicates that the extraction is more aggressive than the lysimeter field model. Looking at Table D-1, once again there are few significant differences among the leaching media as to their ability to extract organic compounds. All the values for the organics comparisons are positive values, indicating that the laboratory tests are generally less aggressive than the lysimeter model.

This is most probably a function of the wastes being extracted in a device which does not prevent loss of volatiles (i.e., losses of volatile organics to the headspace in the extraction vessel), and also a function of the fact that the field leachates were analyzed unfiltered, whereas the laboratory extracts were analyzed filtered. Higher concentrations of some organic compounds, especially polyaromatic hydocarbons, were observed in the unfiltered extracts.

For inorganics, the actual percent differences test did produce some negative values, indicating that some of the leaching media tested were more aggressive towards inorganics than the lysimeter field model. In Phase I, this was true for all three leaching media. In Phase II, however, this was only true for the acetate buffer and EP leaching media. Hence, in Phase II, the carbonic acid leaching media was generally less aggressive towards inorganics than the lysimeter field model (Refs. 7 and 25).

Although the Phase I data indicated that the carbonic acid leaching medium most closely approximated the lysimeter results (Ref. 6), when the Phase II data were taken into account, the sodium acetate buffer leaching medium seemed to be the most appropriate (Refs. 7 and 25). Given the most weight in this evaluation was the multivariate analysis.

The analysis of precision, the last statistical analysis presented in Table D-1, also indicated that the acetate buffer extraction would provide a more precise test procedure than either of the other two media. In addition, the acetate buffer system offers a number of operational advantages over either the carbonic acid medium or the EP leaching medium. Finally, use of the acetate buffer system should minimize the occurrence of false negative results, since the Phase II inorganics analyses indicated that the carbonic acid medium was less aggressive than the lysimeter field results.

For the above reasons, the sodium acetate buffer system has been selected as the medium of choice. Perhaps the only objective that may have been compromised by selection of the acetate buffer system was the objective to have a leaching medium that is applicable to biological testing. Although the acetate buffer system will complicate biological testing, it should not preclude bioassay evaluation of TCLP extracts entirely.

Phase III of the TCLP development program involves an evaluation of ruggedness and precision as well as a multi-laboratory collaborative study. Since the design of these studies, and hence the results are a function of how EPA addressed some of the operational aspects of the EP, a discussion of Phase III follows the next section which presents and discusses some of these procedural problems.

### 6. Operational Aspects

As indicated previously, in moving from the EP to the TCLP protocol, the Agency hoped to improve the test procedure and eliminate some steps in the EP procedure which have caused difficulty for analysts. These include the need for continual pH adjustment, which is time consuming and serves as a source of imprecision, and the difficulty in performing the initial and final liquid/solid separations, which currently involves 0.45 μm pressure filtration. In addition, the need to adequately prevent volatilization of organic compounds during extraction was critical. These three aspects of the test procedure are discussed below. As an aid, Table D-2 presents a comparison between the EP and the TCLP, in terms of procedural aspects. Figures D-1 and D-2 present the flow diagrams for each procedure, respectively.

TABLE D-2.—COMPARISON OF THE EXTRACTION PROCEDURE (EP) AND THE TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) [1]

| Item | EP | TCLP |
|---|---|---|
| (1) Leaching media. | 0.5 N Acetic acid added to distilled deionized water to a pH of 5 with 400 ml maximum addition. Continual pH adjustment. | 0.1 pH 2.9 acetic acid solution for moderate to high alkaline wastes and 0.1 pH 4.9 acetate buffer for other wastes. |
| (2) Liquid/solid separation. | 0.45 um Filtration to 75 psi in 10 psi increments. Unspecified filter type. | 0.6–0.8 um Glass fiber filter filtration to 50 psi. |
| (3) Monolithic material/particle size reduction. | Use of Structural Integrity Procedure or grinding and milling. | Grinding or milling only. Structural Integrity Procedure not used. |
| (4) Extraction vessels. | Unspecified design. Blade/stirrer vessel acceptable. | Zero-headspace vessel required for volatiles. Bottles used for non-volatiles. Blade stirrer vessel not used. |
| (5) Agitation | Prose definition of acceptable agitation. | Rotary agitation only in an end-over-end fashion at 30±2 rpm. |
| (6) Extraction time. | 24 hours | 18 hours. |
| (7) Quality control requirements. | Standard additions required. One blank per sample batch. | Standard additions required in some cases. One blank per 10 extractions and every new batch of extract. Analysis specific to analyte. |

[1] All other attributes between the two tests are generally the same, although there are some minor differences. Note also that while the EP only addresses those species for which National Interim Primary Drinking Water Standards (NIPDWS) exist, the TCLP can be applied to other toxicants.

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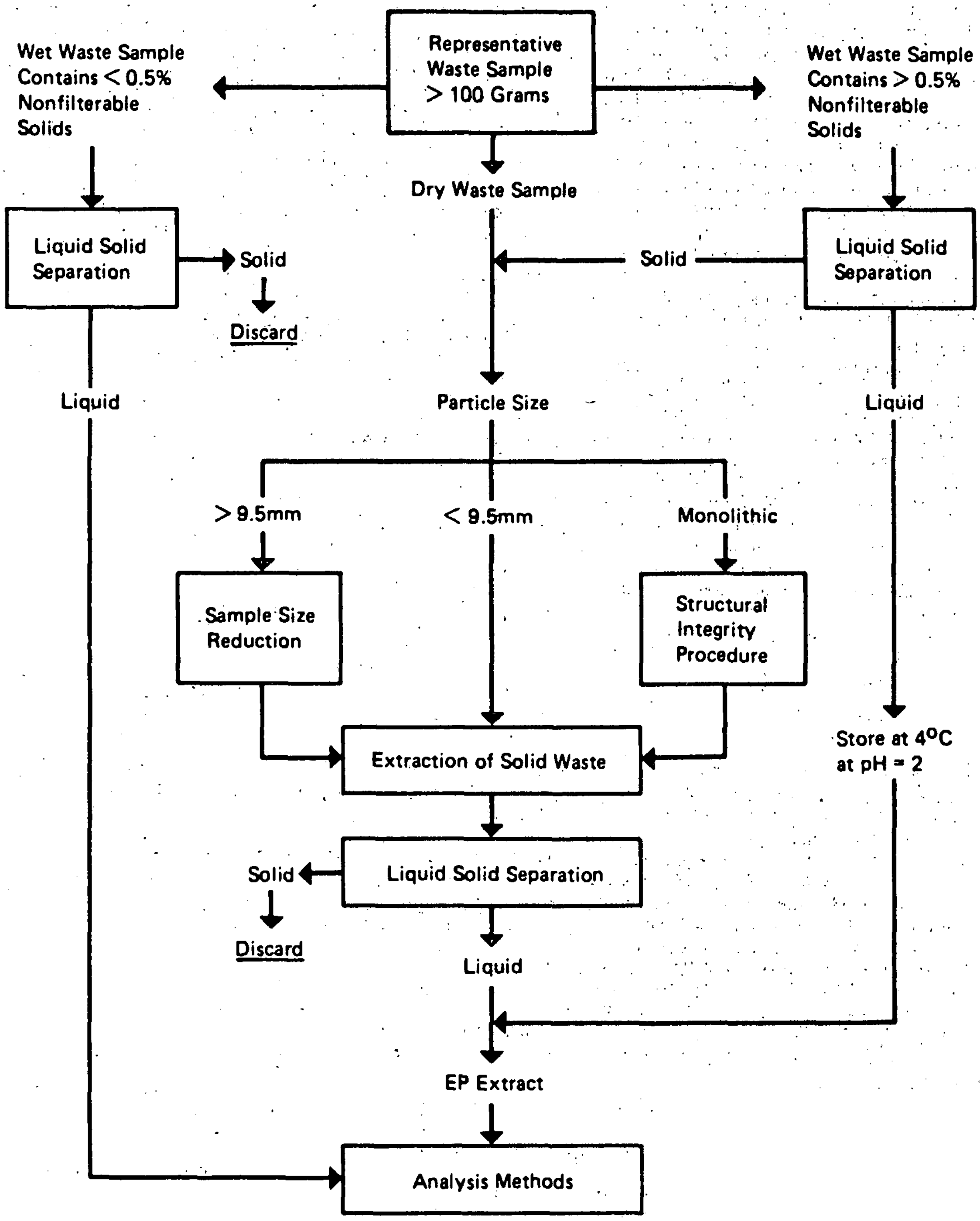
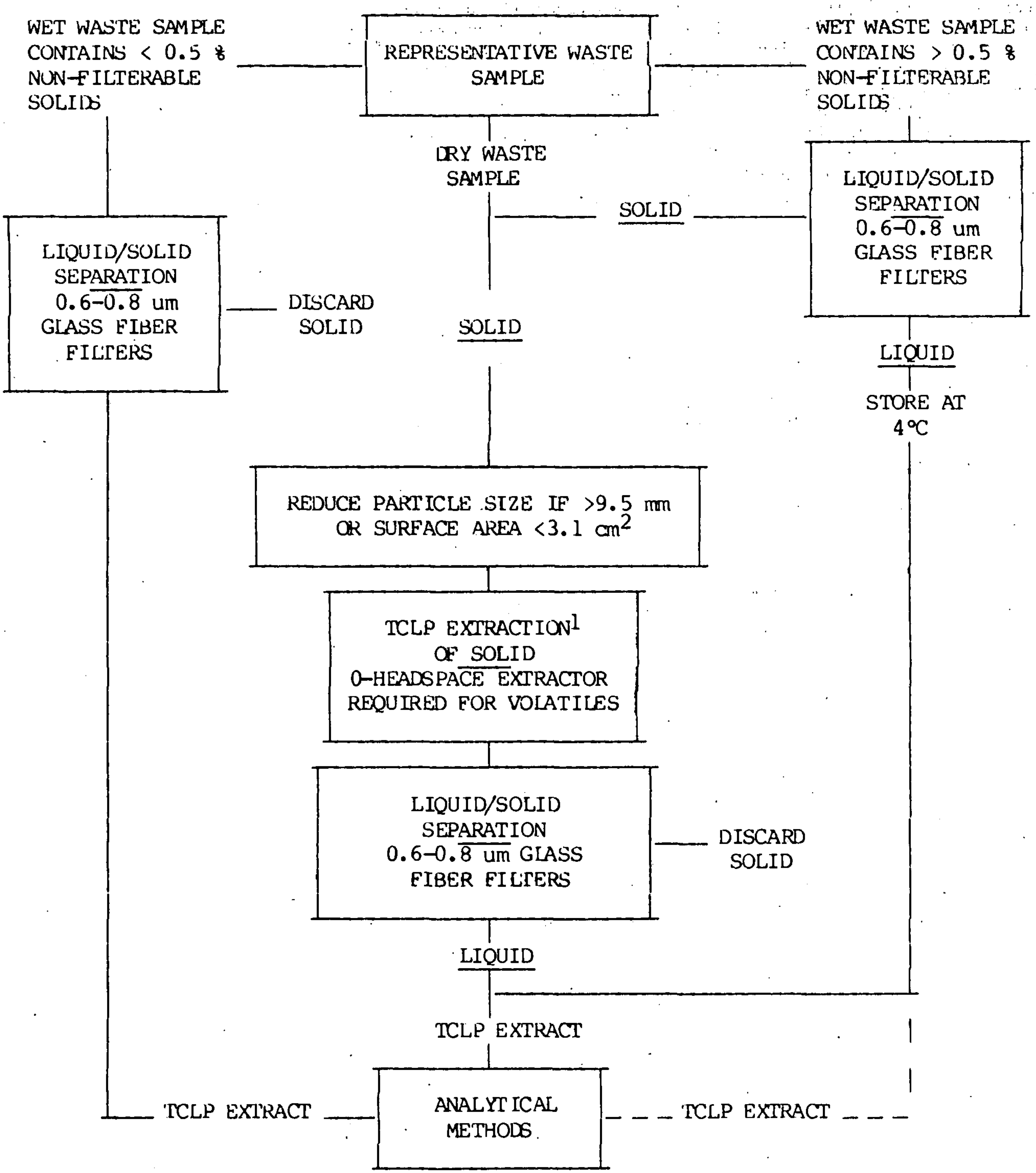


Figure D-2: Extraction Procedure Flowchart

FIGURE D-2: TCLP Flowchart



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[1] The extraction fluid employed is a function of the alkalinity of the solid phase of the waste.

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The EP procedure involves continual pH adjustment or titration. The procedure calls for periodic pH adjustments if necessary, at 15 minute intervals for up to 6 hours or more. This is very tedious, time consuming and expensive, and is also probably the single most important element in the EP protocol contributing to variability. Using pre-defined leaching media eliminates the problem of pH adjustment since such media does not require pH adjustment during extraction.

The initial liquid/solid separation problems are due to the tendency for some materials, such as certain types of oily wastes, to clog the 0.45 um filter, and prevent filtration even if considerable pressure (75 psi) is applied. This problem is serious, since materials which do not pass the 0.45 um filter are treated as solids even if they physically appear to be a liquid. These (liquid) wastes are then carried through EP extraction as a solid.

This is particularly serious for oily wastes, since oils have been known to frequently migrate to ground waters. It is important for the luquid/solid separation to treat, as liquids, those materials which can behave as liquids in the environment. It is important to recognize, however, that some materials, such as many paint wastes and some oily wastes, while they have some liquid properties, they will generally behave as solids in the environment (i.e., will not migrate in total).

In addition, since different analysts may expend varying degrees of effort in accomplishing the liquid/solid separation with these waste types, this problem also contributes to variability. As indicated below, EPA believes that the liquid/solid separation technique that has been developed for the TCLP protocol reduces the variability that was associated with the EP's liquid/solid separation technique, and that it also provides a more adequate differentiation between those materials that behave as liquids in the environment, and those materials which behave as solids.

Initially, it was felt that this problem could be addressed through use of the much simplier liquid/solid separation technique used in RCRA Test Method 9095 (Paint Filter Free Liquid Test) (Ref. 27). This method involves gravity filtration through a 60 mesh paint filter. This test method was promulgated on April 30, 1985 (50 FR 18370). It is intended to be a qualitative determination of whether a waste contains any free liquids, and was developed in response to bans instituted on the disposal of liquids in landfills.

In applying this method to the TCLP, however, a number of problems were encountered (Ref. 3). The most serious of these was the fact that particulates, which are solids, are capable of passing through the paint filter in bulk. Using Method 9095 in the TCLP, would lead to these solids being considered as a liquid, and thus, not subject to extraction. This could lead to an artificially high (or low) apparent extract concentration. In addition, the amount of liquid the method yields varies with how the waste is poured or placed in the filter. These two problems negated the use of Method 9095 in the TCLP.

To overcome the problems encountered with the paint filter method, EPA has returned to the use of pressure filtration to separate the liquid from the solid phase of a waste. In reevaluating this technique, however, several changes have been made which will decrease the time it takes to accomplish separation, improve the precision of the method, and provide a more adequate differentiation between those materials which behave as liquids in the environment, and those which behave as solids. These changes include switching from a 0.45 um filter medium of varying composition, to specifying a 0.6–0.8 um glass fiber filter, as well as limiting the time spent filtering. The use of glass fiber will reduce the possibility of adsorption of analytes to the filter media. Also, these filters have a much higher throughput and show much less tendency to clog, and for these reasons, allow the use of a pressure of 50 psi rather than 75 psi to accomplish separation. Initial experiments indicate substantial operational advantages and time savings with the use of glass fiber filters (Ref. 4).

The third problem deals with the need to prevent loss of volatile organic compounds during the conduct of the procedure. This includes losses during initial and final liquid/solid separation, extraction, and sample handling. With the assistance of laboratory equipment manufacturers, EPA has addressed this problem through development of a Zero-Headspace Extractor (ZHE). After experimentation with several prototype devices, the device described schematically in Figure D–3 has been successfully applied during evaluation of the TCLP procedure. Equipment of this type is now available from two suppliers (See TCLP in the proposed Appendix II to Part 261).

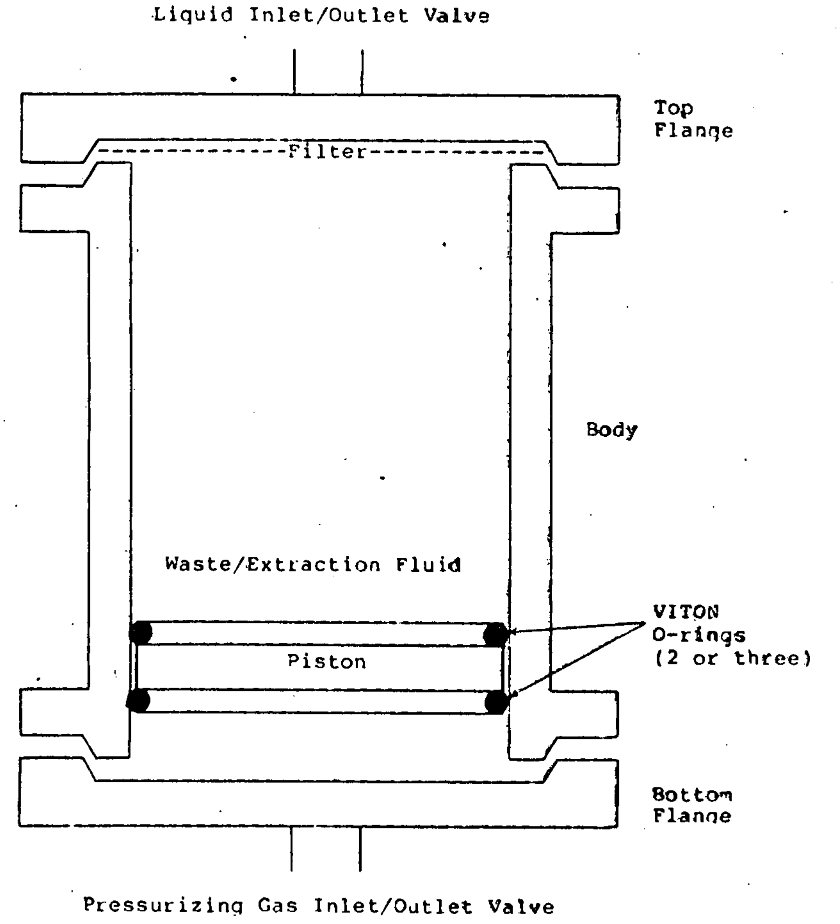

Figure D-3: Zero-Headspace Extraction Vessel

The ZHE is capable of conducting the initial liquid/solid separation, agitation, as well as final extract filtration, with only minimal loss of volatiles. Although considerably more expensive than the bottles used in the current EP, these devices are only required when investigating the leachability of volatile components. Less expensive vessels are used for assessing the mobility of non-volatile components. In addition, since the ZHE is capable of also conducting the liquid/solid separation, no additional filtration apparatus is required.

Due to the need to have the ZHE compatible with common laboratory equipment, such as off-gassing ovens, and laboratory sinks, and also the need to produce a device that is easily handled by laboratory personnel, a device smaller than the 2 liter internal volume device EPA originally had in mind was necessary. Balancing the need to also accommodate as large a sample size as possible, EPA determined that a device with one-half liter (500 ml) internal volume would be more appropriate. Due to the 500 ml internal capacity, the ZHE can only accommodate a maximum sample size of 25 grams for a 100 percent solids sample. For a waste of less than 100 percent solids, the maximum sample size the ZHE can accommodate is tied to the percent solids of the waste. The device can only accommodate the minimal 100 gram sample size specified for bottle extractions for wastes that are 25 percent solids or less.

In addition to the major improvements discussed above, EPA has instituted a number of minor improvements in the TCLP protocol. These improvements are primarily designed to increase the overall precision of the method. For example, in transferring samples from container to filtration apparatus to extractor, etc., the procedure calls for determining the weight of any residual sample material left behind and subtracting this from the total sample size. this will insure that the amount of extracting medium added to the extractor is truly a function of the solid material within the extractor, and will help to improve overall precision.

7. Results of Phase III

Phase III of the TCLP development program involved an evaluation of ruggedness and precision as well as a multilaboratory collaborative study. The experimental design and a summary of the results of the precision evaluations are presented below. While the ruggedness evaluation for the metals and semivolatiles have been completed the work on the volatiles portion of the method is in progress. The results of the ruggedness evaluation for the volatiles will be noticed for comment upon completion.

EPA's collaborative study is currently on-going. In addition, the Electric Power Research Institute (EPRI) has conducted a limited collaborative evaluation of the draft TCLP protocol, primarily as it appies to inorganic constituents. The report on this study is being drafted. The results of both of these studies will be noticed for comment when completed.

*a. Precision evaluation.* As discussed earlier, the TCLP protocol requires the use of a Zero-Headspace Extractor (ZHE) when dealing with volatiles, and the use of common EP extraction equipmenmt (i.e., bottles) when dealing with non-volatile components. In response, EPA has conducted a precision evaluation of the TCLP protocol using both devices. These evaluations were conducted by two laboratories, each laboratory conducting a number of replicate extractions on two wastes. These wastes were an API separator sludge/electroplating waste admixture containing nonvolatile organics and a variety of inorganics, and an ammonia still lime sludge containing a variety of polycyclic aromatic hydrocarbons, and several inorganic compounds. These wastes were also spiked with several volatile compounds.

The results of the precision evaluation for non-volatile components indicate the TCLP to be of acceptable precision (Ref. 23). For the most part, the percent coefficient of variation between replicate extractions for individual constituents was less than 30 percent. This includes the variability contributed by sampling variability and analytical variability. Although sampling variability was minimized to the extent possible, it is reasonable to expect a sample variability contribution to the total variability of between 2 and 5 percent. Analytical variability was in many cases comparable to, and in some cases exceeded, the total variability. This observation is significant as the analytical methods used to analyze the TCLP extracts are well accepted and in widespread use.

Precision for the non-volatiles was observed to be best for those contaminants present at relatively high levels, as is the usual case in any analysis for method precision. For those cases where the contaminant was present at relatively low concentrations, precision was pair, the percent coefficient of variation generally falling below 50 and 60 percent.

The results of the precision evaluations for the volatile components (Ref. 9) are not as clearly interpreted. There are several reasons for this. These evaluations were initiated as the zero-headspace extractor became available. Recall that the present design for the ZHE was the result of experimentation with several prototype devices. Hence, experience with the ZHE, especially by laboratory technicians who were responsible for conducting the work was limited.

In addition, the precision work on the volatiles was conducted using two draft TCLP protocols. The first public draft protocol was released for comment in April of 1985. At this time EPA was still experimenting with several prototype devices, and although the April TCLP draft addressed volatile components, it was largely to obtain technical comments and suggestions and was not based on an actual working ZHE device. It was this protocol under which the TCLP precision evaluation of the volatiles was begun.

The second public draft of the TCLP protocol was released for comment in October of 1985. Although this draft was based on the current design for the ZHE, further experience with the device has led EPA to re-write the TCLP volatiles procedure in the form that it currently appears (see TCLP in the proposed Appendix II to Part 261). In addition, it is possible that further clarifications in the procedure may be advisable.

The remainder of the precision evaluation for the volatiles was conducted using the October, 1985 draft TCLP. Several significant changes have been made in the current (proposed) version due to experience gained with the device. For example, whereas the October 1985 version allowed the use of VOA vials for the collection of the TCLP extract, the proposed method requires the use of air-tight syringes or TEDLAR® bags due to expected losses of volatiles from the VOA vials during collection of the extract. VOA vials were used to collect the extract during the precision evaluation of the volatiles.

Also, in following the protocols, inadvertent errors were apparently made which seem to have affected method precision. For example, whereas the October 1985 version of the protocol placed a maximum of 25 grams on the amount of solid material the ZHE could accommodate, considerably more solid material was extracted during the precision analysis of one of the wastes tested (i.e., the API separator sludge/electroplating waste admixture). This provided for a variable liquid to solid ratio rather than the specified 20 to 1 ratio.

To complicate matters further, due to extenuating circumstances, two individual laboratories conducted the work rather than the intended single laboratory. It is apparent that higher concentrations were obtained on the same waste from the different laboratories.

As indicated above, these factors make the precision data difficult to interpret. Whereas the percent coefficient of variations on the ammonia still lime sludge were mostly less than 60 or 70 percent, which is fair given the nature of volatiles, the numbers generated from the admixture of API separator sludge and electroplating waste indicated more variability. As indicated in the draft report (Ref. 9), some of this can be attributed to severe laboratory contamination problems, and the oily character of the waste, which seemed to have dominated the extraction.

Due to the inconclusive nature of the results, EPA is in the process of conducting another precision evaluation of the volatile components. This study will use the proposal draft of the TCLP, which we believe should help to clear up some of the problems encountered during the first evaluation. This study will be similar to the previous one in most other aspects, except that a third waste will be evaluated (one expected to not react with the spiked volatiles), and two levels of volatile spike will be used (i.e., one of relatively high concentration and one of relatively low concentration). The results of this evaluation will be noticed for comment upon its completion.

*b. Ruggedness evaluation.* A ruggedness evaluation is designed to determine how sensitive a test method is with respect to modest departures from the protocol which can be expected during routine applications of the protocol. The purpose of this evaluation is to identify procedural variables which must be carefully controlled, and then to emphasize in the protocol the limits of acceptable deviation with respect to these variables. If a procedure is "rugged" it will be unaffected by minor departures from the specified method values. If results are affected by variation of conditions, the protocol must be written to specify those parameters which must not be varied beyond a determined amount.

As with the precision evaluation, ruggedness was evaluated for both the ZHE and common EP extractor bottles. Different lots of the same wastes used for the precision evaluations were used for the ruggedness evaluation. These evaluations were performed by one laboratory. Whereas the ruggedness evaluation for the common EP extractor bottles has been completed (Ref. 4a), the ZHE evaluation is still in progress. Table D-3 presents the parameters which were evaluated for ruggedness using both types of extraction equipment.

TABLE D-3.—PARAMETERS INVESTIGATED DURING TCLP RUGGEDNESS EVALUATION

| Parameter | TCLP specification | ZHE device | Common equipment (bottles) |
|---|---|---|---|
| (1) Liquid/Solid ratio | 20 | 19 to 21 | 19 to 21. |
| (2) Extraction time | 18 | | 16 to 20. |
| (3) Headspace: | | | |
| ZHE | Zero | 0 to 5 percent | |
| Bottles | Variable | | 20 to 60 percent. |
| (4) Medium #1 acidity (milliequivalents acid). | 70 | 60 to 80 | |
| (5) Medium #2 acidity (milliequivalents acid). | 200 | | 190 to 210. |
| (6) Aliquots (taking of aliquots directly from ZHE for analysis. | Allowed for ZHE in some cases (see proposed TCLP). | Yes—No | |
| (7) Extractor vessel | (See proposed TCLP) | Associated ZHE—Millipore ZHE. | Borosilicate—Flint glass. |
| (8) Acid wash filters | Required for metals | | Yes—No. |
| (9) Filter type | 0.6–0.8 um glass fiber | | Polycarbonate—Glass fiber. |
| (10) Pressurization of ZHE during agitation (psi). | 5 to 10 | 0 to 20 | |

TABLE D-3.—PARAMETERS INVESTIGATED DURING TCLP RUGGEDNESS EVALUATION—Continued

| Parameter | TCLP specification | ZHE device | Common equipment (bottles) |
|---|---|---|---|
| (11) ZHE extract collection devices | TEDLAR® bag or syringe | TEDLAR® bag—syringe | |

There were several parameters which EPA intended to investigate (i.e., extraction temperature and agitation rate), which could not be accommodated due to lack of appropriate laboratory equipment necessary to vary these parameters. In addition, while EPA had originally intended to evaluate the effects of different glass fiber filters (See Table D-3, Item 9), glass fiber filters other than the type specified in the TCLP protocol were unable to withstand the pressures stipulated in the TCLP. Hence, the EP's use of polycarbonate filters were investigated instead. EPA has already determined that extract concentrations may differ slightly between the two filter types (Ref. 4 and 7). The remainder of the Table D-3 parameters are largely self-explanatory.

The ruggedness evaluation for the common (EP) extraction equipment demonstrated that for the most part, the TCLP if fairly rugged (Ref. 4a). This is especially true for the semi-volatile organics, which, with few exceptions, were unaffected by the parameters investigated. For metals, the results suggest that at least two parameters are critical. As expected, the acidity of the extracting fluid directly influences the extraction of metals. The TCLP protocol emphasizes accuracy in the preparation of the extraction fluids, by specifying the exact recipes for the preparation of these fluids, and indicating that the pH of these fluids should be accurate to within ± 0.05 pH units.

Bottle type (i.e., borosilicate vs flint glass) is the second parameter which apparently affects the concentration of metals in the extract, and may also effect (to a lesser degree), the extraction of semi-volatiles. It appears that using flint glass can result in significantly higher extract concentrations. While acid washing the flint glass bottles, or an expanded use of blanks, may help to solve the problem, specifying borosilicate over flint glass would solve the problem entirely. Due to the substantially higher cost of the borosilicate glass (from 3 to 5 times higher), EPA is reguesting comment on this option.

The volatiles evaluation for the TCLP is currently ongoing. As noted above, the Table D-3 parameters were investigated to determine if they need to be controlled more carefully. As an example, pressurization of the ZHE during agitation is being investigated to determine whether the build-up of pressure within the ZHE during agitation (which is expected to occur for some wastes, particularly carbonate containing waste), needs to be controlled more carefully. The build-up of this pressure could cause the ZHE piston to move, thereby causing the presence of headspace. The ruggedness evaluation would indicate if this variable should be controlled more carefully, perhaps by putting more pressure (e.g., 20 psi) behind the piston during agitation.

As indicated above, the results of the volatiles ruggedness evaluation will be noticed for comment upon completion.

c. *Collaborative study.* As indicated earlier, both EPA and Electric Power Research Institute (EPRI) have planned collaborative evaluations of the TCLP protocol. EPA's evaluation, in which the American Society of Testing and Materials, a number of business associations and individual companies, the Department of Energy, and Environment Canada's Environmental Research Center are participating, is currently ongoing. This study involves 26 laboratories, five different wastes, both types of extraction equipment, and organic and inorganic compounds, including volatiles.

EPRI's study, which is very similar to an evaluation EPRI conducted on the EP (Ref. 2), was limited to the determination of inorganic compounds and deals with common extraction equipment only. This study deals with seven types of utility wastes and involves three laboratories. In addition to total precision, EPRI is investigating the contribution of both variability in sampling, and variability introduced through analytical methods, as was done during the investigation of the EP protocal.

Both studies will be noticed for comment when completed.

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### List of Subjects in 40 CFR Parts 261, 271, and 302

Administrative practice and procedure, Air pollution control, Chemicals, Confidential business information, Hazardous materials, Hazardous materials transportation, Hazardous substances, Hazardous waste, Indian lands, Intergovernmental relations, Natural resources, Nuclear materials, Penalties, Pesticides and pests, Radioactive materials, Recycling, Reporting and recordkeeping requirements, Superfund, Water pollution control, Water supply, Waste treatment and disposal.

Dated: May 31, 1986.

Lee M. Thomas,

*Administrator.*

For the reasons set out in the preamble, it is proposed to amend Title 40 of the Code of Federal Regulations as follows:

## PART 261—IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

1. The authority citation for Part 261 continues to read as follows:

Authority: Secs. 1006, 2002(a), 3001, and 3002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6905, 6912(a), 6921, and 6922).

2. § 261.24 is revised to read as follows:

### § 261.24 Toxicity characteristic.

(a) A solid waste exhibits the characteristic of toxicity if, using the test methods described in Appendix II or equivalent methods approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21, the extract from a representative sample of the waste contains any of the contaminants listed in Table 1 at the concentration equal to or greater than the respective value given in that Table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering using the methodology outlined in Appendix II, is considered to be the extract for the purpose of this section.

(b) A solid waste that exhibits the characteristic of toxicity, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number specified in Table 1 which corresponds to the toxic contaminant causing it to be hazardous.

TABLE 1.—TOXICITY CHARACTERISTIC CONTAMINANTS AND REGULATORY LEVELS

| HWNO and contaminant | CASNO | Regulatory level (mg/1) |
|---|---|---|
| D018—Acrylonitrile | 107-13-1 | 5.0 |
| D004—Arsenic | 7440-38-2 | 5.0 |
| D005—Barium | 7440-39-3 | 100 |
| D019—Benzene | 71-43-2 | 0.07 |
| D020—Bis(2-chloroethyl) ether | 111-44-4 | 0.05 |
| D006—Cadmium | 7440-43-9 | 1.0 |
| D021—Carbon disulfide | 75-15-0 | 14.4 |
| D022—Carbon tetrachloride | 56-23-5 | 0.07 |
| D023—Chlordane | 57-74-9 | 0.03 |
| D024—Chlorobenzene | 108-90-7 | 1.4 |
| D025—Chloroform | 67-66-3 | 0.07 |
| D007—Chromium | 1333-82-0 | 5.0 |
| D026—o-Cresol [1] | 95-48-7 | 10.0 |
| D027—m-Cresol [1] | 108-39-4 | 10.0 |
| D028—p-Cresol [1] | 106-44-5 | 10.0 |
| D016—2,4-D | 94-75-7 | 1.4 |
| D029—1,2-Dichlorobenzene | 95-50-1 | 4.3 |
| D030—1,4-Dichlorobenzene | 106-46-7 | 10.8 |
| D031—1,2-Dichloroethane | 107-06-2 | 0.40 |
| D032—1,1-Dichloroethylene | 75-35-4 | 0.1 |
| D033—2,4-Dinitrotoluene | 121-14-2 | 0.13 |
| D012—Endrin | 72-20-8 | 0.003 |
| D034—Heptachlor (and its hydroxide) | 76-44-8 | 0.001 |
| D035—Hexachlorobenzene | 118-74-1 | 0.13 |
| D036—Hexachlorobutadiene | 87-68-3 | 0.72 |
| D037—Hexachloroethane | 67-72-1 | 4.3 |
| D038—Isobutanol | 78-83-1 | 36 |
| D008—Lead | 7439-92-1 | 5.0 |
| D013—Lindane | 58-89-9 | 0.06 |
| D009—Mercury | 7439-97-6 | 0.2 |
| D014—Methoxychlor | 72-43-5 | 1.4 |
| D039—Methylene chloride | 75-09-2 | 8.6 |
| D040—Methyl ethyl ketone | 78-93-3 | 7.2 |
| D041—Nitrobenzene | 98-95-3 | 0.13 |
| D042—Pentachlorophenol | 87-86-5 | 3.6 |
| D043—Phenol | 108-95-2 | 14.4 |
| D044—Pyridine | 110-86-1 | 5.0 |
| D010—Selenium | 7782-49-2 | 1.0 |
| D011—Silver | 7440-22-4 | 5.0 |
| D045—1,1,1,2-Tetrachloroethane | 630-20-6 | 10.0 |
| D046—1,1,2,2-Tetrachloroethane | 79-34-5 | 1.3 |
| D047—Tetrachloroethylene | 127-18-4 | 0.1 |
| D048—2,3,4,6-Tetrachlorophenol | 58-90-2 | 1.5 |
| D049—Toluene | 108-88-3 | 14.4 |
| D015—Toxaphene | 8001-35-2 | 0.07 |
| D050—1,1,1-Trichloroethane | 71-55-6 | 30 |
| D051—1,1,2-Trichloroethane | 79-00-5 | 1.2 |
| D052—Trichloroethylene | 79-01-6 | 0.07 |
| D053—2,4,5-Trichlorophenol | 95-95-4 | 5.8 |
| D054—2,4,6-Trichlorophenol | 88-06-2 | 0.30 |
| D017—2,4,5-TP (Silvex) | 93-76-5 | 0.14 |
| D055—Vinyl chloride | 75-01-4 | 0.05 |

[1] o-, m-, and p-Cresol concentrations are added together and compared to a threshold of 10.0 mg/1.

3. Appendix II of Part 261 is revised to read as follows:

### Appendix II—Toxicity Characteristic Leaching Procedure (TCLP)

1.0 *Scope and application.*

1.1 The TCLP is designed to determine the mobility of both organic and inorganic contaminants present in liquid, solid, and multiphasic wastes.

1.2 If a total analysis of the waste demonstrates that individual contaminants are not present in the waste, or that they are present, but at such low concentrations that the appropriate regulatory thresholds could not possibly be exceeded, the TCLP need not be run.

2.0 *Summary of method* (See Figure 1).

2.1 For wastes containing less than 0.5% solids, the waste, after filtration through a 0.6–0.8 μm glass fiber filter, is defined as the TCLP extract.

2.2 For wastes containing greater than 0.5% solids, the liquid phase, if any, is separated from the solid phase and stored for later analysis. The particle size of the solid phase is reduced (if necessary), weighed, and extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the alkalinity of the solid phase of the waste. A special extractor vessel is used when testing for volatiles (See Table 1). Following extraction, the liquid extract is separated from the solid phase by 0.6–0.8 μm glass fiber filter filtration.

2.3 If compatible (e.g. precipitate or multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract and these liquids are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield volume weighted average concentration.

3.0 *Interferences.*

3.1 Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

4.0 *Apparatus and materials.*

4.1 Agitation Apparatus: An acceptable agitation apparatus is one which is capable of rotating the extraction vessel in an end-over-end fashion (See Figure 2) at 30±2 rpm. Suitable devices known to EPA are identified in Table 2.

4.2 Extraction vessel:

4.2.1 Zero-Headspace Extraction Vessel (ZHE). When the waste is a being tested for mobility of any volatile contaminants (See Table 1), an extraction vessel which allows for liquid/solid separation within the device, and which effectively precludes headspace (as depicted in Figure 3), is used. This type of vessel allows for initial liquid/solid separation, extraction, and final extract filtration without having to open the vessel (See Section 4.3.1). These vessels shall have an internal volume of 500 to 600 ml and be equipped to accommodate a 90 mm filter. Suitable ZHE devices known to EPA are identified in Table 3. These devices contain viton O-rings which should be replaced frequently.

4.2.2 When the waste is being evaluated for other than volatile contaminants, an extraction vessel which does not preclude headspace (e.g., 2-liter bottle) is used. Suitable extraction vessels include bottles made from various materials, depending on the contaminants to be analyzed and the nature of the waste (See Section 4.3.3). These bottles are available from a number of laboratory suppliers. When this type of extraction vessel is used, the filtration device discussed in Section 4.3.2 is used for initial liquid-solid separation and final extract filtration.

4.3 Filtration devices:

4.3.1 Zero-Headspace Extractor Vessel (See Figure 3): When the waste is being evaluated for volatiles, the zero-headspace extraction vessel is used for filtration. The device shall be capable of supporting and keeping in place the glass fiber filter, and be able to withstand the pressure needed to accomplish separation (50 psi).

**Note.** When it is suspected that the glass fiber filter has been ruptured, an in-line glass fiber filter may be used to filter the extract.

4.3.2 Filter Holder. When the waste is being evaluated for other than volatile compounds, a filter holder capable of supporting a glass fiber filter and able to withstand the pressure needed to accomplish separation is used. Suitable filter holders range from simple vacuum units to relatively complex systems capable of exerting pressure up to 50 psi and more. The type of filter holder used depends on the properties of the material to be filtered (See Section 4.3.3). These devices shall have a minimum internal volume of 300 ml and be equipped to accommodate a minimum filter size of 47 mm. Filter holders known to EPA to be suitable for use are shown in Table 4.

4.3.3 Materials of Construction: Extraction vessels and filtration devices shall be made of inert materials which will not leach or absorb waste components. Glass, polytetrafluoroethylene (PTFE), or type 316 stainless steel equipment may be used when evaluating the mobility of both organic and inorganic components. Devices made of high density polyethylene (HDPE), polypropylene, or polyvinyl chloride may be used when evaluating the mobility of metals.

4.4 Filters: Filters shall be made of borosilicate glass fiber, contain no binder materials, and have an effective pore size of 0.6–0.8 um, or equivalent. Filters known to EPA to meet these specifications are identified in Table 5. Pre-filters must not be used. When evaluating the mobility of metals, filters shall be acid washed prior to use by rinsing with 1.0 N nitric acid followed by three consecutive rinses with deionized distilled water (minimum of 500 ml per rinse). Glass fiber filters are fragile and should be handled with care.

4.5 pH Meters: Any of the commonly available pH meters are acceptable.

4.6 ZHE extract collection devices: TEDLAR® bags or glass, stainless steel or PTFE gas tight syringes are used to collect the initial liquid phase and the final extract of the waste when using the ZHE device.

4.7 ZHE extraction fluid collection devices: Any device capable of transferring the extraction fluid into the ZHE without changing the nature of the extraction fluid is acceptable (e.g., a constant displacement pump, a gas tight syringe, pressure filtration unit (See Section 4.3.2), or another ZHE device).

4.8 Laboratory balance: Any laboratory balance accurate to within ±0.01 grams may be used (all weight measurements are to be within ±0.1 grams).

5.0 *Reagents.*

5.1 Water: ASTM Type 1 deionized, carbon treated, decarbonized, filtered water (or equivalent water that is treated to remove volatile components) shall be used when evaluating wastes for volatile contaminants. Otherwise, ASTM Type 2 deionized distilled water (or equivalent) is used. These waters should be monitored periodically for impurities.

5.2 1.0 N Hydrochloric acid (HCl) made from ACS Reagent grade.

5.3 1.0 N Nitric acid ($HNO_3$) made from ACS Reagent grade.

5.4 1.0 N Sodium hydroxide (NaOH) made from ACS Reagent grade.

5.5 Glacial acetic acid (HOAc) made from ACS Reagent grade.

5.6 Extraction fluid:

5.6.1 Extraction fluid #1: This fluid is made by adding 5.7 ml glacial HOAc to 500 ml of the appropriate water (See Section 5.1), adding 64.3 ml of 1.0 N NaOH, and diluting to a volume of 1 liter. When correctly prepared, the pH of this fluid will be 4.93 ± 0.05.

5.6.2 Extraction fluid #2: This fluid is made by diluting 5.7 ml glacial HOAc with ASTM Type 2 water (See Section 5.1) to a volume of 1 liter. When correctly prepared, the pH of this fluid will be 2.88 ± 0.05.

Note.—These extraction fluids shall be made up fresh daily. The pH should be checked prior to use to insure that they are made up accurately, and these fluids should be monitored frequently for impurities.

5.7 Analytical standards shall be prepared according to the appropriate analytical method.

6.0 *Sample Collection, preservation, and handling.*

6.1 All samples shall be collected using a sampling plan that addresses the consideration discussed in "Test Methods for Evaluating Solid Wastes" (SW–846).

6.2 Preservatives shall not be added to samples.

6.3 Samples can be refrigerated unless it results in irreversible physical changes to the waste.

6.4 When the waste is to be evaluated for volatile contaminants, care must be taken to insure that these are not lost. Samples shall be taken and stored in a manner which prevents the loss of volatile contaminants. If possible, any necessary particle size reduction should be conducted as the sample is being taken (See Step 8.5). Refer to SW–846 for additional sampling and storage requirements when volatiles are contaminants of concern.

6.5 TCLP extracts should be prepared for analysis and analyzed as soon as possible following extraction. If they need to be stored, even for a short period of time, storage shall be at 4°C and samples for volatiles analysis shall not be allowed to come into contact with the atmosphere (i.e., no headspace).

7.0 *Procedure when volatiles are not involved.*

Although a minimum sample size of 100 grams is required, a larger sample size may be necessary, depending on the percent solids of the waste sample. Enough waste sample should be collected such that at least 75 grams of the solid phase of the waste (as determined using glass fiber filter filtration), is extracted. This will insure that there is adequate extract for the required analyses (e.g., semivolatiles, metals, pesticides and herbicides).

The determination of which extraction fluid to use (See Step 7.12) may also be conducted at the start of this procedure. This determination shall be on the solid phase of the waste (as obtained using glass fiber filter filtration).

7.1 If the waste will obviously yield no free liquid when subjected to pressure filtration, weigh out a representative subsample of the waste (100 gram minimum) and proceed to Step 7.11.

7.2 If the sample is liquid or multiphasic, liquid/solid separation is required. This involves the filtration device discussed in Section 4.3.2, and is outlined in Steps 7.3 to 7.9.

7.3 Pre-weigh the filter and the container which will receive the filtrate.

7.4 Assemble filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure. Acid wash the filter if evaluating the mobility of metals (See Section 4.4).

7.5 Weigh out a representative subsample of the waste (100 gram minimum) and record weight.

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7.6 Allow slurries to stand to permit the solid phase to settle. Wastes that settle slowly may be centrifuged prior to filtration.

7.7 Transfer the waste sample to the filter holder.

Note.—If waste material has obviously adhered to the container used to transfer the sample to the filtration apparatus, determine the weight of this residue and subtract it from the sample weight determined in Step 7.5, to determine the weight of the waste sample which will be filtered.

Gradually apply vacuum or gentle pressure of 1–10 psi, until air or pressurizing gas moves through the filter. If this point is not reached under 10 psi, and if no additional liquid has passed through the filter in any 2 minute interval, slowly increase the pressure in 10-psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any 2 minute interval, proceed to the next 10 psi increment. When the pressurizing gas begins to move through the filter, or when liquid flow has ceased at 50 psi (i.e., does not result in any additional filtrate within any 2-minute period), filtration is stopped.

Note.—Instantaneous application of high pressure can degrade the glass fiber filter, and may cause premature plugging.

7.8 The material in the filter holder is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase.

Note.—Some wastes, such as oily wastes and some paint wastes, will obviously contain some material which appears to be a liquid—but even after applying vacuum or pressure filtration, as outlined in Step 7.7, this material may not filter. If this is the case, the material within the filtration device is defined as a solid, and is carried through the extraction as a solid.

7.9 Determine the weight of the liquid phase by subtracting the weight of the filtrate container (See Step 7.3) from the total weight of the filtrate-filled container. The liquid phase may now be either analyzed (See Step 7.15) or stored at 4°C until time of analysis. The weight of the solid phase of the waste sample is determined by subtracting the weight of the liquid phase from the weight of the total waste sample, as determined in Step 7.5 or 7.7. Record the weight of the liquid and solid phases.

Note.—If the weight of the solid phase of the waste is less than 75 grams, review Step 7.0.

7.10 The sample will be handled differently from this point, depending on whether it contains more or less than 0.5% solids. If the sample obviously has greater than 0.5% solids go to Step 7.11. If it appears that the solid may comprise less than 0.5% of the total waste, the percent solids will be determined as follows:

7.10.1 Remove the solid phase and filter from the filtration apparatus.

7.10.2 Dry the filter and solid phase at 100±20°C until two successive weighings yield the same value. Record final weight.

7.10.3 Calculate the percent solids as follows:

Weight of dry waste and filters minus tared weight of filters divided by initial weight of waste (Step 7.5 or 7.7) multiplied by 100 equals percent solids.

7.10.4 If the solid comprises less than 0.5% of the waste, the solid is discarded and the liquid phase is defined as the TCLP extract. Proceed to Step 7.14.

7.10.5 If the solid is greater than or equal to 0.5% of the waste, return to Step 7.1, and begin the procedure with a new sample of waste. Do not extract the solid that has been dried.

Note.—This step is only used to determine whether the solid must be extracted, or whether it may be discarded unextracted. It is not used in calculating the amount of extraction fluid to use in extracting the waste, nor is the dried solid derived from this step subjected to extraction. A new sample will have to be prepared for extraction.

7.11 If the sample has more than 0.5% solids, it is now evaluated for particle size. If the solid material has a surface area per gram of material equal to or greater than 3.1 cm$^2$, or is capable of passing through a 9.5 mm (0.375 inch) standard sieve, proceed to Step 7.12. If the surface area is smaller or the particle size is larger than that described above, the solid material is prepared for extraction by crushing, cutting, or grinding the solid material to a surface area or particle size as described above. When surface area or particle size has been appropriately altered, proceed to Step 7.12.

7.12 This step describes the determination of the appropriate extracting fluid to use (See Sections 5.0 and 7.0).

7.12.1 Weigh out a small sub-sample of the solid phase of the waste, reduce the solid (if necessary) to a particle size of approximately 1 mm in diameter or less, and transfer a 5.0 gram portion to a 500 ml beaker or erlenmeyer flask.

7.12.2 Add 96.5 ml distilled deionized water (ASTM Type 2), cover with watchglass, and stir vigorously for 5 minutes using a magnetic stirrer. Measure and record the pH. If the pH is $\leqslant$ 5.0, extraction fluid #1 is used. Proceed to Step 7.13.

7.12.3 If the pH from Step 7.12.2 is $>$5.0, add 3.5 ml 1.0 N HCl, slurry for 30 seconds, cover with a watchglass, heat to 50°C, and hold for 10 minutes.

7.12.4 Let the solution cool to room temperature and record pH. If pH is $\leqslant$5.0, use extraction fluid #1. If the pH is $>$5.0, extraction fluid #2 is used.

7.13 Calculate the weight of the remaining solid material by subtracting the weight of the sub-sample taken for Step 7.12, from the original amount of solid material, as obtained from Step 7.1 or 7.9. Transfer remaining solid material into the extractor vessel, including the filter used to separate the initial liquid from the solid phase.

Note.—If any of the solid phase remains adhered to the walls of the filter holder, or the container used to transfer the waste, its weight shall be determined, subtracted from the weight of the solid phase of the waste, as determined above, and this weight is used in calculating the amount of extraction fluid to add into the extractor bottle.

Slowly add an amount of the appropriate extraction fluid (See Step 7.12), into the extractor bottle equal to 20 times the weight of the solid phase that has been placed into the extractor bottle. Close extractor bottle tightly, secure in rotary extractor device and rotate at 30 ± 2 rpm for 18 hours. The temperature shall be maintained at 22 ± 3 °C during the extraction period.

Note.—As agitation continues, pressure may build up within the extractor bottle (due to the evolution of gasses such as carbon dioxide). To relieve these pressures, the extractor bottle may be periodically opened and vented into a hood.

7.14 Following the 18 hour extraction, the material in the extractor vessel is separated into its component liquid and solid phases by filtering through a new glass fiber filter as outlined in Step 7.7. This new filter shall be acid washed (See Section 4.4) if evaluating the mobility of metals.

7.15 The TCLP extract is now prepared as follows:

7.15.1 If the waste contained no initial liquid phase, the filtered liquid material obtained from Step 7.14 is defined as the TCLP extract. Proceed to Step 7.16.

7.15.2 If compatible (e.g., will not form precipitate or multiple phases), the filtered liquid resulting from Step 7.14 is combined with the initial liquid phase of the waste as obtained in Step 7.9. This combined liquid is defined as the TCLP extract. Proceed to Step 7.16.

7.15.3 If the initial liquid phase of the waste, as obtained from Step 7.9, is not or may not be compatible with the filtered liquid resulting from Step 7.14, these liquids are not combined. These liquids are collectively defined as the TCLP extract, are analyzed separately, and the results are combined mathematically. Proceed to Step 7.16.

7.16 The TCLP extract will be prepared and analyzed according to the appropriate SW–846 analytical methods identified in Appendix III of 40 CFR 261. TCLP extracts to be analyzed for metals shall be acid digested. If the individual phases are to be analyzed separately, determine the volume of the individual phases (to 0.1 ml), conduct the appropriate analyses, and combine the results mathematically by using a simple weighted average:

$$\text{Final contaminant concentration} = \frac{(V_1)(C_1) + (V_2)(C_2)}{V_1 + V_2}$$

where:

$V_1$ = The volume of the first phase (1)
$C_1$ = The concentration of the contaminant of concern in the first phase (mg/l)
$V_2$ = The volume of the second phase (1)
$C_2$ = The concentration of the contaminant of concern in the second phase (mg/l)

7.17 The contaminant concentrations in the TCLP extract are compared to the thresholds identified in the appropriate regulations. Refer to Section 9 for quality assurance requirements.

8.0 *Procedure when volatiles are involved.*

The ZHE device has approximately a 500 ml internal capacity. Although a minimum sample size of 100 grams was required in the Section 7 procedure, the ZHE can only accommodate a maximum 100 percent solids sample of 25 grams, due to the need to add an amount of extraction fluid equal to 20 times the weight of the solid phase. Step 8.4 provides the means of which to determine the approximate sample size for the ZHE device.

Although the following procedure allows for particle size reduction during the conduct of the procedure, this could result in the loss of volatile compounds. If possible, any necessary particle size reduction (See Step 8.5) should be conducted on the sample as it is being taken. Particle size reduction should only be conducted during the procedure if there is no other choice.

In carrying out the following steps, do not allow the waste to be exposed to the atmosphere for any more time than is absolutely necessary.

8.1 Pre-weigh the (evacuated) container which will receive the filtrate (See Section 4.6), and set aside.

8.2 Place the ZHE piston within the body of the ZHE (it may be helpful to first moisten the piston O-rings slightly with extraction fluid). Secure the gas inlet/outlet flange (bottom flange) onto the ZHE body in accordance with the manufacturer's instructions. Secure the glass fiber filter between the support screens and set aside. Set liquid inlet/outlet flange (top flange) aside.

8.3 If the waste will obviously yield no free liquid when subjected to pressure filtration, weigh out a representative subsample of the waste (25 gram maximum—See Step 8.0), record weight, and proceed to Step 8.5.

8.4 This step provides the means by which to determine the approximate sample size for the ZHE device. If the waste is liquid or multiphasic, follow the procedure outlined in Steps 7.2 to 7.9 (using the Section 7 filtration apparatus), and obtain the percent solids by dividing the weight of the solid phase of the waste by the original sample size used. If the waste obviously contains greater than 0.5% solids, go to Step 8.4.2. If it appears that the solid may comprise less than 0.5% of the waste, go to Step 8.4.1.

8.4.1 Determine the percent solids by using the procedure outlined in Step 7.10. If the waste contains less than 0.5% solids, weigh out a new 100 gram minimum representative sample, proceed to Step 8.7, and follow until the liquid phase of the waste is filtered using the ZHE device (Step 8.8). This liquid filtrate is defined as the TCLP extract, and is analyzed directly. If the waste contains greater than or equal to 0.5% solids, repeat Step 8.4 using a new 100 gram minimum sample, determine the percent solids, and proceed to Step 8.4.2.

8.4.2 If the sample is < 25% solids, weigh out a new 100 gram minimum representative sample, and proceed to Step 8.5. If the sample is > 25% solids, the maximum amount of sample the ZHE can accommodate is determined by dividing 25 grams by the percent solids obtained from Step 8.4. Weigh out a new representative sample of the determined size.

8.5 After a representative sample of the waste (sample size determined from Step 8.4) has been weighed out and recorded, the sample is now evaluated for particle size (See Step 8.0). If the solid material within the waste obviously has a surface area per gram of material equal to or greater than 3.1 $cm^2$, or is capable of passing through a 9.5 mm (0.375 inch) standard sieve, proceed immediately to Step 8.6. If the surface area is smaller or the particle size is larger than that described above, the solid material which does not meet the above criteria is separated from the liquid phase by sieving (or equivalent means), and the solid is prepared for extraction by crushing, cutting, or grinding to a surface area or particle size as described above.

Note.—Wastes and appropriate equipment should be refrigerated, if possible, to 4°C prior to particle size reduction. Grinding and milling machinery which generates heat shall not be used for particle size reduction. If reduction of the solid phase of the waste is necessary, exposure of the waste to the atmosphere should be avoided to the extent possible.

When surface area or particle size has been appropriately altered, the solid is recombined with the rest of the waste.

8.6 Waste slurries need not be allowed to stand to permit the solid phase to settle. Wastes that settle slowly shall not be centrifuged prior to filtration.

8.7 Transfer the entire sample (liquid and solid phases) quickly to the ZHE. Secure the filter and support screens into the top flange of the device and secure the top flange to the ZHE body in accordance with the manufacturer's instructions. Tighten all ZHE fittings and place the device in the vertical position (gas inlet/outlet flange on the bottom). Do not attach the extract collection device to the top plate.

Note.—If waste material has obviously adhered to the container used to transfer the sample to the ZHE, determine the weight of this residue and subtract it from the sample weight determined in Step 8.4, to determine the weight of the waste sample which will be filtered.

Attach a gas line to the gas inlet/outlet valve (bottom flange), and with the liquid inlet/outlet valve (top flange) open, begin applying gentle pressure of 1–10 psi (or more if necessary) to slowly force all headspace out of the ZHE device. At the first appearance of liquid from the liquid inlet/outlet valve, quickly close the valve and discontinue pressure.

8.8 Attach evacuated pre-weighed filtrate collection container to the liquid inlet/outlet value and open valve. Begin applying gentle pressure of 1–10 psi to force the liquid phase into the filtrate collection container. If no additional liquid has passed through the filter in any 2 minute interval, slowly increase the pressure in 10 psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if no additional liquid has passed through the filter in any 2 minute interval, proceed to the next 10 psi increment. When liquid flow has ceased such that continued pressure filtration at 50 psi does not result in any additional filtrate within any 2 minute period, filtration is stopped. Close the liquid inlet/outlet valve, discontinue pressure to the piston, and disconnect the filtrate collection container.

Note.—Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.

8.9 The material in the ZHE is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase.

Note.—Some wastes, such as oily wastes and some paint wastes, will obviously contain some material which appears to be a liquid—but even after applying pressure filtration, this material will not filter. If this is the case, the material within the filtration device is defined as a solid, and is carried through the TCLP extraction as a solid.

If the original waste contained less than 0.5% solids, (See Step 8.4) this filtrate is defined as the TCLP extract, and is analyzed directly—proceed to Step 8.13.

8.10 Determine the weight of the liquid phase by subtracting the weight of the filtrate container (See Step 8.1) from the total weight of the filtrate-filled container. The liquid phase may now be either analyzed (See Steps 8.13 and 8.14), or stored at 4°C until time of analysis. The weight of the solid phase of the waste sample is determined by subtracting the weight of the liquid phase from the weight of the total waste sample (See Step 8.4). Record the final weight of the liquid and solid phases.

8.11 The following details how to add the appropriate amount of extraction fluid to the solid material within the ZHE and agitation of the ZHE vessel. Extraction fluid #1 is used in all cases (See Section 5.6).

8.11.1 With the ZHE in the vertical position, attach a line from the extraction fluid reservoir to the liquid inlet/outlet valve. The line used shall contain fresh extraction fluid and should be preflushed with fluid to eliminate any air pockets in the line. Release gas pressure on the ZHE piston (from the gas inlet/outlet valve), open the liquid inlet/outlet valve, and begin transferring extraction fluid (by pumping or similar means) into the ZHE. Continue pumping extraction fluid into the ZHE until the amount of fluid introduced into the device equals 20 times the weight of the solid phase of the waste that is in the ZHE.

8.11.2 After the extraction fluid has been added, immediately close the liquid inlet/outlet valve, and disconnect the extraction fluid line. Check the ZHE to make sure that all valves are in their closed positions. Pick up the ZHE and physically rotate the device in an end-over-end fashion 2 or 3 times.

Reposition the ZHE in the vertical position with the liquid inlet/outlet valve on top. Put 5–10 psi behind the piston (if necessary), and slowly open the liquid inlet/outlet valve to bleed out any headspace (into a hood) that may have been introduced due to the addition of extraction fluid. This bleeding shall be done quickly and shall be stopped at the first appearance of liquid from the valve. Re-pressurize the ZHE with 5–10 psi and check all ZHE fittings to insure that they are closed.

8.11.3 Place the ZHE in the rotary extractor apparatus (if it is not already there), and rotate the ZHE at 30 + 2 rpm for 18 hours. The temperature shall be maintained at 22 ± + 3°C during agitation.

8.12 Following the 18 hour extraction, check the pressure behind the ZHE piston by quickly opening and closing the gas inlet/outlet valve, and noting the escape of gas. If the pressure has not been maintained (i.e., no gas release observed), the device is leaking. Replace ZHE O-rings or other fittings, as necessary, and redo the extraction with a new sample of waste. If the pressure within the device has been maintained, the material in the extractor vessel is once again separated into its component liquid and solid phases. If the waste contained an initial liquid phase, the liquid may be filtered directly into the same filtrate collection container (i.e., TEDLAR* bag, gas-tight syringe) holding the initial liquid phase of the waste, unless doing so would create multiple phases, or unless there is not enough volume left within the filtrate collection container. A separate filtrate collection container must be used in these cases. Filter through the glass fiber filter, using the ZHE device as discussed in Step 8.8. All extract shall be filtered and collected if the extract is multi-phasic or if the waste contained an initial liquid phase.

Note.—If the glass fiber filter is not intact following agitation, the filtration device discussed in the NOTE in Section 4.3.1 may be used to filter the material within the ZHE.

8.13 If the waste contained no initial liquid phase, the filtered liquid material obtained from Step 8.12 is defined as the TCLP extract. If the waste contained an initial liquid phase, the filtered liquid material obtained from Step 8.12, and the initial liquid phase (Step 8.8) are collectively defined as the TCLP extract.

8.14 The TCLP extract will be prepared and analyzed according to the appropriate SW-846 analytical methods, as identified in Appendix III of 40 CFR 261. If the individual phases are to be analyzed separately, determine the volume of the individual phases (to 0.1 ml), conduct the appropriate analyses and combine the results mathematically by using a simple volume weighted average:

$$\text{Final contaminant concentration} = \frac{(V_1)(C_1)+(V_2)(C_2)}{V_1+V_2}$$

where:

$V_1$ = The volume of the first phase (1)

$C_1$ = The concentration of the contaminant of concern in the first phase (mg/l)

$V_2$ = The volume of the second phase (1)

$C_2$ = The concentration of the contaminant of concern in the second phase (mg/l)

8.15 The contaminant concentrations in the TCLP extract are compared to the thresholds identified in the appropriate regulations. Refer to Section 9 for quality assurance requirements.

9.0 *Quality Assurance requirements.*

9.1 All data, including quality assurance data, should be maintained and available for reference or inspection.

9.2 A minimum of one blank for every 10 extractions that have been conducted in an extraction vessel shall be employed as a check to determine if any memory effects from the extraction equipment is occurring. One blank shall also be employed for every new batch of leaching fluid that is made up.

9.3 All quality control measures described in the appropriate analytical methods shall be followed.

9.4 The method of standard addition shall be employed for each waste type if: 1) Recovery of the compound from spiked splits of the TCLP extract is not between 50 and 150%, or 2) If the concentration of the constituent measured in the extract is within 20% of the appropriate regulatory threshold. If more than 1 extraction is being run on samples of the same waste, the method of standard addition need only be applied once and the percent recoveries applied to the remainder of the extractions.

9.5 TCLP extracts shall be analyzed within the following periods after generation: Volatiles—14 days, Semi-volatiles—40 days, Mercury—28 days, and other Metals—180 days.

TABLE 1.—VOLATILE CONTAMINANTS [1]

| Compound | CASNO |
|---|---|
| Acetone | 67-64-1 |
| Acrylonitrile | 107-13-1 |
| Benzene | 71-43-2 |
| n-Butyl alcohol | 71-36-6 |
| Carbon disulfide | 75-15-0 |
| Carbon tetrachloride | 56-23-5 |
| Chlorobenzene | 108-90-7 |
| Chloroform | 67-66-3 |
| 1,2-Dichloroethane | 107-06-2 |
| 1,1-Dichloroethylene | 75-35-4 |
| Ethyl acetate | 141-78-6 |
| Ethyl benzene | 100-41-4 |
| Ethyl ether | 60-29-7 |
| Isobutanol | 78-83-1 |
| Methanol | 67-56-1 |
| Methylene chloride | 75-09-2 |
| Methyl ethyl ketone | 78-93-3 |
| Methyl isobutyl ketone | 108-10-1 |
| 1,1,1,2-Tetrachloroethane | 630-20-6 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 |
| Tetrachloroethylene | 127-18-4 |
| Toluene | 108-88-3 |
| 1,1,1-Trichloroethane | 71-55-6 |
| 1,1,2-Trichloroethane | 79-00-5 |
| Trichloroethylene | 79-01-6 |
| Trichlorofluoromethane | 75-69-4 |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 76-13-1 |
| Vinyl chloride | 75-01-4 |
| Xylene | 1330-20-7 |

[1] Includes compounds identified in both the Land Disposal Restrictions Rule and the Toxicity Characteristic.

TABLE 2.—SUITABLE ROTARY AGITATION APPARATUS [1]

| Company | Location | Model |
|---|---|---|
| Associated Design and Manufacturing Co. | Alexandria, Virginia, (703) 549-5999. | 4-vessel device.<br>6-vessel device. |
| Lars Lande Manufacturing. | Whitmore Lake, Michigan, (313) 449-4116. | 10-vessel device. |
| IRA Machine Shop and Laboratory. | Santurce, Puerto Rico, (809) 752-4004. | 16-vessel device. |
| EPRI Extractor | | 6-vessel device.[2] |

[1] Any device which rotates the extraction vessel in an end-over-end fashion at 30 ± 2 rpm is acceptable.

[2] Although this device is suitable, it is not commercially made. It may also require retrofitting to accommodate ZHE devices.

TABLE 3.—SUITABLE ZERO-HEADSPACE EXTRACTOR VESSELS

| Company | Location | Model No. |
|---|---|---|
| Associated Design and Manufacturing Co. | Alexandria, Virginia, (703) 549-5999. | 3740-ZHB |
| Millipore Corp | Bedford, Massachusetts, (800) 225-3384. | SD1P581C5 |

TABLE 4.—SUITABLE FILTER HOLDERS [1]

| Company | Location | Model | Size (mm) |
|---|---|---|---|
| Nucleopore Corp | Pleasanton, California, (800) 882-7711. | 425910<br>410400 | 142<br>47 |
| Micro Filtration Systems. | Dublin, California, (415) 828-6010. | 302400 | 142 |
| Millipore Corp | Bedford, Massachusetts, (800) 225-3384. | YT30142HW<br>XX1004700 | 142<br>47 |

[1] Any device capable of separating the liquid from the solid phase of the waste is suitable, providing that it is chemically compatible with the waste and the constituents to be analyzed. Plastic devices (not listed above) may be used when only inorganic contaminants are of concern.

TABLE 5.—SUITABLE FILTER MEDIA

| Company | Location | Model | Poro size [1] |
|---|---|---|---|
| Whatman Laboratory Products, Inc. | Clifton, New Jersey (201) 773-5800. | GFF | 0.7 |

[1] Nominal pore size.

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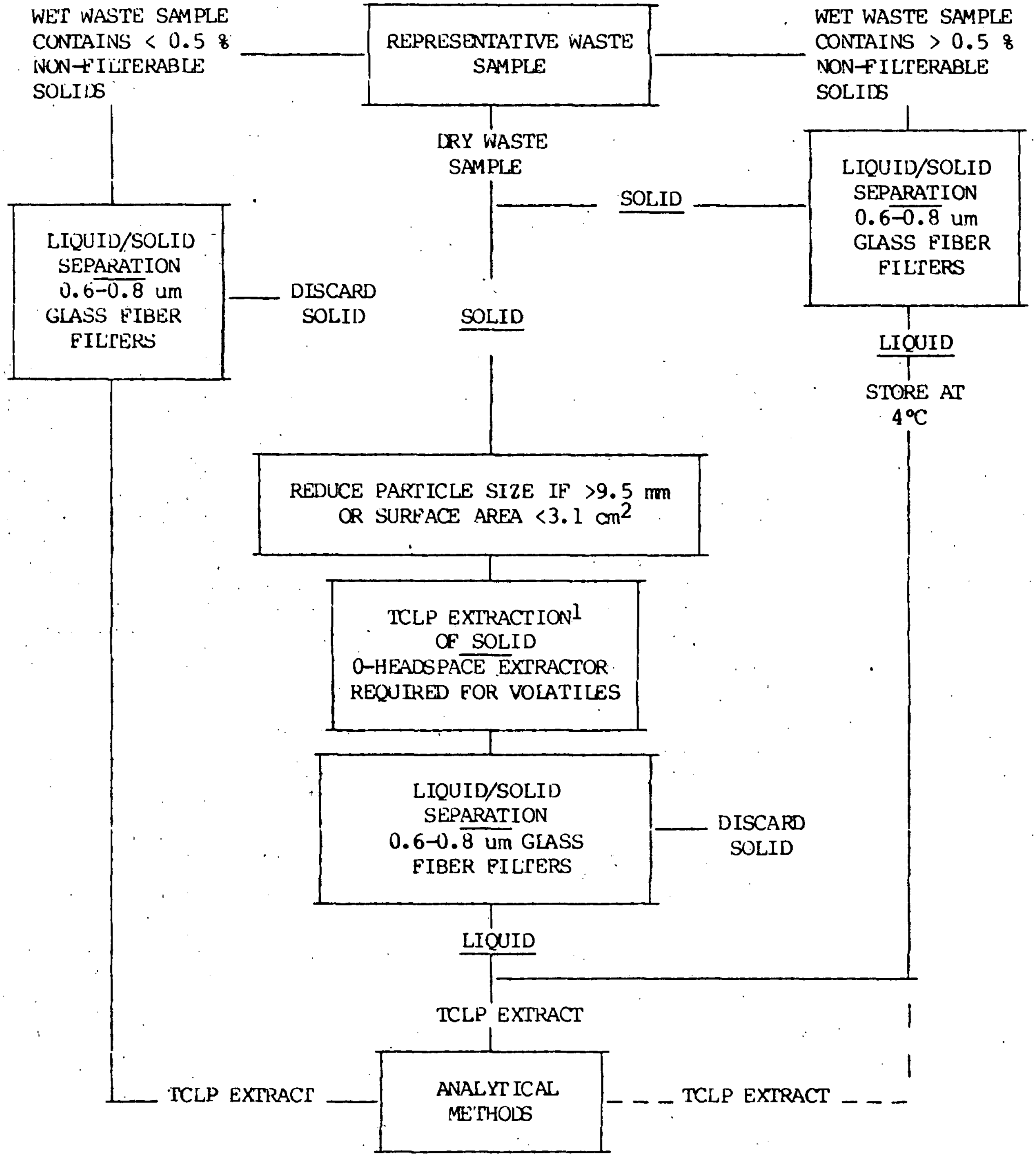
FIGURE 1: TCLP Flowchart



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[1] The extraction fluid employed is a function of the alkalinity of the solid phase of the waste.

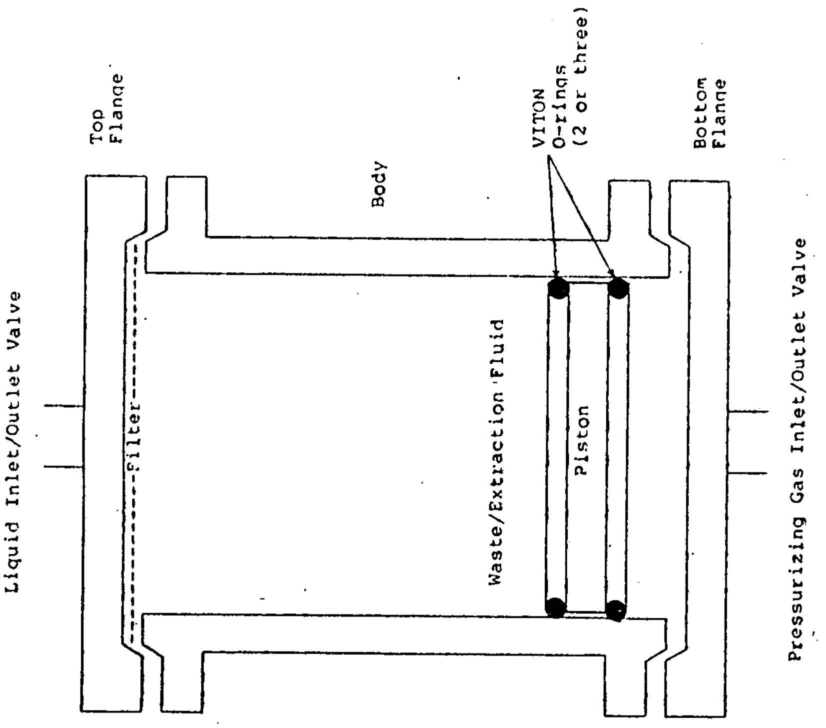

Figure 3: Zero-Headspace Extraction Vessel

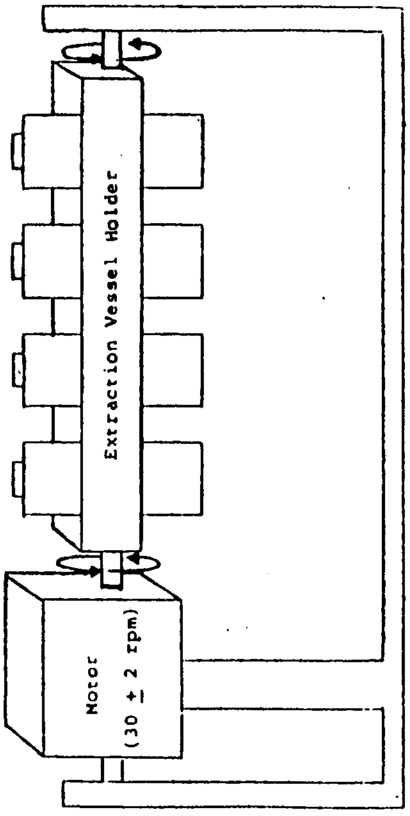

Figure 2: Rotary Agitation

BILLING CODE 6560-50-C

4. Amend Table 1 of Appendix III of Part 261 to add the following compounds and methods in alphabetical order:

### Appendix III—Chemical Analysis Test Methods

* * * * *

TABLE 1.—ANALYSIS METHODS FOR ORGANIC CHEMICALS CONTAINED IN SW-846

| Compound | First edition method(s) | Second edition method(s) |
|---|---|---|
| * * * | * | * |
| Benzene | 8.02, 8.24 | 8020, 8024, 5030/8240 |
| * * * | * | * |
| Bis(2-chloroethyl)ether | 8.01, 8.24 | 8010, 8240, 3510/8270 |
| * * * | * | * |
| Cresol(s) | 8.04, 8.25 | 8040, 8250, 3510/8270 |
| * * * | * | * |
| Dichlorobenzene(s) | 8.01, 8.02, 8.12, 8.25 | 8010, 8120, 8250, 3519/8270 |
| 1,2-Dichloroethane | 8.01, 8.24 | 8010, 8240, 5030/8240 |
| 1,1-Dichloroethylene | | 5030/8240 |
| * * * | * | * |
| 2,4-Dinitrotoluene | 8.09, 8.25 | 8090, 8250, 3510/8270 |
| * * * | * | * |
| Hexachlorobenzene | 8.12, 8.25 | 8120, 8250, 3510/8270 |
| Hexachlorobutadiene | 8.12, 8.25 | 8120, 8250, 3510/8270 |
| Hexachloroethane | 8.12, 8.25 | 8010, 8240, 3510/8270 |
| * * * | * | * |
| Isobutanol | | 5030/8240 |
| * * * | * | * |
| Methoxychlor | | 8080 |
| Methylene chloride | | 5030/8240 |
| * * * | * | * |
| Nitrobenzene | 8.09, 8.25 | 8090, 8250, 3510/8270 |

TABLE 1.—ANALYSIS METHODS FOR ORGANIC CHEMICALS CONTAINED IN SW-846—Continued

| Compound | First edition method(s) | Second edition method(s) |
|---|---|---|
| * * * | * | * |
| Pentachlorophenol | 8.04, 8.25 | 8040, 8250, 3510/8270 |
| Phenol | 8.04, 8.25 8.22 | 8040, 8250, 8140, 3510/8270 |
| * * * | * | * |
| Pyridene | 8.06, 8.09, 8.25 | 8090, 8250, 3510/8270 |
| * * * | * | * |
| Tetrachloroethane(s) | 8.01, 8.24 | 8010, 8240, 5030/8240 |
| * * * | * | * |
| Tetrachloroethylene | | 5030/8240 |
| Tetrachlorophenol(s) | 8.04, 8.24 | 8040, 8250, 3510/8270 |
| Toluene | 8.02, 8.24 | 8020, 8024, 5030/8240 |
| * * * | * | * |
| Trichloroethane(s) | 8.01, 8.24 | 8010, 8240, 5030/8240 |
| Trichloroethylene | | 5030/8240 |
| * * * | * | * |
| Trichlorophenol(s) | 8.04, 8.25 | 8040, 8250, 3510/8270 |
| * * * | * | * |

## PART 271—REQUIREMENTS FOR AUTHORIZATION OF STATE HAZARDOUS WASTE PROGRAMS

1. The authority citation for Part 271 continues to read as follows:

**Authority:** Secs. 1006, 2002(a), and 3006 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6905, 6912(a), and 6926).

2. Amend § 271.1 Paragraph (j) by adding the following entry to Table 1 in chronological order by date of publication:

### § 271.1 Purpose and scope.

* * * * *

(j) * * *

TABLE 1.—REGULATIONS IMPLEMENTING THE HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984

| Date | Title of regulation |
|---|---|
| * * * | * * |
| June 13, 1986 | Toxicity Characteristic. |
| * * * | * * |

## PART 302—DESIGNATION, REPORTABLE QUANTITIES, AND NOTIFICATION

1. The authority citation for Part 302 continues to read as follows:

**Authority:** Sec. 102 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9602; Secs. 311 and 501(a) of the Federal Water Pollution Control Act, 33 U.S.C. 1321 and 1361.

2. Section 302.4 is amended by revising the entry for "Characteristic of EP Toxicity" in Table 302.4 and the footnotes are republished as follow:

### § 302.4 Designation of hazardous substances.

* * * * *

TABLE 3024.—LIST OF HAZARDOUS SUBSTANCES AND REPORTABLE QUANTITIES

| Hazardous substance | CASRN | Regulatory synonyms | Statutory | | | Final RQ | |
|---|---|---|---|---|---|---|---|
| | | | RQ | Code† | RCRA waste No. | Category | Pounds (Kg) |
| * | * | * * | * | | | | |
| Unlisted Hazardous Wastes | | | 1* | 4 | | | |
| * | * | * * | * | | | | |
| Toxicity Characteristic | | | 1* | 4 | | | |
| Acrylonitrile | 107131 | 2-Propenenitrile | 100 | 1,2,4 | D018 | B | 100#(45.4) |
| Arsenic | | | 1* | 4 | D004 | X | 1#(0.454) |
| Barium | | | 1* | 4 | D005 | C | 1000(454) |
| Benzene | 71432 | | 1000 | 1,2,3,4 | D019 | C | 1000#(454) |
| Bis(2-chloroethyl) ether | 111444 | Dichloroethyl ether Ethane, 1,1′-oxybis[2-chloro- | 1* | 2,4 | D020 | X | 1#(0.454) |
| Cadmium | | | 1* | 4 | D006 | X | 1#(0.454) |
| Carbon disulfide | 75150 | Carbon bisulfide | 5000 | 1,4 | D021 | D | 5000##(2270) |
| Carbon tetrachloride | 56235 | Methane, tetrachloro- | 5000 | 1,2,4 | D022 | D | 5000#(2270) |
| Chlordane | 57749 | Chlordane, technical 4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-. | 1 | 1,2,4 | D023 | X | 1#(0.454) |
| Chlorobenzene | 108907 | Benzene, chloro- | 100 | 1,2,4 | D024 | B | 100(45.4) |
| Chloroform | 67663 | Methane, trichloro- | 5000 | 1,2,4 | D025 | D | 5000#(2270) |
| Chromium | | | 1* | 4 | D007 | X | 1#(0.454) |
| o-Cresol | 95487 | o-Cresylic acid | 1000 | 1,4 | D026 | C | 1000##(454) |
| m-Cresol | 108394 | m-Cresylic acid | 1000 | 1,4 | D027 | C | 1000##(454) |
| p-Cresol | 106445 | p-Cresylic acid | 1000 | 1,4 | D028 | C | 1000##(454) |
| 2,4-D | | | 100 | 1,4 | D016 | B | 100(45.4) |
| 1,2-Dichlorobenzene | 95501 | Benzene, 1,2-dichloro-o-Dichlorobenzene | 100 | 1,2,4 | D029 | B | 100(45.4) |
| 1,4-Dichlorobenzene | 106467 | Benzene, 1,4-dichloro-p-Dichlorobenzene | 100 | 1,2,4 | D030 | B | 100(45.4) |
| 1,2-Dichloroethane | 107062 | Ethane, 1,2-dichloro-Ethylene dichloride | 5000 | 1,2,4 | D031 | D | 5000#(2270) |
| 1,1-Dichloroethylene | 75354 | Ethene, 1,1-dichloro-Vinylidene chloride | 5000 | 1,2,4 | D032 | D | 5000#(2270) |
| 2,4-Dinitrotoluene | 121142 | Benzene, 1-methyl-2,4-dinitro- | 1000 | 1,2,4 | D033 | C | 1000#(454) |
| Endrin | | | 1 | 1,4 | D012 | X | 1(0.454) |
| Heptachlor (and hydroxide) | 76448 | 4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-. | 1 | 1,2,4 | D034 | X | 1#(0.454) |
| Hexachlorobenzene | 118741 | Benzene, hexachloro | 1* | 2,4 | D035 | X | 1#(0.454) |
| Hexachlorobutadiene | 87683 | 1,3-Butadiene, 1,1,2,3,4,4- hexachloro- | 1* | 2,4 | D036 | X | 1#(0.454) |
| Hexachloroethane | 67721 | Ethane, 1,1,1,2,2,2-hexachloro- | 1* | 2,4 | D037 | X | 1#(0.454) |
| Isobutanol | 78831 | Isobutyl alcohol 1-Propanol, 2-methyl- | 1* | 4 | D038 | D | 5000(2270) |
| Lead | | | 1* | 4 | D008 | X | 1##(0.454) |

TABLE 3024.—LIST OF HAZARDOUS SUBSTANCES AND REPORTABLE QUANTITIES—Continued

| Hazardous substance | CASRN | Regulatory synonyms | Statutory | | | Final RQ | |
|---|---|---|---|---|---|---|---|
| | | | RQ | Code† | RCRA waste No. | Category | Pounds (Kg) |
| Lindane | | | 1 | 1,4 | D013 | X | 1≠(0.454) |
| Mercury | | | 1* | 4 | D009 | X | 1(0.454) |
| Methoxychlor | | | 1 | 1,4 | D014 | X | 1(0.454) |
| Methylene chloride | 75092 | Methane, dichloro- | 1* | 2,4 | D039 | C | 1000(454) |
| Methyl ethyl ketone | 78933 | 2-Butanone | 1* | 4 | D040 | D | 5000(2270) |
| Nitrobenzene | 98953 | Benzene, nitro- | 1000 | 1,2,4 | D041 | C | 1000(454) |
| Pentachlorophenol | 87865 | Phenol, pentachloro | 10 | 1,2,4 | D042 | A | 10≠(4.54) |
| Phenol | 108952 | Benzene, hydroxy- | 1000 | 1,2,4 | D043 | C | 1000≠≠(454) |
| Pyridine | 110861 | | 1* | 4 | D044 | X | 1≠≠(0.454) |
| Selenium | | | 1* | 4 | D010 | X | 1≠≠(0.454) |
| Silver | | | 1* | 4 | D011 | X | 1(0.454) |
| 1,1,1,2-Tetrachloroethane | 630206 | Ethane, 1,1,1,2-tetrachloro | 1* | 4 | D045 | X | 1≠(0.454) |
| 1,1,2,2-Tetrachloroethane | 79345 | Ethane, 1,1,2,2-tetrachloro- | 1* | 2,4 | D046 | X | 1≠(0.454) |
| Tetrachloroethylene | 127184 | Ethene, 1,1,2,2-tetrachloro- | 1* | 2,4 | D047 | X | 1≠(0.454) |
| 2,3,4,6-Tetrachlorophenol | 58902 | Phenol, 2,3,4,6-tetrachloro- | 1* | 4 | D048 | A | 10(4.54) |
| Toluene | 108883 | Benzene, methyl- | 1000 | 1,2,4 | D049 | C | 1000(454) |
| Toxaphene | | | 1 | 1,4 | D015 | X | 1≠(0.454) |
| 1,1,1-Trichloroethane | 71556 | Methyl chloroform | 1* | 2,4 | D050 | C | 1000(454) |
| 1,1,2-Trichloroethane | 79005 | Ethane, 1,1,2-trichloro- | 1* | 2,4 | D051 | X | 1≠(0.454) |
| Trichloroethylene | 79016 | Trichloroethene | 1000 | 1,2,4 | D052 | C | 1000≠(454) |
| 2,4,5-Trichloro-phenol | 95954 | Phenol, 2,4,5-trichloro- | 10 | 1,4 | D053 | A | 10≠(4.54) |
| 2,4,6-Trichloro-phenol | 88062 | Phenol, 2,4,6-trichloro- | 10 | 1,2,4 | D054 | A | 10≠(4.54) |
| 2,4,5-TP | | | 100 | 1,4 | D017 | B | 100(45.4) |
| Vinyl chloride | 75014 | Ethene, chloro- | 1* | 2,3,4 | D055 | X | 1≠(0.454) |

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†—Indicates the statutory source as defined by 1,2,3, or 4 below.
1—Indicates that the statutory source for designation of this hazardous substance under CERCLA is CWA Section 311(b)(4).
2—Indicates that the statutory source for designation of this hazardous substance under CERCLA is CWA Section 307(a).
3—Indicates that the statutory source for designation of this hazardous substance under CERCLA is CAA Section 112.
4—Indicates that the statutory source for designation of this hazardous substance under CERCLA is RCRA Section 3001.

* * * * *

1*—Indicates that the 1-pound RQ is a CERCLA statutory RQ.

* * * * *

≠—Indicates that the RQ is subject to change when the assessment of potential carcinogenicity and/or chronic toxicity is completed.
≠≠—Indicates that an adjusted RQ is proposed in a spearate NPRM [50 FR 13154, April 4, 1985].
≠≠≠—The Agency may adjust the RQ for methyl isocyanate in a future rulemaking; until then the statutory 1-pound RQ applies.

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