THE TOXICITY CHARACTERISTIC RULE FOR HAZARDOUS WASTE DETERMINATION: HAS EPA SATISFIED CONGRESS' MANDATE?

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I. INTRODUCTION

When Congress enacted the 1984 Hazardous and Solid Waste Amendments (HSWA),[1] legislators expressed concern that existing hazardous waste regulations failed to address the threat of a number of hazardous wastes, most notably the threat from organic chemicals.[2] Because of this concern, Congress amended section 3001 of the Resource Conservation and Recovery Act of 1976 (RCRA),[3] using especially strong language which required the Environmental Protection Agency (EPA or the Agency) to "examine the deficiencies of the extraction procedure toxicity characteristic [EPTC] as a predictor of the leaching potential of wastes . . . ."[4] Congress also mandated changes in the way in which hazardous wastes are identified. These changes were to take the form of a new leachate extraction test which would "accurately predict[] the leaching potential of wastes which pose a threat to human health and the environment when mismanaged."[5]

In March 1990, EPA promulgated the Toxicity Characteristic Leaching Procedure (TCLP) to meet Congress' mandate for a new test under RCRA section 3001,[6] thus adding twenty-five toxins to the existing fourteen regulated under 40 C.F.R. section 261.24. Most of these newly added toxins are organic chemicals and all are known toxins, carcinogens, mutagens or teratogens derived from a pre-existing list of toxins located in EPA hazardous waste regulations at Appendix VIII of 40 C.F.R. Part 261.

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[1] Pub. L. No. 98-616, 98 Stat. 5576 (1984).

[2] OFFICE OF SOLID WASTE, U.S. ENVIRONMENTAL PROTECTION AGENCY, TOXICITY CHARACTERISTIC TRAINING COURSE 1-5 (1990) [hereinafter TOXICITY CHARACTERISTIC TRAINING COURSE]. *See also* 55 Fed. Reg. 11,798, at 11,800 (1990) (promulgation of final Toxicity Characteristics rule).

[3] 42 U.S.C. §§ 6901-6992k (1988).

[4] RCRA § 3001(g), 42 U.S.C. § 6921(g) (1988).

[5] *Id.*

[6] 55 Fed. Reg. 11,798, at 11,800 (1990).

Although the TCLP is an improvement over the former EPTC test, the TCLP still falls far short of Congress' mandate. As this paper will discuss, the new test procedure is not an effective attempt to protect the environment. The new test is only slightly more aggressive and reliable than the former test, and adds only twenty-five toxins to the list of regulated chemicals. This slight improvement over the EPTC fails to protect human health and the environment in the manner envisioned by Congress in the explicit language of RCRA section 3001. As a result, unless the TCLP is refined and hundreds more toxic chemicals added to the TCLP list, toxins will be free to enter the environment unregulated, thus creating soil and groundwater contamination.

II. HAZARDOUS WASTE IDENTIFICATION AND LISTING

Hazardous waste identification and listing is the core of RCRA.[7] Wastes are defined as hazardous (1) if they are listed in 40 C.F.R. Part 261, or (2) if wastes exhibit any of the characteristics of hazardous waste found in 40 C.F.R. Part 261. As required by section 3001(a) of RCRA, EPA has promulgated regulations for both listed and characteristic wastes.[8] Since 1980, this effort has produced 218 specific listings and four hazardous waste characteristics.[9]

EPA categorizes its listed hazardous wastes as K, F, P or U depending upon the source of the waste. K-wastes are the products of specific industries or processes as set forth in 40 C.F.R. section 261.32. K-wastes are not defined by their chemical constituents, but rather by the production of particular compounds used in the chemical industry.[10] For example, wastewater sludges from the production of

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[7] 42 U.S.C. § 6921. This section requires EPA to promulgate regulations for the identification and listing of hazardous wastes. The bulk of those regulations were promulgated in 1980. *See* 45 Fed. Reg. 33,084, at 33,119-33 (1980) (codified at 40 C.F.R. pt. 261 (1992)).

[8] *See* 42 U.S.C. § 6921(a) (1988). Wastes may also be deemed hazardous if they are a mixture of solid and hazardous waste via the mixture rule, promulgated at 40 C.F.R. § 261.3(a)(2), or if they are derived from the treatment, storage or disposal of hazardous wastes under the derived-from rule, also promulgated at 40 C.F.R. § 261.3. *See also* 40 C.F.R. § 261.30-.33 (1992) (listed-waste regulations); 40 C.F.R. § 261.20-.24 (1992) (characteristic-waste regulations).

[9] TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-1; *see generally* 40 C.F.R. pt. 261 (1992).

[10] *See* 40 C.F.R. § 261.32 (1992).

paints are listed as hazardous without reference to specific constituents.[11]

F-wastes are hazardous wastes from nonspecific sources that must fit within the twenty-three regulatory descriptions found in 40 C.F.R. section 261.31. F-wastes can be similar to K-wastes in that wastes from chemical processes are included. However, the F-waste list also contains some specific chemical compounds from particular processing operations.[12]

P-wastes and U-wastes form a catch-all grouping of discarded commercial chemical products, off-specification species, container residues, and spill residues.[13] The P and U lists contain over 400 specific chemical compounds.[14] At first glance, these lists look quite comprehensive. However, the comment to the P and U list rule indicates that in reality the list is limited. The comment limits P and U wastes to (1) certain types of chemical substances that are manufactured or formulated for commercial or manufactured use consisting of the pure grade of the chemical; (2) any technical grades of the chemical that are produced or marketed; and (3) all formulations in which the chemical is the sole active ingredient.[15]

Because of limitations imposed by *source-specific* listings, the percentage of toxic chemical compounds covered by these lists is relatively small in comparison to the universe of hazardous and toxic substances that pose a threat to human health and the environment. To fill the gaps created by the inherent limitations in listing, Congress required EPA not only to develop criteria to list specific hazardous wastes but also to promulgate criteria for identifying the characteristics that made wastes hazardous.[16] In May 1980, EPA promulgated regulations for four characteristics of hazardous waste: ignitability,[17] corrosivity,[18] reactivity,[19] and toxicity.[20]

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[11] *Id.*

[12] *See* 40 C.F.R. § 261.31 (1992).

[13] 40 C.F.R. § 261.33 (1992); *see* 45 Fed. Reg. 78,532, at 78,540 (1980).

[14] *See* 40 C.F.R. § 261.33 (1992).

[15] *See* 40 C.F.R. § 261.33(d) cmt. (1992).

[16] 42 U.S.C. § 6921(a) & (b). Congress specifically required EPA to take into account “toxicity, persistence, and degradability in nature, potential for accumulation in tissue, and other related factors such as flammability, corrosiveness, and other hazardous characteristics.” *Id.* § 6921(a).

[17] 40 C.F.R. § 261.21 (1992). The ignitability characteristic includes: liquids with a flash point of less than 60 degrees centigrade; nonliquids that may catch fire at standard

Definitions of the first three characteristics are dependent upon general physical properties of wastes. In promulgating the toxicity characteristic, however, EPA has for all practical purposes resorted again to listing specific chemicals. The problem with this approach is that while a toxicity characteristic has the greatest potential for preventing damage to human health or the environment from wastes that would otherwise escape listing, EPA's approach to the toxicity characteristic drastically underrepresents the universe of hazardous wastes.[21] Thus, as promulgated and presently used, EPA's toxicity characteristic fails to perform the function anticipated by Congress and leaves the environment at risk from exposure to the many toxins and hazardous wastes produced by industry.[22]

The definition of what constitutes a hazardous waste under RCRA has serious implications for the environment and the regulated community. RCRA regulates the treatment, handling, and disposal of hazardous wastes from the "cradle to the grave." Of particular importance is disposal since improper disposal can result in hazardous waste leaching. This leaching of toxic substances is the primary mechanism of mass hazardous waste transport.[23] Because of the rising number of sites where leachate has contaminated groundwater aquifers, EPA has tightened management practices and regulatory requirements associated with waste disposal. As a consequence of

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temperature and pressure through friction; and ignitable compressed gases. Ignitable hazardous wastes are given the hazardous waste number D001. *Id.*

[18] 40 C.F.R. § 261.22 (1992). Corrosive wastes include: wastes with a pH less than or equal to 2 (strongly acidic), or a pH greater than or equal to 12.5 (strongly basic); or liquids that corrode steel at a rate greater than 6.35 millimeters per year at 55 degrees centigrade. Corrosive wastes are given the hazardous waste number D002. *Id.*

[19] 40 C.F.R. § 261.23 (1992). Reactive wastes include normally unstable wastes, wastes which react violently with water, cyanide- or sulfide-bearing wastes, and wastes capable of detonation or explosion. Reactive wastes are given the hazardous waste number D003. *Id.*

[20] 40 C.F.R. § 261.24 (1992). Toxicity Characteristic constituents are given the hazardous waste numbers D004 through D042. *Id.*

[21] The legislative history of the 1984 HSWA indicates that Congress believed that the extraction procedure toxicity test was underinclusive in identifying hazardous wastes. H.R. CONF. REP. NO. 1133, 98th Cong., 2d Sess. 105-06 (1984), *reprinted in* 1984 U.S.C.C.A.N. 5649, 5676-77.

[22] *See also* Gregory P. Barton, Comment, *RCRA Leachate Testing Regulations: Is the Groundwater Safe? Are We Safe?*, 22 ENVTL. L. 387 (1992) (discussing generally the environmentally dangerous status of the hazardous waste industry and regulation).

[23] *See* IAN J. TINSLEY, CHEMICAL CONCEPTS IN POLLUTANT BEHAVIOR 32, 34-35 (1979) (discussing chemical movement through soil).

this increased regulation, the importance of the TCLP as an indicator of leachability of wastes will also increase.[24]

III. THE EXTRACTION PROCEDURE TOXICITY TEST

EPA promulgated the Extraction Procedure Toxicity Characteristic (EPTC) in May 1980.[25] Under the EPTC, the EPA required wastes to be tested by the Extraction Procedure (EP) test for fourteen particular contaminants. Eight of these contaminants were metals[26] and six were pesticides.[27]

EPA intended the EPTC to identify wastes with the potential for leaching toxic constituents into groundwater.[28] Therefore, the EPTC test attempted to simulate the conditions under which leaching occurred in actively decomposing landfills.[29] The maximum allowable concentrations for constituents in the leachate was set according to the National Primary Drinking Water Standards (NPDWS).[30] In setting these benchmarks, EPA simply applied a dilution/attenuation factor (DAF)[31] of 100 to the NPDWS.[32] Thus, the toxicity levels set under the EP toxicity test were established at 100 times the allowable levels for those metals and pesticides in the NPDWS.[33]

The scientific community noted a number of problems with the EPTC. For example, the initial solid/liquid separation technique

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[24] Danny R. Jackson et al., *Comparison of Batch and Column Methods for Assessing Leachability of Hazardous Waste*, 18 ENVTL. SCI. & TECH. 668-73 (1984).

[25] 45 Fed. Reg. 33,084, at 33,122 (1980) (codified at 40 C.F.R. § 261.24 (1989)).

[26] The eight metals tested for by the EP toxicity test are arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. 40 C.F.R. § 261.24, tbl. I (1989).

[27] The six pesticides included four insecticides (Endrin, Lindane, Methoxychlor, and Toxaphene) and two herbicides (2,4-D (2, 4-Dichlorophenoxyacetic acid) and 2,4,5-TP silvex (2,4,5-Trichlorophenoxypropionic acid)). *Id.* Todd A. Kimmell & David Friedman, *Model Assumptions and Rationale Behind the Development of EP-III, in* HAZARDOUS AND INDUSTRIAL SOLID WASTE TESTING: FOURTH SYMPOSIUM, AMERICAN SOCIETY FOR TESTING AND MATERIALS 36, 37 (J. K. Petros et al. eds., 1986).

[28] *See* 45 Fed. Reg. 33,084, at 33,110 (1980); TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-5.

[29] *See* Kimmell & Friedman, *supra* note 27, at 37-38.

[30] TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-5.

[31] The dilution/attenuation factor is the expected reduction in concentration of a constituent during transport through soil and groundwater from leachate release at the exposure point. *Id.* at 1-15.

[32] *Id.* at 1-5.

[33] *Id.*

required by the EPTC involved pressure filtration through a 0.45-micron nitrocellulose filter which tended to clog when oily wastes were tested.[34] As a result, materials that did not pass through the filter were treated as solids even though they behaved as liquids in the environment.[35] Another problem was the continual pH monitoring that EPA required under the EPTC. Under this requirement, the Agency required maintenance of a constant pH level of 5.0, plus or minus 0.2.[36] These constant pH levels were difficult to maintain over the length of the test.[37] Further, there was concern that the EPTC's failure to adequately define the agitation technique could introduce unnecessary variability into the test.[38] Individual testing laboratories could therefore subject samples to different agitation techniques, thereby affecting the dissolution of toxins and changing test results.

IV. THE TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)

EPA proposed to expand the Toxicity Characteristic (TC) in June 1986.[39] The rule was formally promulgated in March 1990 and became effective on September 25, 1990.[40] It requires a new and improved test for hazardous wastes, the Toxicity Characteristic Leaching Procedure (TCLP).[41] While the proposed TCLP originally listed fifty-two toxins, the final rule listed only thirty-nine.[42]

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[34] Kimmell & Friedman, *supra* note 27, at 51; 51 Fed. Reg. 21,648, at 21,681 (1986) (proposed TCLP rule).

[35] *Id.* at 21,651. *See infra* notes 121-22 and accompanying text discussing the implications of solid-phase composition of wastes on toxicity testing.

[36] 40 C.F.R. pt. 261, App. II, Step A.5 (1989).

[37] *See* 51 Fed. Reg. 21,648, at 21,653, 21,681 (1986).

[38] ANDREA M. DIETRICH ET AL., COMPARISON OF TWO TESTS FOR TRACE-ORGANIC COMPOUNDS IN LAND-APPLIED SEWAGE SLUDGE 11 (1990) (available from Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University); 51 Fed. Reg. 21,648, at 21,656. *See also* D.K. BROWN ET AL., OAK RIDGE NAT'L LAB., MOBILITY OF ORGANIC COMPOUNDS FROM HAZARDOUS WASTES 4 (Nat'l Technical Info. Serv., No. PB83-163956, 1983).

[39] 51 Fed. Reg. 21,648 (1986).

[40] 55 Fed. Reg. 11,798 (1990).

[41] 40 C.F.R. pt. 261, App. II (1992).

[42] *Compare* 51 Fed. Reg. 21,648, at 21,652 (1986) (listing 52 compounds for the proposed TCLP) *with* 40 C.F.R. § 261.24, tbl. 1 (1992) (final TCLP rule listing 39 compounds).

Fourteen of the thirty-nine listed toxins were already included in the EPTC test.[43]

In accordance with the explicit congressional mandate of the amended section 3001 of RCRA, the TCLP test features a number of improvements over the EPTC test. Rather than using the drinking water standards (NPDWS), EPA determined chronic toxicity reference levels (CTRLs) for each individual chemical on the TC list.[44] EPA based many CTRLs for the new TC upon the Safe Drinking Water Act's Maximum Contaminant Levels (MCLs).[45] If the compound is a carcinogen, EPA based the CTRLs on risk specific doses (RSDs).[46] The RSDs in the final rule were designed so that the risk of getting cancer was 1 in 100,000.[47] For noncarcinogens, the TCLP uses reference doses (RfDs) as an estimate of the daily dose of a substance that would result in no observed adverse effects after a lifetime of exposure.[48]

EPA established the regulatory levels for TCLP toxic constituents in 40 C.F.R. section 261.24 based on two criteria: (1) the toxicity of each constituent; and (2) the expected fate, or persistence, of the constituent in the environment.[49] Fate is expressed as a dilution/attenuation factor (DAF) which is multiplied by the toxicity value resulting in the regulatory level set in the TCLP.[50] Unlike the EP, the TCLP set compound-specific DAFs to better predict the leaching and groundwater transport for the compounds.[51]

The Agency set the regulatory level for the TCLP by multiplying the CTRL (as established by MCLs, RfDs or RSDs, where applicable), by the DAF, set at 100 for most compounds.[52] For example, under this formula, EPA determined the regulatory level for arsenic to be arsenic's MCL of 0.05 mg/l multiplied by a DAF of 100

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[43] *Compare* 40 C.F.R. § 261.24, tbl. I (1989) *with* 40 C.F.R. § 261.24, tbl. 1 (1992).

[44] TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-14.

[45] *See id.* A constant assumption in the model was that a representative number of the relevant population drinks two liters of water per day for 70 years. *Id.* at 1-16.

[46] *Id.* at 1-14.

[47] *Id.*

[48] *Id.* Appendix A of the TOXICITY CHARACTERISTIC TRAINING COURSE contains a list of the toxicity characteristic constituents and the CTRL basis for which they were chosen. *Id.* at A-2.

[49] 55 Fed. Reg. 11,798, at 11,843 (1990).

[50] *Id.*

[51] *See id.* at 11,816, 11,843.

[52] TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-15 to 1-16.

for the regulatory level of 5.0 mg/l.[53] If the quantitation limit for a chemical, the lowest level that can be reliably measured in the laboratory, exceeded the regulatory level calculated by this formula, the quantitation limit was used as the regulatory level.[54] The regulatory levels already established under the EP test remained the same for the TCLP.[55]

In order to understand the problems with the TCLP test, one must understand the assumptions upon which the test was based. The groundwater transport model used to estimate contamination levels was based upon an infinite source of pollutant going into an aquifer of constant thickness under steady-state conditions.[56] EPA assumed that aquifer flow was uniform and continuous in a vertical direction, and that the groundwater upstream from the point of contamination was uncontaminated.[57] Although EPA assumed that constituents in the landfill would degrade, degradation was limited to hydrolysis, a reaction involving water.[58] The Agency assumed that hydraulic conditions such as conductivity were continuous under varying temperatures.[59]

V. MAJOR TECHNICAL DIFFERENCES BETWEEN THE TESTS

The new TCLP test has four major changes from the prior EPTC test:[60]

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[53] 55 Fed. Reg. 11,798, at 11,804 (tbl. II.2.), 11,813-16 (1990).

[54] TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-16. Three constituents were set at the quantitation limit: 2,4-dinitrotoluene, hexachlorobenzene, and pyridine. *Id.*

[55] *Id.* However, because the leaching procedures for the two tests are different, wastes that are hazardous under the EP and the TCLP may not be the same. *Id.*

[56] *Id.* at 1-15.

[57] *Id.*

[58] Fate is a measure of the persistence of a compound under certain conditions. *See supra* note 49 and accompanying text. Fate is affected by environmental factors such as hydrolysis. *See* 55 Fed. Reg. 11,798, at 11,843 (1990).

Hydrolysis has two potential effects on a toxin: first, it may decrease the concentration of the toxin; or second, it may react to yield a chemical constituent which is itself a toxin. *Id.* One of the problems with the TCLP is that the product of hydrolysis of a toxin may be a toxin in and of itself, and may not necessarily be regulated. *See id.*

[59] *See* 55 Fed. Reg. 11,798, at 11,817, 11,822 (1990).

[60] L.P. JACKSON & S. SORINI, W. RESEARCH INST., EVALUATION OF THE TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) ON UTILITY WASTES S-1 (1987) (Elec. Power Research Inst., CS-5355, Research Project 2708-2).

(1) ORGANIC CONSTITUENTS: The EPTC tested only for inorganic constituents, while the TCLP also tests for semi-volatile and volatile organic compounds.[61]

(2) LEACHING MEDIUM: The EPTC uses an acetic acid leaching medium at variable pH depending upon the alkalinity of the waste. The TCLP uses either a buffered sodium-acetate leach medium or a nonbuffered acetic acid leach medium of fixed pH based on the alkalinity of the waste.[62]

(3) FILTER PORE SIZE: The TCLP test procedure uses a larger filter pore size of 0.7 microns as compared to the 0.45-micron filter used in the EPTC.[63]

(4) TESTING TIME: The TCLP extraction period is eighteen hours while the EPTC period was twenty-four hours.[64]

The TCLP test procedure differs from the EP test by requiring selection of one of two different leaching solutions, depending upon the pH of the waste being tested.[65] Furthermore, the testing protocol under the TCLP is split into two extractions: one for volatile constituents[66] and another for nonvolatile constituents.[67] Nonvolatile constituents are tested using "filtration, extraction and/or separation

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[61] *Id.* An organic compound is any one of the large group of chemicals whose molecular structure is based upon the carbon atom. The EPTC tested mainly for elemental chemicals rather than organic compounds, with the exception of six pesticides which are, in fact, also organic compounds. *See* 40 C.F.R. § 261.24 tbl. I (1989); Kimmell & Friedman, *supra* note 27, at 37.

[62] JACKSON & SORINI, *supra* note 60, at S-1; *see also* 40 C.F.R. pt. 261, App. II, Step A.5 (1989); 40 C.F.R. pt. 261, App. II, Step 5.0 (Reagents) (1992).

[63] JACKSON & SORINI, *supra* note 60, at S-1; *see also* 40 C.F.R. pt. 261, App. II, Step A (Separation Procedure) (1989); 40 C.F.R. pt. 261, App. II, Step 4.0 (Apparatus and Materials) (1992).

[64] JACKSON & SORINI, *supra* note 60, at S-1; *see also* 40 C.F.R. pt. 261, App. II, Step A.5(d) (1989); 40 C.F.R. pt. 261, App. II, Step 7.0 (Procedure) (1992).

[65] Wastes with a pH of 5.0 or greater (slightly acidic to alkaline wastes) are extracted with an acidic unbuffered solution (pH 2.88 +/- 0.05), while wastes with a pH of less than 5.0 (strongly to slightly acidic wastes), are extracted with a slightly acidic buffered acetic acid solution (pH 4.93 +/- 0.05). *See* 40 C.F.R. pt. 261, App. II, Steps 5.0 (Reagents) & 7.0 (Procedure) (1992).

[66] Volatility is a physical property of chemicals and is expressed as a point at which vaporization of a chemical compound occurs. Volatility is largely dependent upon the molecular structure of a chemical and temperature, where chemical compounds of lower molecular weight are generally more volatile, and volatility increases with an increase in temperature. *See generally* JACK E. FERNANDEZ, ORGANIC CHEMISTRY 6-8 (1984).

[67] 40 C.F.R. pt. 261, App. II, Step 7.0 (Procedure) (1992).

of a waste,"[68] while volatile constituents are tested using the zero-headspace extraction procedure.[69] This procedure requires a new piece of equipment that is expensive and difficult to operate. The device is prone to scoring when testing small abrasive particles, and the filter is prone to clogging,[70] thereby adversely affecting test results.

Many improvements in the TCLP are designed to reduce the chance of erroneous readings due to innate properties of the testing equipment itself. For example, the TCLP requires that all equipment be inert towards organic and inorganic analytes.[71] Such equipment is considerably more expensive than the plastic devices formerly used in the EPTC test and requires rigorous and expensive cleaning.[72] To avoid binding of testing material with the filter, EPA discontinued use of the nitrocellulose filter in favor of an expensive and fragile glass filter which must be acid-washed for decontamination after each use.[73] Finally, EPA analyzes TCLP extract by inductively coupled emission spectroscopy,[74] graphite furnace atomic absorption[75] and cold vapor atomic absorption.[76]

A. Organic Compounds

In mandating a new, revised toxicity test, Congress was concerned that the EPTC did not identify hazardous wastes due to toxic levels of organic constituents.[77] A great number of organic chemicals known as carcinogens, mutagens, teratogens or chronically toxic pollutants were not included in the original EPTC list.[78] In

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[68] TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-17.

[69] *Id.* Zero-headspace extraction involves the use of an enclosed container designed to prevent volatile components from dissipating into the atmosphere and escaping detection. *Id. See* 40 C.F.R. pt. 261, App. II, Step 7.0 (Procedure) (1992).

[70] JACKSON & SORINI, *supra* note 60, at 2-2, 4-1.

[71] *Id.* at 2-1.

[72] *Id.* at 2-2.

[73] *Id.*

[74] This method is typically used for analysis of barium, cadmium, chromium, lead, nickel, and silver, for example. *See* JACKSON & SORINI, *supra* note 60, at 6-10.

[75] This method is typically used for analysis of arsenic, selenium, and thallium. *See id.*

[76] This method is typically used for analysis of mercury. *See id.*

[77] H.R. REP. NO. 198, 98th Cong., 2nd Sess. 52-53 (1984) *reprinted in* 1984 U.S.C.C.A.N. 5576, 5615-16; 51 Fed. Reg. 21,648, at 21,649 (1986).

[78] H.R. REP. NO. 198, at 52-53.

response to Congress' mandate under the amended section 3001, EPA added twenty-five constituents in the TCLP test to the original fourteen EPTC test constituents.[79] The new organic compounds were selected from the list of hazardous constituents in Appendix VIII of 40 C.F.R. Part 261 known to have toxic, carcinogenic, mutagenic or teratogenic effects.[80]

The concern is that organic compounds may be volatile, while metals typically are not (with the notable exception of mercury). Volatility complicates the testing procedure by requiring the use of the zero-headspace extractor (ZHE) for some of the most volatile organic chemicals. The following volatile and semi-volatile compounds must be analyzed using the ZHE: benzene; carbon disulfide; chlorobenzene; chloroform; methylene chloride; 1,1,2,2-tetrachloroethane; tetrachloroethylene; 1,1,1-trichloroethane; 1,1,2-trichloroethane; trichloroethylene; and vinyl chloride.[81]

B. Leaching Medium

The leaching medium of the EPTC was the single largest source of error in the test results, and it required considerable labor costs.[82] The EPTC required the constant attention of an operator to maintain the pH level of the sample at 5.0, plus or minus 0.2,[83] while the TCLP requires a one-time addition of the proper extraction fluid.[84] Under the TCLP, the proper extraction fluid is determined according to the alkalinity of the waste: for neutral or acidic wastes, this fluid is a slightly acidic buffered acetic acid solution (pH 4.93, plus or minus 0.05) and for alkaline wastes, this fluid is an acidic unbuffered solution (pH 2.88, plus or minus 0.05).[85]

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[79] *See* 40 C.F.R. § 261.24, tbl. 1 (1992). The original proposal called for the addition of thirty-eight organic constituents to the toxicity characteristic. *See* 51 Fed. Reg. 21,648 at 21,652, tbl. 1 (1986).

[80] 55 Fed. Reg. 11,798, at 11,801 (1990).

[81] *See also* 40 C.F.R. pt. 261, App. II, Step 7.3 (Procedures When Volatiles are Involved) (1992).

[82] *See* JACKSON & SORINI, *supra* note 60, at 2-3.

[83] This pH is met by adding up to 400 ml of 0.5N acetic acid to a solution of 100 grams of waste in 1600 ml of distilled water until the desired pH is obtained or the maximum amount of acid solution is added. *Id.* at 5-1. *See also* DIETRICH ET AL., *supra* note 38, at 11.

[84] *See* 40 C.F.R. pt. 261, App. II, Step 7.0 (Procedure) (1992). *See also* JACKSON & SORINI, *supra* note 60, at 2-3.

[85] *Id.* at 5-1. If the waste has a pH of less than 5.0 (neutral to acidic), 2.0 L of a buffered acetic acid solution is used per 100 grams of waste. If the waste has a pH value of

The pH level is the dominant chemical variable affecting the leaching potential of inorganic chemicals in wastes.[86] For alkaline wastes, because the unbuffered TCLP solution results in an extraction fluid of the same pH as the EPTC, extraction would not be expected to differ for neutral or acidic wastes under either test.[87] However, for acidic or neutral constituents, the use of a buffered acid solution in the TCLP test subjects neutral and acidic constituents to the effects of the buffering agents, thereby reducing the total acidity of the wastes themselves.[88] Thus, significant differences existed in leachate from TCLP and EPTC tests.[89] Some scientists have suggested that the level of extractable compounds may increase with increasing acidity.[90] Therefore, the TCLP, with its more acidic leachate medium for alkaline wastes, would be expected to produce higher concentrations of wastes. This increased concentration has been the case in the limited number of studies conducted.[91]

C. *Filter Pore*

Another major problem with the EPTC test was that the small 0.45-micron pore size resulted in filtration times commonly greater than one hour.[92] Moreover, the filter was prone to clogging.[93] The TCLP increased the filter pore size, thereby reducing the time required to filter leachate.[94] The TCLP also changed the filter material from nitrocellulose to glass to minimize the absorption of organics from the leachate onto the filter.[95]

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greater than 5.0 (slightly acidic to alkaline), it is leached with 2.0 L of unbuffered acetic acid. 51 Fed. Reg. 40,572, at 40,643-45 (1986) (codified at 40 C.F.R. pt. 261, App. II, Steps 5, 7, 7.1.4.4 (1992)).

[86] JACKSON & SORINI, *supra* note 60, at 5-2.

[87] *See id.* at 5-1.

[88] *See id.*

[89] *See id.* at 5-16 tbl. 5-3. As table 5-3 demonstrates, the TCLP test is more aggressive for leaching silver, arsenic, and chromium, while the EPTC is more aggressive for barium. *Id.* at 5-16. *See infra* part VI.

[90] *See id.* at 5-23.

[91] *Id.* at ch. 5.

[92] *Id.* at 4-1.

[93] *Id.*

[94] *Id.*

[95] *Id.;* OFFICE OF SOLID WASTE, ENVIRONMENTAL PROTECTION AGENCY, TOXICITY CHARACTERISTIC LEACHING PROCEDURE: BACKGROUND DOCUMENT (1986) [hereinafter TCLP BACKGROUND DOCUMENT].

These changes to the filter pore size and to the filter material may dramatically increase the quantity of compounds recovered from the test.[96] Thus, it would be expected that the increased pore size and new filter material might result in increased detection of toxins under the TCLP.

Under the TCLP, all samples now must be able to pass through a 9.5-millimeter sieve at a pressure of fifty pounds per square inch (psi) prior to testing.[97] Samples that cannot pass through the sieve are defined as solids and carried through the extraction with no additional preparation.[98]

D. Additional Improvements

To prevent variability due to differences in agitation techniques, the TCLP set specific agitation guidelines.[99] EPA selected rotary agitation because of its ability to promote contact between the liquid and solid phases.[100] These specific guidelines and the use of rotary agitation would appear to be a reasonable improvement.

VI. ANALYSIS OF TCLP AND EPTC RESULTS

The electric utility industry and others have studied the EPTC and the newer TCLP. As discussed in this section, the studies have demonstrated significant differences in detection of toxins between the two test protocols.

A. The Electric Utility Industry Studies

The electric utility industry studies were concerned with hazardous waste characterization of by-products of fossil fuel combustion, particularly the characterization of fly ash, bottom ash,

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[96] C.M. WHITE ET AL., PITTSBURGH ENERGY TECHNOLOGY CTR., DEVELOPMENT OF AN ANALYTICAL METHOD FOR THE DETERMINATION OF ORGANIC COMPOUNDS IN FOSSIL-FUEL AQUEOUS LEACHATES 6, 39 (Dep't of Energy, DOE/PETC/TR-84/1, 1983) (1983 Department of Energy report documenting the dramatic difference in relative recovery of compounds when using the larger glass filter).

[97] 40 C.F.R. pt. 261, App. II (1992).

[98] *See* JACKSON & SORINI, *supra* note 60, at 4-4.

[99] *See* TCLP BACKGROUND DOCUMENT, *supra* note 95.

[100] *Id.*

and flue sludge.[101] These wastes are produced from conventional and advanced sulfur dioxide control technologies commonly used in the electric utility industry.[102] The studies were designed to characterize the toxins in electric utility wastes and to compare the results obtained from the EPTC testing protocol with the new TCLP testing protocol.[103] Additionally, the studies were to evaluate the reproducibility of the TCLP on utility waste samples.[104]

The electric utility studies hypothesized that three aspects of the TCLP would account for variation with the EPTC: (1) the increase of filter pore size from 0.45 microns in the EPTC to 0.7 microns in the TCLP; (2) the effect of changing the chemical nature, especially pH level, of the leachate medium; and (3) the additional requirement of testing for organic compounds in the TCLP test.[105]

The significance of the first factor is based upon the hypothesis that the increase in filter pore size mandated by the new TCLP test allows smaller particles to pass into the leachate, thereby increasing the concentration of toxins.[106] The electric utility industry expected the change in leachate medium to affect the leachate sample significantly due to the differences in dissolution of toxins under varying pH conditions.[107] Determination of the levels of organic compounds in coal combustion wastes assisted the electric utility industry in ascertaining the levels of organic toxins previously

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[101] *E.g.*, B.J. MASON & D.W. CARLILE, ETHURA & BATTELLE, PAC. N.W. LAB., ROUND-ROBIN EVALUATION OF REGULATORY EXTRACTION METHODS FOR SOLID WASTES 2-1 (Elec. Power Research Inst. EA-4740, Research Project 2485-8, 1986).

Coal combustion wastes are exempted from RCRA regulation under 40 C.F.R. § 261.4(b)(4) (1992). At the time the study was conducted, the exemption for coal combustion wastes was under review by EPA. JACKSON & SORINI, *supra* note 60, at 7-1. Nevertheless, the electric utility industry has been most active in characterization of its wastes under the toxicity characteristic testing protocols, perhaps in order to maintain this exception from RCRA regulation.

[102] JACKSON & SORINI, *supra* note 60, at iii.

[103] *Id.* at S-1; MASON & CARLILE, *supra* note 101, at 1-1; C.C. AINSWORTH & D. RAI, BATTELLE, PAC. N.W. LAB., CHEMICAL CHARACTERIZATION OF FOSSIL FUEL COMBUSTION WASTES iii (Elec. Power Research Inst. EA-5321, Research Project 2485-8, 1987). This study was conducted in 1987 to determine the total chemical composition of fly ash, bottom ash, flue sludge, and oil ash from forty-five power plants. The study used four extraction techniques: TCLP, EPTC, concentrated nitric acid extraction, and Paar bomb hot-water extraction.

[104] MASON & CARLILE, *supra* note 101, at 1-1.

[105] JACKSON & SORINI, *supra* note 60, at 3-1.

[106] *Id.*

[107] *Id.* at iii.

unregulated, but now regulated under the TCLP, present in combustion wastes.[108]

1. TCLP Leached Higher Concentrations For Most Toxins

A 1986 study by Mason and Carlile found that the average concentrations of toxic constituents extracted by the TCLP fell within twenty percent of the EPTC test results sixty percent of the time.[109] Significantly, however, fifteen percent of the concentrations varied by more than two hundred percent.[110]

The results show that for particular chemicals, the TCLP extraction detected significantly higher levels. This was especially true for chromium where levels were consistently higher under the TCLP test, particularly for acidic fly ash, which read 0.860 mg/l under TCLP and 0.016 mg/l under EPTC.[111]

A 1987 report by Jackson and Sorini produced similar results.[112] In that study, TCLP leachate gave higher concentrations of elemental toxins than the EPTC leachate in twenty-five percent of tests of identical split leachate samples.[113] The results were most dramatic for silver, chromium, and arsenic.[114] Interestingly, however, the EPTC gave higher values for barium in twenty-five percent of the tests.[115]

In a 1987 study by Evans and Olsen, TCLP and EPTC results were consistent,[116] although for most wastes in most samples, the TCLP extraction indicated slightly higher levels of toxins than the

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[108] *Id.* at ch. 6.

[109] MASON & CARLILE, *supra* note 101, at 7-6. The study compared the results of TCLP and EPTC tests on fly ash, bottom ash, and flue sludge from four utility companies. *Id.* at 3-1.

[110] *Id.* at 7-6, 7-34.

[111] *Id.* at 7-1 to 7-14, tbl. 7-2, fig. 7-3.

[112] JACKSON & SORINI, *supra* note 60, at 5-2. The study was performed upon 41 utility wastes from conventional and advanced sulfur dioxide control technologies. *Id.* at S-1 to S-3.

[113] *Id.* at S-2. Test results for half of the elemental toxins were at or below the limit of reliable quantitation. *Id.*

[114] *Id.*

[115] *Id.*

[116] J.C. Evans & K.B. Olsen, *Evaluation of Selected Utility Waste Samples Using Extraction Procedure and Toxicity Characteristic Leaching Procedure* C-13, *in* AINSWORTH & RAI, *supra* note 103. In this study, 23 samples of major coal combustion wastes were subjected to leach tests by the EPTC and TCLP. *Id.*

EPTC test.[117] A notable exception was fluorine, where the EPTC detected higher levels than the TCLP half of the time.[118] Even though overall arsenic and chromium extraction was higher for the TCLP, the EPTC extracted more arsenic and chromium than the TCLP for acidic fly ash wastes.[119]

2. Higher Concentrations of Toxins in TCLP Tests Were Probably a Result of pH of the Leachate Medium

The electric utility industry studies demonstrated that the change in leachate medium had the largest effect on test results. Each of the three studies cited above noted the probable effect of the pH of the leachate medium on test results,[120] which implies that the higher levels of toxins for TCLP tests were a result of pH levels.

In 1987 a study by Ainsworth and Rai found that pH and solid phase composition of wastes were the most important factors in predicting the results of leachate extraction. The scientists hypothesized that solid phase composition and pH worked together to affect leachate because most waste elements form compounds with hydroxides, oxides or anions of weak acids that have pH-dependent solubilities.[121] Therefore, the study concluded that variability among the extraction techniques could be explained by the pH level and the solid phase composition.[122]

3. Extraction Time and Pore Size Had No Discernible Effect on Test Results

The 1987 Jackson and Sorini report concluded that the shorter extraction time and smaller pore size of the TCLP had no discernible

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[117] *Id.* at C-10 to C-11.

[118] *Id.*

[119] *Id.* at C-9 to C-12.

[120] JACKSON & SORINI, *supra* note 60, at S-2 to S-3; MASON & CARLILE, *supra* note 101, at 7-34; AINSWORTH & RAI, *supra* note 103, at S-2 to S-3.

The greater sensitivity of the TCLP due to the new leaching media was one of the subjects of litigation in the recent challenge to the TCLP. Edison Elec. Inst. v. EPA, 2 F.3d 438, 444 (D.C. Cir. 1993). Language in the *Edison* case indicates the court's general approval of the TCLP as an improvement over the EP toxicity test. The court characterized the use of two leaching fluids, one acidic and one alkaline, as a "reasonable" response to the congressional mandate for improved accuracy. *Id.* at 447-48.

[121] AINSWORTH & RAI, *supra* note 103, at S-2 to S-3.

[122] *Id.* at 4-5 to 4-6.

effect on test results.[123] Regarding pore size, they hypothesized that the coal combustion wastes may have formed a self-filtering pad during the filtration step of the test.[124]

Overall, the electric utility studies found that the level of toxicity characteristic compounds in coal combustion wastes were below the regulatory level set by EPA using either the TCLP or the EPTC test.[125]

B. Sewage Sludge Studies

In 1989, Dietrich, Chestnutt, and Alderman conducted a study to analyze the ability of the TCLP and EPTC to recover chemical compounds in domestic wastewater sludges.[126] The researchers conducted TCLP and EPTC tests on both sewage sludge spiked with organic compounds and pesticides and control samples composed of distilled water and spiked with the same organic compounds and pesticides.[127] Results showed that for some volatile compounds, the

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[123] *Id.*

[124] JACKSON & SORINI, *supra* note 60, at S-3, 4-20.

[125] *Id.*

[126] *Id.* at S-2 to S-3, 5-28, 6-15; MASON & CARLILE, *supra* note 101, at Cover 2; *see also* Evans & Olsen, *supra* note 116, at C-13.

These results are collaborated by EPTC testing performed and documented in other major reports. *See* LARRY P. JACKSON & FRANK MOORE, W. RESEARCH INST., ANALYTICAL ASPECTS OF THE FOSSIL ENERGY WASTE SAMPLING AND CHARACTERIZATION PROJECT vii (Dep't of Energy, DOE/LC/00022-1599, 1984) (concluding that fossil energy wastes would not be hazardous under the EP toxicity test); SARA JANE ROSE ET AL., EXTRACTION PROCEDURE AND UTILITY INDUSTRY SOLID WASTE 3 (Elec. Power Research Inst., EA-1667, Research Project No. 1487, 1981) (indicating that different analysis methods produce varying opinions of the hazardous nature of a certain waste); *but see* FRED C. HART & B. TOD DELANEY, FRED C. HART ASSOC., THE IMPACT OF RCRA (PL 94-580) ON UTILITY SOLID WASTE S-11 (Elec. Power Research Inst., FP-878, Technical Planning Study 78-779, 1978) (offering results of EP Toxicity test on utility solid wastes which indicate that many of the wastes could be hazardous); WILLIAM P. GULLEDGE & WILLIAM C. WEBSTER, ENGINEERING-SCIENCE, INC., ASTM LEACHATE TEST EVALUATION PROGRAM vi (Elec. Power Research Inst., FP-1183, Research Project 1260-6, 1979) (opining that the variability in analysis methods create a potential that utility wastes may receive a hazardous classification). *See also* WILLIAM C. WEBSTER ET AL., PHASE II SUPPLEMENTAL LEACHING PROGRAM: ANALYSIS OF SELECTED TRACE METALS IN LEACHATE FROM REFERENCE FLY ASH vi-vii (Dep't of Energy, DOE/LETC/TPR-81-1, 1981) (finding poor reproducibility in two leaching procedures, including EP, for trace metals' results due to variability in mixing, agitation, and separation procedures).

[127] DIETRICH ET AL., *supra* note 38, at 2. The study was also intended to determine the effects, if any, of toxins binding to organic waste in the sludge. *Id.*

TCLP was a better indicator of concentration than the EPTC.[128] Overall, however, the report concluded that there was no significant difference between the TCLP and EPTC for recovery of toxins from sludge.[129] The report further concluded that neither the TCLP nor the EPTC were reliable indicators of concentration of volatile and semi-volatile compounds in sewage sludge, based on a comparison of the spiked sludge with the spiked distilled water samples.[130] One possible reason for this conclusion was that organic particles in the sewage sludge influenced the recovery of compounds for both test procedures.[131]

C. Other Studies

Other studies performed on electroplating wastes and hazardous waste incinerators support the conclusion that the TCLP is slightly more aggressive than the EPTC for most toxins. A 1987 Metcalf and Eddy report prepared for the EPA compared the levels of metal toxins in electroplating wastes.[132] The results showed the TCLP to be slightly more aggressive overall and to be particularly more aggressive for barium.[133]

The most convincing evidence that TCLP is more aggressive toward most toxins comes from an inter-industry study conducted in 1986.[134] This study was conducted on various wastes, including copper slag from a copper smelting furnace, waste from styrene production reactor bottoms, waste activated sludge from treatment of woven fabric finishing plant waste, dust from a steel arc furnace, sludge from treatment of waste water from an electric industry, and a composite waste.[135] The study concluded that there was a significant

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[128] *Id.* at 31.

[129] *Id.* at 32, 37.

[130] *Id.* at 31. By the same token, neither the TCLP nor the EPTC were considered to provide reliable measures of trace organic compounds, due to the same problems with particulate matter in sludges. *See id.* at 31, 38.

[131] *Id.* at 31-32.

[132] BARRY D. KAPLAN, METCALF & EDDY, INC., CHARACTERIZATION OF TREATMENT RESIDUES FROM HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITIES 1-9 (Nat'l Technical Info. Serv. No. PB87-212668, 1987).

[133] *See id.* at 12.

[134] *See* LANCY INTERNATIONAL, INC., INTER-INDUSTRY COLLABORATIVE STUDY OF THE TOXICITY CHARACTERISTIC LEACHING PROCEDURE—ADDENDUM TO COMPILATION OF PHASE IA AND PHASE II DATA (Nat'l Technical Info. Serv. No. PB87-155545, 1986).

[135] *Id.* at 5.

difference in relative standard deviation of TCLP and EPTC values for six of eleven waste samples tested.[136] Further, mean TCLP values were higher than mean EPTC values for all but five out of 105 test cases.[137] However, the study found that neither the TCLP nor the EPTC were sufficiently precise to allow reliance upon one determination.[138]

The 1986 inter-industry study also hypothesized that the differences between the TCLP and EPTC results were due to the difference in extraction fluid, namely differences in pH.[139]

VII. DISCUSSION

EPA's promulgation of the TCLP to replace the EPTC will further the purposes of RCRA. Most test results would support a general inference that the TCLP is a more aggressive test for leaching toxic compounds. At the very least, the TCLP is more aggressive than the EPTC for specific chemicals.[140] However, the new test does not meet the challenge of Congress' mandate.

A. Problems with Test Reliability

Problems still exist with reliability of the test. The sludge studies indicate that the presence of certain particulates in samples may cause TCLP extraction to report lower concentrations than actually present.[141] This discrepancy could be due to one of two factors: (1) disturbance with the filtration process by particulate matter in a sample;[142] or (2) the effect of the pH level and of solid phase composition of wastes.[143] As demonstrated by the electric utility industry studies, the pH level of the leachate medium is the single most important factor in extraction and should be maintained

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[136] *Id.* at 38-42.

[137] *Id.* at 38.

[138] *Id.* at 25.

[139] *Id.* at 43-46 (further differences cited by the study included buffer capacity of the leachates and filter media).

[140] *See* Lynn R. Newcomer et al., *Performance of the Toxicity Characteristic Leaching Procedure, in* 2 WASTE TESTING AND QUALITY ASSURANCE 201-03, 215 (David Friedman ed., 1990).

[141] *See, e.g.,* DIETRICH ET AL., *supra* note 38, at 31-32.

[142] *See generally id.* This study indicated that filamentous bacterial colony growth may have interfered with the filtration process. *Id.* at 32.

[143] AINSWORTH & RAI, *supra* note 103, at S-2.

within plus or minus 0.5 pH units to ensure accuracy.[144] A logical conclusion from the sludge studies and from the electric utility studies is that both the presence of certain types of particulates and varying pH levels combine to alter the extraction concentration of the TCLP, rendering it less reliable.

Another problem with the TCLP that appears very likely to occur is that samples which cannot pass through the filter will be treated as solids. Although the larger filter pore size is expected to alleviate the problem somewhat, at least one researcher indicated that the filter may clog,[145] and this may skew TCLP test results.

Most disturbing is the significant variability between laboratories performing toxicity characteristic tests. Studies have found that interlaboratory variability is the major source of discrepancy between TCLP and EPTC test results.[146] The laboratories involved in the studies cited have considerable experience in conducting laboratory leach tests and analysis. Experts indicate that this level of expertise in performing the test should not be expected in most commercial laboratories until the method has been used by the commercial laboratories for approximately one year.[147] However, the TCLP test has proven to be much more reliable and consistent than other extraction methods such as concentrated nitric acid or hot water extraction.[148]

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[144] *See supra* notes 120-122 and accompanying text. For example, waste samples that are very alkaline may prevent the acid buffer from maintaining a constant pH of 5.0, thereby skewing TCLP results. *See* Barton, *supra* note 22, at 405-06.

[145] JACKSON & SORINI, *supra* note 60 at 4-1.

[146] WEBSTER ET AL., *supra* note 126, at vi, 20-21, tbls. 4, 5; ROSE ET AL., *supra* note 126, at 12; BARRY EYNON & PAUL SWITZER, A STATISTICAL COMPARISON OF TWO STUDIES ON TRACE ELEMENT COMPOSITION OF COAL ASH LEACHATES (Elec. Power Research Inst., EA-3181, Research Project No. 1487, 1983). All of these tests were performed using the EPTC testing method.

The Mason and Carlile study concluded that variability between laboratories was not the major source of variation between test results for the TCLP, although interlaboratory variation could account for discrepancies in the EPTC results of the study. MASON & CARLILE, *supra* note 101, at 7-32.

[147] JACKSON & SORINI, *supra* note 60, at 5-27.

[148] *See generally* AINSWORTH & RAI, *supra* note 103, at 4-5 to 4-17. *See also* Newcomer et al., *supra* note 140, at 215 (concluding that the TCLP "performs equally well or better than the EP procedure").

It must be noted that the TCLP test has been considered consistent by EPA-commissioned studies. *See, e.g.,* W.B. BLACKBURN ET AL., MAXWELL LAB., COLLABORATIVE STUDY OF THE TOXICITY CHARACTERISTICS LEACHING PROCEDURE 4 (Nat'l Technical Info. Serv. No. PB88-165691, 1987). However, in that study, different samples were measured by

The validity of the TCLP can be questioned on the same bases as the earlier EP test. The underlying assumptions regarding steady-state conditions and groundwater modeling are subject to scientific scrutiny to determine whether EPA's assumptions are reasonable. By using MCLs established under the Safe Drinking Water Act as the basis for TCLP regulatory levels, alternative exposure pathways and harm to the environment, ecosystems and wildlife have not been adequately considered by EPA. MCLs are specifically set for ingestion of contaminants in drinking water and do not take into account other factors.

With these obvious and documented problems of reliability, the unscrupulous waste generator is free to shop around for a laboratory that produces the desired test results. Laboratories with less experienced staff or limited resources may tend to encounter TCLP testing problems and more frequently produce unreliable results.

B. The TCLP Regulates Only a Small Number of Organic Toxins

An obvious weakness of the TCLP is that it regulates only a very small number of known carcinogens, mutagens, teratogens, and toxins. This weakness was also present in the EPTC and was one of the reasons Congress required EPA to promulgate the new test. When compared to the hundreds of compounds known to have toxic, carcinogenic, mutagenic, or teratogenic effects in Appendix VIII of 40 C.F.R. Part 261,[149] the thirty-nine chemicals on the TCLP list is alarmingly small.

Under the TCLP as it stands, only a few of the organic chemicals that pose a risk to human health or the environment will come under RCRA regulation. As previously discussed, wastes that do not fall within the TCLP, or the other characteristics of corrosivity, reactivity or ignitability, are not always from one of the sources listed in 40 C.F.R. sections 261.30-.35. Therefore, such wastes are unregulated. The list is small because, according to EPA, EPA selected organic constituents based upon the ability to establish a

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different laboratories, and therefore the results of that study as to interlaboratory variability are not conclusive or persuasive. *See id.* at 8.

[149] *See* 55 Fed. Reg. 11,798, at 11,801 (1990).

CTRL and a constituent-specific DAF.[150] Constituents without a CTRL were not regulated by the final TC rule,[151] leaving very few chemicals to regulate.

Further, all of the new organic constituents are nonhydrolyzing or minimally hydrolyzing.[152] EPA found that the subsurface fate model predicts high DAFs for hydrolyzing constituents, and on this basis the Agency deferred a number of organic chemicals for future action.[153] In comments to the TCLP rule, commenters successfully argued that the use of a steady-state model[154] would result in lower DAFs than was realistic for hydrolyzing toxins.[155] EPA therefore agreed to postpone the promulgation of regulatory levels for certain hydrolyzing constituents.[156] The subsurface model also does not account for the toxicity of by-products generated through leaching.[157] Therefore, the products of hydrolysis of toxins, which may be toxins in and of themselves, are left unregulated.[158]

Other organic constituents were deferred for future action solely because they moved slowly into groundwater aquifers.[159] EPA stated that for these chemicals, the steady-state condition assumed by the subsurface-fate and transport model may have overpredicted or overestimated the concentrations for these constituents due to their relatively slow movement.[160]

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[150] *See* TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-14.

[151] *Id.*

[152] *Id.* at 1-8.

[153] *Id.* at 1-12. The following seven hydrolyzing constituents that were listed in the June 13, 1986 proposed rule will eventually be added to the toxicity characteristic: acrylonitrile; bis(2-chloroethyl) ether; methylene chloride; 1,1,1,2-tetrachloroethane; 1,1,2,2-tetrachloroethane; 1,1,1-trichloroethane; 1,1,2-trichloroethane.

[154] The steady-state model assumes that "leaching has occurred for a period of time that is sufficiently long to allow the concentration at the receptor well to become constant." 55 Fed. Reg. 11,798, at 11,823 (1990).

[155] The commenters argued that in landfills where the concentration of a constituent was particularly low, the steady-state model would assume a continuous emission of the constituent and would therefore overpredict the resulting concentration in the downgradient well. *Id.*

[156] *Id.*

[157] TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-12.

[158] *See supra* notes 54-59 and accompanying text.

[159] *See* TOXICITY CHARACTERISTIC TRAINING COURSE, *supra* note 2, at 1-13.

[160] *Id.* These constituents are: carbon disulfide; 1,2-dichlorobenzene; isobutanol; phenol; 2,3,4,6-tetrachlorophenol; and toluene. Regulatory levels will eventually be promulgated for these constituents. *Id.*

The difficulties that a regulatory agency such as EPA faces in promulgating such an important and far-reaching regulation as the TCLP cannot be underestimated. However, given the known and documented significant dangers posed by the compounds listed by EPA itself in Appendix VIII of its hazardous waste definition regulations, the failure to regulate these compounds is inexcusable. In the nearly four years since the promulgation of the TCLP, EPA has had adequate time, although probably inadequate resources, to develop the missing data to repromulgate TCLP levels for a much larger number of toxic constituents.

C. Dilution of Wastes to Avoid Regulation is Possible

Regardless of the test method, a major problem with any toxicity characteristic criteria will be dilution. Because determination of whether a waste is hazardous depends upon whether the waste contains a toxin on the TCLP list in concentration above the regulatory level, wastes which are diluted will effectively avoid regulation.[161] The problem is significant because the dangers from hazardous wastes are not always solely dependent upon the concentration of toxins. Arguably, the dangers posed by a large quantity of dilute hazardous waste will be equivalent to the dangers posed by a small quantity of more concentrated hazardous waste. However, some very dilute wastes may concentrate or synergistically combine under natural environmental conditions to become more hazardous. Thus, a policy goal of the RCRA program should be to concentrate and isolate hazardous wastes from the general environment. Hazardous waste tests, such as the TCLP, that are concentration-based may be subverted through manipulation of production processes so as to produce more dilute wastes. Hazardous waste regulations that encourage concentration of hazardous constituents, on the other hand, facilitate proper and efficient treatment and disposal of hazardous wastes.

EPA has promulgated two rules, the mixture rule[162] and the derived-from rule[163] to address the dilution of wastes under certain

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[161] *See* 45 Fed. Reg. 33,084, at 33,095 (1980).

[162] 40 C.F.R. § 261.3(a)(2)(iii) (1992).

[163] 40 C.F.R. § 261.3(c)(2)(i) (1992).

circumstances.[164] EPA intended the mixture rule to prevent generators of hazardous waste from mixing their waste with solid waste and disposing of the entire waste stream as nonhazardous.[165] However, neither rule solves the problem of dilution of wastes deemed hazardous solely by the operation of the toxicity characteristic rule. According to the mixture rule a solid waste is a hazardous waste if:

> [i]t is a mixture of a solid waste and a hazardous waste that is listed in [40 C.F.R. pt. 261] subpart D . . . solely because it exhibits one or more of the characteristics of hazardous waste identified in [40 C.F.R. pt. 261] subpart C . . ., unless the resultant mixture no longer exhibits any of the characteristics of hazardous waste of subpart C . . . .[166]

The effect of this regulation is to exclude wastes which are diluted to levels where the hazardous waste constituent is at concentrations below the level regulated by the TCLP test at 40 C.F.R. section 261.24.

The derived-from rule reads: "Except as otherwise provided in paragraph (c)(2)(ii) of this section, any solid waste generated from the treatment, storage, or disposal of a hazardous waste . . . is a hazardous waste."[167]

The derived-from rule does not apply to waste generation, although the process of dilution of wastes would fall within the ambit

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[164] The mixture and derived-from rule were invalidated in December 1991 on the grounds that EPA failed to provide notice and an opportunity to comment on the regulations. Shell Oil Co. v. EPA, 950 F.2d 741, 750-52 (D.C. Cir. 1991). The rules were repromulgated as interim rules on March 3, 1992. 57 Fed. Reg. 7630 (1992) (codified at 40 C.F.R. § 261.3 (1992)). On May 20, 1992, EPA issued a new proposal to deal with wastes previously regulated under the mixture and derived-from rules, the Hazardous Waste Identification Rule (HWIR). 57 Fed. Reg. 21,450 (proposed May 20, 1992). The HWIR proposed eight options for replacing the mixture and derived-from rule, 57 Fed. Reg. 21,450, at 21,455-63 (1992), but was subsequently withdrawn after coming under fire from state agencies and environmental groups. Rule-withdrawal Notice, 57 Fed. Reg. 49,280 (Oct. 30, 1992). The HWIR was criticized by both industry and environmentalists alike for allowing generators to make their own hazardous waste determinations and for its heavy reliance on concentration of wastes. *See* 23 Envtl. Rep. (BNA) 1491 (Oct. 2, 1992). *See also* Julianne Platz Hand, Comment, *The Mixture and Derived-From Rules Under RCRA: Is There Life After* Shell Oil?, 28 TULSA L.J. 497, 508-17 (1993) (summarizing comments to proposed HWIR).

[165] 45 Fed. Reg. 33,084, at 33,095 (1980).

[166] 40 C.F.R. § 261.3(a)(2)(iii) (1992).

[167] 40 C.F.R. § 261.3(c)(2)(i) (1992).

of treatment. Thus, diluted wastes can also escape the derived-from rule because the process of generation of a waste may act to dilute the waste, thereby avoiding application of the derived-from rule. Therefore, whether the waste is hazardous again depends upon the outcome of a TCLP test of a potentially diluted waste.

VIII. LEGAL CHALLENGE TO THE TOXICITY CHARACTERISTIC RULE

The Toxicity Characteristic Rule was challenged shortly after its promulgation. In *Edison Electric Institute v. EPA*,[168] the TCLP was challenged on a number of grounds raising both legal and scientific issues. Mining and electric utility industries challenged the rule's assumption of a "generic mismanagement scenario" whereby EPA assumed that certain mineral processing and manufactured gas plant wastes would be disposed of in municipal solid waste (MSW) landfills.[169] Pulp and paper industry representatives challenged the regulatory level established for chloroform on the basis that the rule failed to take into account biodegradation that would occur under normal circumstances.[170] Scrap recyclers challenged the rule on administrative law grounds for failure to provide adequate public notice and opportunity for comment.[171] The Natural Resources Defense Council (NRDC) and Hazardous Waste Treatment Council argued that temporary deferral of the TC rule's application to petroleum-contaminated media from cleanup of underground storage tanks (USTs) violated the statute.[172]

The United States Court of Appeals for the District of Columbia upheld the rule, with the exception of remanding the portion of the rule dealing with the generic mismanagement scenario for mineral processing and manufactured gas wastes for development of a sufficient record.[173] The court agreed that EPA had the authority to adopt the generic mismanagement scenario,[174] but found that the Agency had not provided sufficient factual support for its use in the

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[168] 2 F.3d 438 (D.C. Cir. 1993).

[169] *Id.* at 443, 445.

[170] *Id.* at 442-43, 447.

[171] *Id.* at 443, 449-50.

[172] *Id.* at 443, 451-52.

[173] *Id.* at 453.

[174] *Id.* at 445 (citing Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837 (1984)).

record.[175] Commenters to the proposed rule argued that industrial solid wastes are not normally disposed of in MSW landfills, to which EPA responded that states impose few restrictions on MSW landfills and that a substantial amount of industrial solid waste is in fact disposed of at MSW landfills.[176] The court noted, however, that "the Agency did not point to any evidence that any of these wastes were generated by the mineral processing or electric utility industries."[177]

EPA prevailed on all other challenges to the rule. Although the pulp and paper industry groups were correct that EPA had not taken into account degradation of chloroform (as well as other TC toxic wastes) in the rule, the court found that EPA had not acted arbitrarily or capriciously in rejecting commenters' requests to defer establishment of a TC regulatory level for chloroform.[178] The court stated that EPA had reasonably rejected data that was lacking in scientific accuracy.[179]

The scrap recycling industry challenged the TCLP on a theory that combined administrative law and science. They contended that because the TCLP was more sensitive to lead and other metals, the new test in effect changed the regulatory level without adequate public notice and opportunity for comment, as is required by the Administrative Procedure Act.[180] The scrap recycling challengers pointed to the Regulatory Impact Analysis in the proposed rule, which stated that "[t]he 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."[181] Thus, the scrap recycling challengers argued that EPA failed to provide notice that the TCLP in effect established a different regulatory standard for wastes containing lead and other TCLP metals. The court rejected these arguments because of the Agency's expertise in scientific matters and the fact

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[175] *Id.* at 446.

[176] *Id.* at 445.

[177] *Id.* at 446 ("[T]he Agency must at least provide some factual support for its conclusion that such a mismanagement scenario is plausible.").

[178] *See id.* at 449.

[179] *Id.*

[180] *Id.* at 450 (citing 5 U.S.C. § 553(b)(3)).

[181] 51 Fed. Reg. 21,648, at 21,661 (1986).

that EPA had from the time of the TCLP's proposal made it clear that the new test would affect both organic compounds and metals.[182]

NRDC challenged the TCLP's deferral in dealing with petroleum wastes from cleanup of USTs as violative of RCRA.[183] One of the toxic constituents added by the TCLP is benzene, a primary component of petroleum. NRDC argued that RCRA subtitle C governed the regulation of "all hazardous wastes."[184] Building upon the regulation of petroleum in USTs under subtitle I of RCRA, NRDC argued that once petroleum migrates from an UST, it becomes a waste and is therefore subject to the requirements of Subtitle C, including the TCLP test for toxicity.[185] The court characterized this argument as "plausible, indeed elegant," but deferred to EPA's interpretation as a permissible construction of the statute.[186]

IX. CONCLUSION

The TCLP is a slight technical improvement over the former EPTC test. A few additional toxins are regulated by the TCLP than by the EPTC. However, the regulation cannot be considered an effective attempt to protect human health and the environment from hazardous waste contamination, as is mandated by Congress under RCRA. Congress has already used strong words in the 1984 amendment to RCRA section 3001(g) to force EPA to take steps toward effective hazardous waste regulation. Unfortunately, the small step in the right direction that the TCLP represents is simply not enough. Toxic substances that are not one of the thirty-nine listed in the TCLP and which are not one of EPA's listed wastes, are free to enter the environment unregulated, notwithstanding Congress' mandate.

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[182] *Edison Elec. Inst.,* 2 F.3d at 450-51.

[183] *Id.* at 451.

[184] *Id.*

[185] *Id.* at 452. The theory that leaking or migration of toxins constitutes disposal of hazardous waste under RCRA has long been established and accepted by the courts. *See, e.g.,* United States v. Waste Indus., Inc., 734 F.2d 159, 164 (4th Cir. 1984) (leaking of wastes constituted disposal); United States v. Conservation Chem. Co., 619 F. Supp. 162, 200 (W.D. Mo. 1985) (migration of wastes from their initial location constituted disposal). *See also* RCRA § 1003(3), 42 U.S.C. § 6903(3) (1988 & Supp. III 1991).

[186] *Edison Elec. Inst.*, 2 F.3d at 452 (citing Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837 (1984)).

There is no indication that the new leadership at EPA will review the inadequacies of the TCLP, and EPA has not proposed a better or more comprehensive testing regimen. In the upcoming reauthorization of RCRA, Congress must again intervene and force EPA to regulate the thousands of different toxic chemicals threatening the environment. EPA has proven to be incapable of promulgating an effective toxicity test. Therefore, the only method that would ensure that the list of chemicals subject to the toxicity characteristic is comprehensive enough to protect human health and the environment is for Congress specifically to list the chemicals and their concentrations that are subject to regulation under RCRA's Toxicity Characteristic.