Table 4-2 (continued)

Application	Condition of Item or Facility	Action
		• Moveable equipment used in storage areas, must be decontaminated by swabbing surfaces that have contacted PCB chemical substances or mixtures, with a solvent that contains less than 0.05 percent PCB contaminant and in which the solubility of PCBs is 5 percent or more by weight. (Annex IV, Section 761.43).
7. PCB articles and PCB containers	a. Stored for disposal prior to January 1, 1983.	• Must be removed from storage and disposed of by January 1, 1984.
	b. Stored for disposal after January 1, 1983.	• Must be removed from storage and disposed of within one year from the date it was first put into storage.

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Table 4-3

DECONTAMINATION OF UTILITY PCB ARTICLES AND CONTAINERS PRIOR TO DISPOSAL

Applicability	Method of Disposal	Required Procedure
PCB transformers	Approved chemical waste landfill	Transformer must be drained of all free-flowing fluid, filled with a solvent such as kerosene, xylene, or toluene, allowed to stand for 18 hr, and then drained thoroughly.
PCB contaminated transformers	Approved chemical waste landfill	Drained of free-flowing liquid.
PCB containers	None. Container intended to be reused.	Container must be decontaminated by flushing three times with a solvent in accordance with Annex IV, Section 761.43.
PCB containers	Approved chemical waste landfill	If container is used to hold PCB liquids, it must first be drained of that liquid, and the liquid disposed of by incineration. Landfilled PCB containers are not required to be further decontaminated with solvent prior to disposal.

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Table 4-4

REGULATIONS WHICH GOVERN THE DISPOSAL OF OUT-OF-SERVICE PCBs AFFECTING THE UTILITY INDUSTRY

Applicability	Disposal Option			Permitted Activity				
	Incineration	Approved Chemical Waste Landfill	Alternative (Waiver Provision)	As Per Annex I Incineration	As Per Annex II: Chemical Waste Landfill	As Per Annex III: Storage for Disposal	As Per Annex IV: Decontamination	Comments
PCB chemical substances	X			X		X		
PCB liquids	X			X		X		
PCB contaminated liquids		X		X	X			Can be landfilled if not ignitable.
PCB solids								
Contaminated soil and debris resulting from a spill or as excavation material taken from an old disposal site.	X	X		X	X	X		
Other								
Contaminated soil, rags, debris	X	X		X	X	X		Can be landfilled until January 1, 1988.
Dredge spoils	X	X		X	X	X		
			X			X		Upon application to the EPA Regional Administrator, by a disposal method to be determined by the Administrator.

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Table 4-4 (continued)

Applicability	Disposal Option			Permitted Activity				
	Incineration	Approved Chemical Waste Landfill	Alternative (Waiver Provision)	As Per Annex I Incineration	As Per Annex II: Chemical Waste Landfill	As Per Annex III: Storage for Disposal	As Per Annex IV: Decontamination	Comments
PCB transformers	X			X		X		
		X			X	X		Must be decontaminated prior to disposal as per Sec. 761.10[c][1][ii]. That is, drained of PCBs, filled with solvent, and drained of solvent after standing 18 hr.
			X			X		A waiver may be granted by the EPA Regional Administrator if unusually-sized articles prevent disposal by the approved method.
Large high and low-voltage PCB capacitors	X			X		X		
		X			X	X		Can be landfilled until January 1, 1980.
			X			X		A waiver may be granted by the EPA Regional Administrator if unusually-sized articles prevent disposal by the approved method.

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Table 4-4 (continued)

Applicability	Disposal Option			Permitted Activity				
	Incineration	Approved Chemical Waste Landfill	Alternative (Waiver Provision)	As Per Annex I Incineration	As Per Annex II: Chemical Waste Landfill	As Per Annex III: Storage for Disposal	As Per Annex IV: Decontamination	Comments
PCB containers	X			X		X		If not decontaminated prior to disposal.
		X			X	X		Containers must be drained of all PCB liquids, but need not be decontaminated prior to disposal.
			X			X	X	If properly decontaminated, container may be reused.
PCB-contaminated equipment			X				X	Equipment used in handling PCBs may not be removed from a storage or disposal site without first being decontaminated.
Spills								
Uncontrolled discharges of PCB chemical substances or PCB mixtures			PCB chemical substances and mixtures resulting from spill incidents are to be stored and disposed of as PCB chemical substances and mixtures. If spill results in contamination levels of soil, water, etc., exceeding 500 ppm, the person who spills PCBs must contact the EPA Regional Administrator for further instructions. Liabilities under the Federal Water Pollution Control Act and the Resource Conservation and Recovery Act are not exempted by the PCB regulations.					This is considered to be an unacceptable form of disposal.

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to the environment. Thus, upon written approval from the Administrator, an alternative disposal option may be practiced. Several options to incineration of PCBs are either available or feasible. These options are discussed in Chapter VI of this report.

Final PCB Regulations for Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions

The final PCB "Ban Regulations were issued on May 31, 1979, implementing Sections 6(e)(2) and (3) of TSCA. It is intended that these regulations be added to the existing PCB disposal and marking regulation. The regulation addresses prohibitions to the manufacture, processing, distribution in commerce, and use of PCBs which are not addressed in the current disposal and marking re· ·ations.

General Modifications. Additions and modifications to existing sections of the disposal and marking regulation were also finalized. Some of the important changes to the existing regulation which affect the utility industry are as follows:

- Section 761.2-Definitions:

  Several new definitions have been proposed which could affect utility industry compliance activities:

  --PCB transformer is defined as any transformer containing fluid with a concentration of PCBs greater than 500 ppm.

  --PCB-contaminated transformer is defined as any transformer containing fluid with a concentration between 50 and 500 ppm.

  --Proc· ·; for commercial purposes means to process for purpose of · · for disposal or use (not including sale for dist· ibution in commerce).

  --Totally enclosed manner means that the effects of exposure of PCBs on humans or the environment are not detectable or measurable by any analytical method.

  --Waste oil is defined to include dielectric fluids.

- Section 761.10 - Disposal Requirements. Redefinition of PCB-contaminated transformers to include PCB levels from 50 to 500 ppm has resulted in a proposed change in the disposal method for transformers containing dielectric fluid with <500 ppm PCBs and ≥50 ppm PCBs.

- Section 761.20 - Marking Requirements. Redefinition of PCB transformers as described above has resulted in a proposed exemption to marking for transformers containing PCBs at a concentration of between 50 and 500 ppm.

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Additions to Subpart C, Section 761.20 Marking of PCBs. It will not be required that transformers containing dielectric fluids with PCB concentrations of between 50 ppm and 500 ppm be labeled. Marking requirements will, however, be extended to cover containers holding PCB mixtures with greater than 50 ppm of PCBs.

Changes to Subpart B, Section 761.10 - Disposal of PCBs. The proposed redefinition of transformers will significantly affect the disposal of some transformer fluids and will increase the quantity of PCB liquids, nonliquid PCBs (such as spill debris), and PCB containers requiring storage and eventual disposal.

Only disposal of transformers is addressed directly in the proposed regulations. The regulations governing transformers, which prior to disposal contained dielectric fluid with a PCB content exceeding 500 ppm, are identical to those affected by the disposal and marking regulation.

The final "Ban" Regulations permit transformers containing fluid with a PCB content of between 50 ppm and 500 ppm to be disposed of in any of three ways, landfill being the most practical (that is, as non-PCB articles), provided that they are thoroughly drained of fluid. They need not be decontaminated. The drained dielectric fluid shall be disposed of as PCB-contaminated liquid and incinerated in a high-temperature incinerator, efficiency boiler, or chemical landfill if nonignitable. If fluids are to be stored in the interim, they must be batch-tested to determine PCB concentration before disposal. All data and relevant information must then be included in the records as required under Annex IV of the Disposal and Marking Regulation.

High-temperature incineration is the only permitted disposal method for transformer fluids containing greater than 500 ppm PCBs. Dilution of this fluid to less than 500 ppm to increase disposal options is not permissible. However, conversion of a PCB transformer to a PCB-contaminated transformer is allowable with certain post-retrofill testing procedures.

Subpart D, Sections 761.32 Manufacture, Processing, Distribution in Commerce, and Use of PCBs. Proposed Subpart D consists of three sections, one of which is reserved:

761.30 - Prohibitions
761.31 - Authorizations
761.32 - Exemptions (Reserved)

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The regulation states the following:

- The distribution in commerce and use of nonleaking, intact PCB transformers and capacitors are considered activities which are conducted in a totally enclosed manner. Thus, authorizations are not required for distributing or using these PCB articles except when they are serviced.

- The preparation or processing of PCBs for disposal is not considered to be distribution in commerce or use. Thus, activities relating to disposal are not subject to either the January 1, 1978, totally enclosed manner requirements or to the July 1, 1979, bans.

- Servicing of PCB transformers and dielectric fluid is considered to be a non-totally enclosed use which may be authorized by the EPA Administrator if deemed appropriate. Authorization is not required for servicing of PCB-contaminated transformers.

The prohibitions of the manufacture, processing, distribution in commerce, and use of PCBs are effected under TSCA Sections 6(e)(2), which will ban all but totally enclosed applications after January 1, 1978; and 6(e)(3), which would ban the manufacture of PCBs after January 1, 1979, and any processing or distribution in commerce of PCBs after July 1, 1979.

TSCA does not impose bans on the use of PCBs. As a result, EPA has provided special authorization for PCB use in a non-totally enclosed manner when servicing PCB transformers. For example, when the owner of a PCB transformer services that article in his own shop, he is subject to the use authorizations. If he sends that article to a transformer service company, however, servicing would be considered both processing and distribution in commerce (ownership of the PCB fluid used in servicing would change hands). The transformer service company would therefore be required to petition for processing and distribution authorizations each year (effective June 30, 1979). Owners and operators are authorized to service their own PCB transformers for 5 yr after enactment of the regulation (this excludes transformer rebuilding). The authorization period may be extended if the EPA Administrator determines that no significant risk is involved. Under the new regulation, only routine servicing of PCB transformers containing greater than 500 ppm PCBs would be permitted. The rule also authorizes refilling of these transformers with PCB fluid. The servicing of PCB-contaminated transformers containing fluid with 50-500 ppm would not be restricted.

The final regulation stipulates that a PCB transformer can be converted to a PCB-contaminated transformer to extend its service life. A PCB-contaminated transformer

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can be rebuilt, whereas a PCB transformer must be converted or disposed of. If the transformer is converted, it must, after three months of service, still contain only a concentration less than 500 ppm of PCBs. The coil also cannot be removed in the conversion process.

The proposed prohibitions and authorizations are summarized in Figures 4-2 and 4-3.

Spill Prevention Procedures. Spill prevention procedures have been determined as necessary to provide adequate environmental protection during PCB storage. Some stored PCB liquids may qualify as oils under Section 311 of the Clean Water Act and therefore may be subject to the spill prevention provisions of 40CFR, Part 112. In order to provide equivalent control for all PCB liquids, the Spill Prevention, Control, and Countermeasure (SPCC) provisions of the 40CFR, Part 112, have been incorporated into the final "Ban" Regulations with only a few modifications. SPCC planning is already widely practiced by industry throughout the nation with great success and minimal cost.

SPCC requirements do not apply to tanks smaller than 660 gal and underground tanks smaller than 42,000 gal. However, due to the persistent nature of PCB liquids, even small amounts require spill protection. Thus, the above tank exemptions do not apply to PCB liquids (50 ppm or greater) and their holding tanks or containers. A second modification to 40CFR, Part 112, is the added provision for impervious ground cover between the storage tanks or containers and the required secondary containment. SPCC plan procedures also indicate a formalized notification procedure in the event of a spill. These will not be required for PCB spills.

Presently, the EPA is proposing a spill prevention rule for hazardous substances which will include PCBs. However, until such time as this proposed rule is finalized, these SPCC guidelines will apply. When this proposed rule is finalized as a part of the Clean Water Act, the present SPCC PCB requirements will be revised to eliminate duplications and inconsistencies.

Proposed Rules for Exposure and Contamination Control (ECC) Plans - Annex VII, Section 761.46. The expressed objective of Annex VII is to "help insure that risks associated with activities either authorized by or exempted from requirements of this regulation are minimal." To accomplish this, a written ECC Plan is required which must include the following:

1. An operations plan that describes step-by-step procedures to be followed in the performance of an authorized PCB activity.

MONS 028316

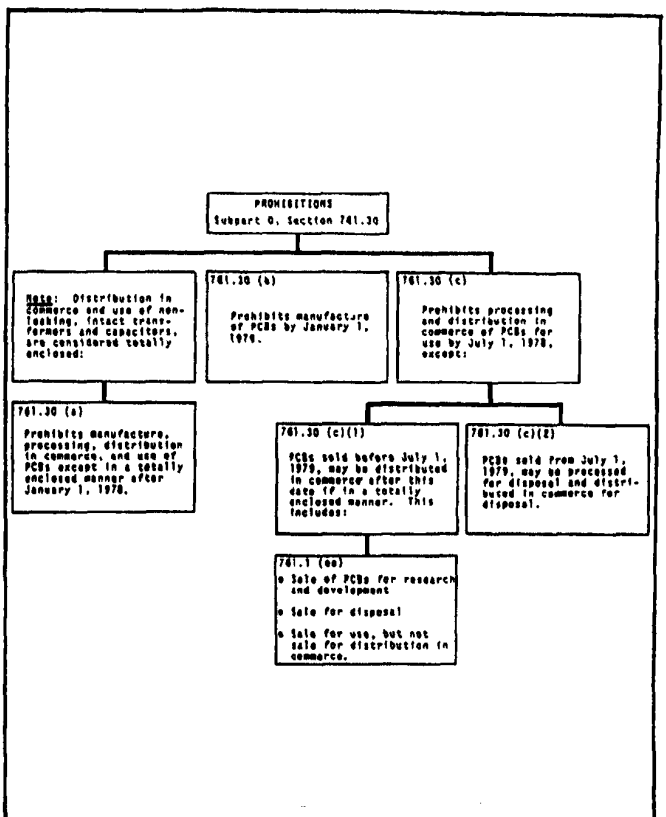

Figure 4-2. Prohibitions pertaining to the manufacture, processing, distribution in commerce, and use of PCBs as they apply to the utility industry.

MONS 028317

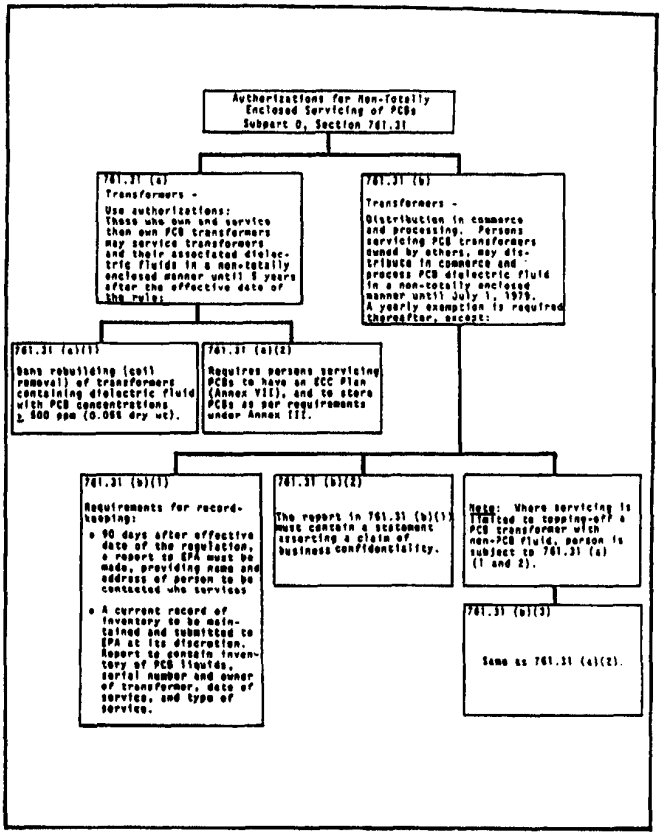

Figure 4-3. Proposed authorizations pertaining to the manufacture, processing, distribution in commerce, and use of PCBs as they apply to the utility industry.

MONS 028318

2. A spill response contingency plan that describes notification and cleanup procedures to be used in the event of an accidental release of PCBs.

Operative plans must address assembly and servicing techniques, safe and spill-free use of equipment, and containment procedures for preventing accidental releases from escaping the immediate work area.

In assessing the need for containment (i.e., drainage controls such as dikes, curbs, drain plugs, etc.) around PCB equipment and servicing or storage areas, the utility must make a risk assessment based on PCB volumes and existing drainage patterns. PCB releases that could go directly to surface or ground water resources pose the greatest risk.

Proposed Implementation of Regulatory Activities under Section 6 of TSCA. A primary objective of EPA is to develop an integrated approach to implementing toxic substances regulations under the various statutes, i.e., TSCA, Clean Water Act, RCRA, CAA, and SDWA. To accomplish this objective, EPA has established the Toxic Substances Priorities Committee*. An important task of the committee is to insure consistency between existing regulations controlling hazardous or toxic substances.

Potential conflicts between regulations are already apparent. For example, the legal authority proposed in RCRA was not used in framing TSCA's PCB marking and disposal regulations. Conflicts could arise, should PCB-contaminated solid wastes meet the criteria for "hazardous wastes" to be defined under Section 3001 of RCRA. These wastes would then be subject to the broader regulations being developed under RCRA. If conflicts should arise between the two Acts, either the TSCA regulations would be amended or an exception to RCRA requirements would be required.

Another area of conflict involves transport of hazardous wastes. Regulation of transportation more appropriately falls under the jurisdiction of the Department of Transportation (DOT). DOT's Materials Transportation Bureau has recently published proposed Transportation of Hazardous Waste Materials Regulations pursuant to both RCRA and the Hazardous Materials Transportation Act (PL93-633). Additional regulation of PCB transportation through TSCA could only be repetitive should PCBs be defined under "hazardous."

*The committee is chaired by the USEPA Office of Toxic Substances.

MONS 028319

Currently, EPA is attempting to consolidate inspection procedures and enforcement follow-up under RCRA and TSCA. It is theorized that one "manual" would be developed covering general inspection procedures and legal requirements. In the interim, PCB control enforcement shall reside under the rules of TSCA.

Under this new integrated approach, existing programs (especially permitting programs such as the National Pollution Discharge Elimination System [NPDES]) would be coordinated at the Regional EPA level. One element of the intended strategy would be to reduce all permitting activities required under TSCA, RCRA, the Clean Water Act, the Safe Drinking Water Act, and the Clean Air Act to a single permitting process.

EPA strategy for handling violations of the PCB regulations is described in the draft enforcement proceedings manual developed by the Pesticide and Toxic Substances Enforcement Division (PTSED) of EPA. The draft manual can be regarded as a precedent for EPA enforcement of TSCA Section 6 regulations. The manual calls for each EPA Regional Administrator to appoint a Violation Coordinator for PCBs. It will be the job of the Violation Coordinator to examine each Inspection Report and determine the answers to the following questions: "(1) Is there a probable violation? (2) If yes, what type of action, if any, should be brought against the alleged violator? (3) If the action is one for administrative civil penalty assessment, how much should the proposed civil penalty be?"

If a violation is determined, one of the following courses of action may be taken against the alleged violator:

- Notice of noncompliance.
- Administrative civil penalty.
- Civil court action.
- Criminal court action.

Most violations will be handled through administrative civil penalties.

MONS 028320

In its guidelines on determining the size of a civil penalty, the manual sets down four levels of violations. These are as follows:

- Level I -- This violation is of the type, such as failure to promptly dispose of PCB-contaminated rags, minor leaks in stored transformers, etc. The initial assessment for a Level I violation will be $1,000 per day per violation. Where such a violation meets the criteria for issuance of a Notice of Noncompliance, the penalty may be waived.

- Level II -- These violations are generally serious in nature, and may include general record keeping and marking violations, and storage violations where exposure is more hazardous than at Level I. The initial assessment for a Level II violation is $5,000 per day per violation.

- Level III -- This level applies to violations of a very serious nature, such as failure of incinerators to maintain proper temperatures for sufficient periods of time, and leakage from a chemical waste landfill not resulting in permanent environmental damage. The initial assessment for a Level III violation is $15,000 per day per violation.

- Level IV -- These violations are the most egregious, both in terms of blatant disregard for the requirements of the standard and the damage caused. Such violations would include significant spilling and dumping of PCBs resulting in large-scale contamination, and operating an unapproved disposal facility. The initial assessment for Level IV is $25,000 per day per violation.

The manual concludes that, upon making the level of gravity determination, the indicated penalty should be used as a base from which adjustments should be made according to the following additional statutory criteria: (1) violator's ability to pay; (2) inability of a violator to continue in business; (3) history of prior violations; and (4) the degree of culpability of the violator.

STATE AND LOCAL ORDINANCES GOVERNING PCB HANDLING AND DISPOSAL

Several states and local communities have enacted legislation governing the commercial production distribution and/or disposal of PCBs. Under TSCA, any state or local law governing PCBs is superseded if the law is less stringent than the federal requirements. Some state and local laws do exist which are either more stringent than the federal law or address additional requirements for PCB handling or disposal.

Only two states currently have PCB legislation in force which is more stringent than the federal regulation. In 1976, Michigan passed an act which prohibited the manufacture, sale, and use of PCBs, and provided for labeling and reporting

MONS 028321

requirements, as well as for PCB disposal. It redefines PCB mixtures as having 100 ppm or more PCB (compared to the 500 ppm federal limit). Additionally, the law requires the preparation of a pollution incident prevention plan similar in scope to the ECC Plan proposed under Annex VII of the federal regulations.

Oregon law specifies that PCBs not be used, manufactured, or distributed except in an enclosed manner (transformers and capacitors). Currently, Oregon does not base its regulations on minimum ppm requirements. However, beginning January 1, 1980, PCB mixtures will be defined by the 100 ppm limit. The 1980 Oregon law as written is also more stringent than the federal regulation in terms of marking and disposal requirements.

Other states have enacted legislation which reinforces or expands the current federal regulation. Minnesota PCB legislation calls for a ban on the use, possession, sale, purchase, or manufacture of PCBs or products containing PCBs, unless exempted by the Minnesota Pollution Control Agency. It does not cover either individual PCB uses in the home or PCB disposal.

Connecticut law (July 1, 1976) applies only to the use of PCBs. It does not affect totally enclosed systems such as transformers and capacitors. The Connecticut Department of Environmental Protection can grant annual exemptions.

Wisconsin law (1977) establishes procedures for the storage, collection, transportation, processing, and final disposal of PCBs and products containing PCBs taken out of service for disposal. These provisions do not affect PCBs and products containing PCBs while in use. The requirements are identical to those specified in the federal regulations.

Local ordinances governing PCB management are few in number and typically come about due to public opposition to a particular existing or proposed PCB disposal facility. Ordinances which are directed at the operation of a single facility have a strong negative impact on nationwide progress in PCB management because such ordinances (1) provide a useful tool to public opposition movements elsewhere, and (2) further reduce the already small number of PCB disposal facilities in the United States. Similar problems have historically been encountered in siting and/or operating other types of waste disposal sites.

MONS 028322

The only anti-PCB ordinance currently in force has preempted the efforts of the Energy Systems Company (ENSCO) to obtain a PCB permit for their El Dorado, Arkansas, incineration system.

Union County, Arkansas (which includes El Dorado), recently enacted an ordinance prohibiting the incineration of PCB materials within county limits. This ordinance is currently being challenged in court by ENSCO on constitutional grounds. The implications of this ban, should it be upheld, could be far-reaching within the chemical waste disposal industry. A legal precedent for allowing the closing of a PCB's disposal site (without supporting evidence of environmental impact) could provide the means for closing many existing sites to specific toxic or hazardous wastes.

In another recent example, SCA Chemical Waste Services, Inc., filed an application with the EPA Regional office for approval of its Wilsonville, Illinois, chemical waste landfill for PCB disposal. Prior to approval, the site was closed under court order due to public opposition. In this instance, the opposition centered around trucks driving through the local community. The case is still in litigation.

The ENSCO and SCA cases reemphasize the need to address public opinion when choosing and/or operating a disposal site. Local ordinances of this type have been independent of state or federal site approval. The existing climate of public opinion surrounding a given site should be researched by a utility in order to assess the site's reliability.

Section 5

NATIONAL PROFILE OF PCB WASTE DISPOSAL REQUIREMENTS

The PCB production statistics presented in Chapter III give an indication of the magnitude of present and future PCB disposal requirements. Recognizing the current lack of PCB landfill and incineration capacity in many areas of the country, utilities have elected to store much of their waste PCB materials until more convenient disposal facilities are constructed. The actual future demand for PCB incineration and landfill capacity will be a function of the PCB generation and cumulative storage process.

Unfortunately, the construction of PCB disposal facilities is, in turn, predicated upon a regional demand for the disposal service. The lack of published information on regional demand has only retarded capacity expansion. Cement production companies, for example, which operate equipment capable of destroying a major portion of the PCB liquid wastes, cannot justify the initial capital and administrative expenses required to accept PCBs without firm long-term supply commitments. Estimates of regional demand for PCB disposal would provide a valuable decision-making tool to these cement companies and other industries with similar capabilities.

This chapter presents an analysis of annual utility-owned PCB equipment disposal requirements. The findings are presented on a national and regional basis, along with the background data and assumptions. These estimates are then compared to current and projected disposal capacity to identify areas of the United States where additional capacity will be needed.

NATIONAL DEMAND FOR PCB DISPOSAL CAPACITY

One method of estimating PCB waste generation is through the use of input/output (or mass balance) analysis. Knowing the date of which a piece of equipment was produced, as well as its expected service life, the year in which it will be discarded can be approximated. In this manner, national PCB equipment production data can be applied to the expected service life and failure rates of PCB capacitors and transformers to estimate the annual discard rate.

MONS 028324

Future utility PCB disposal requirements were estimated (169) based on historical production data (Chapter III) and characteristic equipment service life statistics. Transformers, large high-voltage capacitors, and large low-voltage capacitors were considered in the analysis.

Table 5-1 lists the expected average service life and early failure rates for PCB equipment (29). The average service life shown for utility transformers may be reduced as a result of proposed regulations affecting the repair and servicing of PCB-contaminated equipment.*

Waste PCB Capacitor Generation

In the absence of reliable historical data, it was assumed that all utility capacitors purchased before 1958 have been removed from service (20-yr average service life). An estimated 8.6 million utility capacitors of all types are therefore presently in service (29).

The fraction of in-service PCB capacitors requiring disposal each year was computed based on available annual U.S. sales data. It was assumed, for the computations, that (1) capacitors surviving the first year of operation would remain in service for 19 additional years (on the average) and (2) approximately 50 percent of domestic capacitor sales were to utilities. Table 5-2 displays the projected annual disposal requirements for utility-owned PCB capacitors.

Waste PCB Transformer Generation

Approximately 84,000 utility PCB transformers are currently in service. These transformers contain a total of 180 million lb of PCB mixtures. Domestic PCB sales data for the period 1957 to 1975 (58) were used to estimate the age distribution of the in-service transformer population (data for the time period 1937 to 1957 are not available).

First-year transformer failures average 1 percent, according to industry estimates. Assuming that routine servicing extends the average transformer service life to 40

*In accordance with Section 761.31(a)(1) of the proposed ban regulations, PCB transformers and dielectric fluids may be serviced in a non-totally enclosed manner until 5 yr after the effective date of the PCB ban rule. This, however, excludes major service involving removal of coils from transformers containing fluids with a PCB content greater than 500 ppm.

MONS 028325

Table 5-1

ESTIMATED SERVICE LIFE AND EARLY FAILURE RATE OF PCB EQUIPMENT*

Equipment Item	Estimated Service Life (Years)	Percent Failing in First Year
Transformers (PCB)	40†	1.0
Capacitors (PCB)		0.2
Large High Voltage	20	
Large Low Voltage	15	
High Intensity	20	
Small Appliance	15	
Fluorescent Light	15	

*Ref. 29
†Assuming draining and refilling of PCB transformers is permitted under the proposed regulations.

MONS 028326

Table 5-2

ESTIMATED ANNUAL DISPOSAL REQUIREMENTS FOR UTILITY-OWNED PCB CAPACITORS, 1978-1998

Year	No. of PCB Capacitors, Generated	Total Weight of PCB Capacitors (10^6 lb)	Weight of Fluid Fraction (10^6 lb)	Weight of Solid Fraction (10^6 lb)[†]	Volume of Solid Fraction[‡] (m^3)
1978	329,300	39.52	8.233	31.28	31,640
1979	338,700	40.64	8.466	32.17	32,540
1980	318,100	38.17	7.952	30.22	30,560
1981	307,000	36.84	7.676	29.17	29,500
1982	311,500	37.38	7.784	29.59	29,930
1983	390,000	46.80	9.750	37.05	37,470
1984	470,000	56.88	11.85	45.03	45,540
1985	576,500	69.18	14.41	54.77	55,390
1986	597,900	71.14	14.82	56.32	56,960
1987	589,800	70.78	14.75	56.03	56,670
1988	499,600	59.93	12.49	47.45	47,990
1989	533,100	63.97	13.33	50.64	51,220
1990	262,300	33.87	7.056	26.81	27,120
1991	405,600	48.67	10.14	38.53	38,970
1992	470,400	56.45	11.76	44.69	45,190
1993	439,100	52.69	10.98	41.72	42,190
1994	412,100	49.45	10.30	39.15	39,590
1995	439,100	52.69	10.98	41.72	42,190
1996	439,100	52.69	10.98	41.72	42,190
1997	170,000	20.40	4.250	16.15	16,330
Total	600,000	998.14	252.21	790.21	799,280

*LHV and LLV capacitors.
†Residue from combustion of shredded capacitors; assumes weight of solid combustibles, e.g., paper, in capacitors is negligible.
‡Shredded, incinerated bulk density of capacitor residue = 756 lb/m^3.

MONS 028327

yr (excluding catastrophic failures), approximately 847 units were taken out of service between 1930 and 1957.

The following formula was used to estimate the waste PCB transformer generation profile through the year 2017:

$$D_n = 0.01\ P_n + 0.99\ P_{n-40}$$

where:

D_n = estimated number of transformers requiring disposal in year m, and

P_n = estimated number of transformers placed into service in year n.

The weighting factors (0.01 and 0.99) reflect first-year transformer failures (1 percent) and 40-yr chance and wear-out failures (99 percent), respectively. First-year failures are assumed to be irreparable, while the 40-yr life includes intermediate repair.

The results of this calculation are shown in Table 5-3. Once again, because only the total production of transformers from 1937 to 1957 is known, a uniform annual rate of production (1262 units per yr) was assumed during this period.

Table 5-3 also provides the associated generation profile of transformer PCB liquids, PCB mixtures, and contaminated flushing solvents. The term "PCB liquids" shown in the table represents the equivalent "pure" PCB content of the transformer drainings. "PCB mixtures" represent the total fluid content of the transformer. Before the drained transformer casing can be disposed of (landfilled), it must also be flushed with an equal volume of solvent to remove residual PCBs. The contaminated flushing solvents must be disposed of in the same manner as PCB mixtures under the law.

The contaminated solvents, however, will not necessarily compete with pure PCBs for disposal capacity. Based on an assessment of possible PCB incineration systems (see Chapter VI), it appears that most systems could readily use all the solvents as a supplementary fuel.* Landfill capacity would be affected significantly, but only until 1980, when land disposal of PCB liquids is no longer permitted.

*This is contingent on the availability of approved PCB incinerators.

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Table 5-3

ESTIMATED ANNUAL DISPOSAL REQUIREMENTS FOR UTILITY-OWNED PCB TRANSFORMERS

Year	Number of PCB Transformers	Total of Drained Solids Weight (10^6 Lb)	Total of Drained Solids Volume (m^3)	Weight of PCB Liquids (10^6 Lb)	Weight of PCB Mixtures[a] (10^6 Lb)	Weight of PCB Flushing Solvents (10^6 Lb)[b]	Total Fluids to Disposal 10^6 Lb	Total Fluids to Disposal 10^6 Gal[c]	Total Fluids to Disposal 55-gal. Drum Equiv.[c]
1978-1996 (per year)	1,262	8.203	4,220	2.713	3.786	2.066	5.851	0.5070	10,672
1997	2,587	23.32	12,016	7.772	10.76	5.870	16.63	1.648	30,334
1998	1,580	10.27	5,293	3.397	4.740	2.585	7.325	0.7349	13,361
1999	1,053	10.74	5,538	3.564	4.959	2.705	7.664	0.7688	13,976
2000	2,100	14.22	7,330	4.704	6.564	3.580	10.14	1.018	18,503
2001	1,735	11.28	5,812	3.730	5.205	2.839	8.044	0.8070	14,672
2002	2,206	14.34	7,390	4.743	6.618	3.610	10.23	1.026	18,655
2003	2,014	13.09	6,747	4.330	6.042	3.296	9.338	0.9377	17,031
2004	2,010	13.06	6,734	4.322	6.030	3.289	9.319	0.9369	16,996
2005	2,397	15.55	8,013	5.143	7.176	3.914	11.09	1.113	20,220
2006	2,461	15.99	8,244	5.291	7.383	4.027	11.41	1.145	20,811
2007	3,060	19.88	10,244	6.576	9.174	5.004	14.18	1.422	25,860
2008	3,201	20.81	10,723	6.882	9.603	5.238	14.84	1.489	27,070
2009	3,344	21.74	11,202	7.190	10.03	5.472	15.50	1.555	28,279
2010	3,829	24.82	12,797	8.213	11.46	6.251	17.71	1.777	32,304
2011	3,076	19.99	10,305	6.613	9.228	5.033	14.26	1.431	26,012
2012	1,674	9.681	4,990	3.169	4.422	2.412	6.834	0.6856	12,465
2013	3,016	25.45	13,119	8.419	11.75	6.408	18.16	1.821	33,116
2014	3,315	21.55	11,109	7.129	9.948	5.426	15.37	1.542	28,042
2015	3,121	20.29	10,465	6.710	9.363	5.107	14.47	1.452	26,393
2016	3,000	19.5	10,060	6.450	9.000	4.909	13.91	1.395	25,370
2017	3,000	19.5	10,060	6.450	9.000	4.909	13.91	1.395	25,370

[a] It is assumed that on the average, 60 percent of PCB transformer fluid (PCB mixture) is PCB chemical substance (PCB liquid).
[b] PCB mixture means PCB transformer fluid.
[c] In accordance with Sec. 761.20(c) of the disposal and marking regulations, transformers must be flushed with a solvent.
[d] Assuming 12.9 lb per gal for PCB mixtures.

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REGIONAL PROFILE OF PCB WASTE DISPOSAL REQUIREMENTS

The estimated distribution of PCB equipment in the United States according to EPA region is presented in Chapter III. In the absence of more specific distribution data from the electrical equipment manufacturers, it is assumed that PCB equipment is distributed in proportion to regional electrical sales.

Similarly, the regional PCB waste disposal profile is assumed to be distributed as a function of electrical sales. The following factors were used to apportion the national PCB disposal requirements (from the preceding section) among the ten EPA regions:

EPA Region	Distribution Weighting Factor
I	.039
II	.091
III	.108
IV	.209
V	.210
VI	.119
VII	.045
VIII	.023
IX	.104
X	.058

Table 5-4 displays the total annual quantities of PCBs and PCB-contaminated articles estimated as available for disposal in each EPA region. These quantities are grouped according to the method of disposal required. For example, all capacitors must be incinerated beginning in 1980, and the resulting residue must then be disposed of to an approved PCB landfill. The total landfill capacity requirement therefore includes (1) the total volume of transformer shells (drained) and (2) the total volume of residue from capacitor incineration. It does not include estimates of spill debris which, according to the regulations, may also be disposed of in a landfill. The total disposal quantities are presented in the units appropriate for disposal site design. Material destined for incineration is expressed in pounds of liquid and solid (due to heat incineration design constraints). Material destined for landfill is expressed in cubic yards of solid (due to a volumetric design constraint).

DESCRIPTION OF REGIONAL PCB DISPOSAL CAPACITY

The disposal regulations outlined in Chapter IV have severely restricted the existing landfill and incineration capacity available for utility PCB disposal. As of

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Table 5-4

ESTIMATED PCB DISPOSAL REQUIREMENTS BY EPA REGION

Region I

Years	To Incineration, Per Year				To Landfill, Per Year				Totals	
	PCB Mixtures (Transformer Fluids) (10^3 lb)	Transformer Flushing Solvents[a] (10^3 lb)	Undrained Capacitors (10^3 lb)	Total Weight (10^3 lb)	Transformer Shells Weight (10^3 lb)	Transformer Shells Volume (m^3)	Incinerator Residue Weight (10^3 lb)	Incinerator Residue Volume (m^3)	Weight (10^3 lb)	Volume (m^3)
1978	147.7	80.54	1,541	1,769	319.9	165	1,156	1,169	1,476	1,334
1979	147.7	80.54	1,585	1,813	319.9	165	1,189	1,202	1,509	1,367
1980-1983	147.7	80.54	1,552	1,780	319.9	165	1,164	1,177	1,484	1,342
1984	147.7	80.54	2,218	2,446	319.9	165	1,664	1,682	1,984	1,847
1985-1989	147.7	80.54	2,613	2,841	319.9	165	1,960	1,982	2,280	2,147
1990	147.7	80.54	1,321	1,549	319.9	165	991	1,002	1,311	1,167
1991-1996	147.7	80.54	2,032	2,260	319.9	165	1,524	1,541	1,844	1,706
1997	419.6	220.9	796	1,445	909.5	469	597	603	1,507	1,072
1998-2002	256.0	139.6	--	395.6	564.6	286	--	--	555	286
2003-2007	279.9	152.6	--	432.5	606.4	313	--	--	606	313
2008-2012	446.9	243.8	--	690.7	968.4	499	--	--	968	499
2013-2017	365.2	199.1	--	564.3	791.3	408	--	--	791	408
Totals				17,906					16,315	13,488

[a] Does not include PCB-contaminated mineral oils.

MONS 028331

Table 5-4 (continued)

Region II

Years	To Incineration, Per Year				To Landfill, Per Year				Totals	
	PCB Mixtures (Transformer Fluids) (10^3 lb)	Transformer Flushing Solvents, (10^3 lb)	Undrained Capacitors (10^3 lb)	Total Weight (10^3 lb)	Transformer Shells Weight (10^3 lb)	Transformer Shells Volume (m^3)	Incinerator Residue Weight (10^3 lb)	Incinerator Residue Volume (m^3)	Weight (10^3 lb)	Volume (m^3)
1978	344.5	187.9	3,896	4,128	746.5	385	2,697	2,727	3,444	3,112
1979	344.5	187.9	3,698	4,230	746.5	385	2,774	2,804	3,521	3,189
1980-1983	344.5	187.9	3,622	4,154	746.5	385	2,716	2,746	3,463	3,131
1984	344.5	187.9	5,176	5,708	746.5	385	3,682	3,925	4,429	4,310
1985-1989	344.5	187.9	6,097	6,629	746.5	385	4,573	4,624	5,320	5,009
1990	344.5	187.9	3,082	3,614	746.5	385	2,312	2,337	3,059	2,722
1991-1996	344.5	187.9	4,742	5,274	746.5	385	3,556	3,596	4,303	3,981
1997	979.2	534.2	1,836	3,349	2,122	1,093	1,392	1,408	3,514	2,501
1998-2002	597.3	325.8	--	923.1	1,294	667	--	--	1,294	667
2003-2007	653.0	356.2	--	1,009	1,415	729	--	--	1,415	779
2008-2012	1,082.9	568.6	--	1,612	2,260	1,165	--	--	2,260	1,165
2013-2017	852.0	464.7	--	1,317	1,846	951	--	--	1,846	951
Totals				41,967					37,868	31,467

[a]Does not include PCB-contaminated mineral oils.

MONS 028332

Table 5-4 (continued)

Region III

Years	To Incineration, Per Year				To Landfill, Per Year				Totals	
	PCB Mixtures (Transformer Fluids) (10^3 lb)	Transformer Flushing Solvents, (10^3 lb)	Undrained Capacitors (10^3 lb)	Total Weight (10^3 lb)	Transformer Shells		Incinerator Residue			
					Weight (10^3 lb)	Volume (m^3)	Weight (10^3 lb)	Volume (m^3)	Weight (10^3 lb)	Volume[a] (m^3)
1978	488.9	223.0	4,288	4,900	885.9	457	3,201	3,237	4,087	3,694
1979	488.9	223.0	4,309	5,021	885.9	457	3,292	3,328	4,178	3,785
1980-1983	488.9	223.0	4,298	4,930	885.9	457	3,[illegible]4	3,759	4,110	3,716
1984	488.9	223.0	6,143	6,775	885.9	457	4,608	4,659	5,494	5,116
1985-1989	488.9	223.9	7,236	7,868	885.9	457	5,427	5,488	6,313	5,945
1990	488.9	223.9	3,658	4,290	885.9	457	2,743	2,774	3,629	3,231
1991-1996	488.9	223.0	5,628	6,260	885.9	457	4,221	4,268	5,107	4,725
1997	1,162	634.0	2,203	3,999	2,519	1,299	1,652	1,671	4,171	2,969
1998-2002	708.9	386.6	--	1,096	1,536	792	--	--	1,536	792
2003-2007	776.0	422.7	--	1,198	1,679	865	--	--	1,679	865
2008-2012	1,236	675.1	--	1,913	2,682	1,382	--	--	2,682	1,382
2013-2017	1,011	551.6	--	1,563	2,191	1,129	--	--	2,191	1,129
Totals				49,813					45,177	37,349

[a] Does not include PCB-contaminated mineral oils.

MONS 028333

Table 5-4 (continued)

Years	To Incineration, Per Year				To Landfill, Per Year				Totals	
	PCB Mixtures (Transformer Fluids) (10^3 lb)	Transformer Flushing Solvents (10^3 lb)	Undrained Capacitors (10^3 lb)	Total Weight (10^3 lb)	Transformer Shells Weight (10^3 lb)	Transformer Shells Volume (m^3)	Incinerator Residue Weight (10^3 lb)	Incinerator Residue Volume (m^3)	Weight (10^3 lb)	Volume (m^3)
1978	791.3	431.6	8,259	9,482	1,714	884	6,195	6,263	7,909	7,147
1979	791.3	431.6	9,494	9,717	1,714	884	6,370	6,441	8,084	7,325
1980-1983	791.3	431.6	8,318	9,541	1,714	884	6,238	6,308	7,952	7,192
1984	791.3	431.6	11,089	13,112	1,714	884	8,917	9,016	10,631	9,900
1985-1989	791.3	431.6	14,003	15,226	1,714	884	10,503	10,619	12,217	11,503
1990	791.3	431.6	7,079	8,302	1,714	884	5,309	5,368	7,023	6,252
1991-1996	791.3	431.6	10,091	12,114	1,714	884	8,168	8,259	9,882	9,143
1997	2,249	1,227	4,264	7,740	4,076	2,311	3,188	3,233	7,982	5,744
1998-2002	1,372	748.2	--	2,120	2,972	1,532	--	--	2,972	1,532
2003-2007	1,500	818.0	--	2,318	3,250	1,675	--	--	3,250	1,675
2008-2012	2,395	1,306	--	3,701	5,189	2,675	--	--	5,189	2,675
2013-2017	1,957	1,067	--	3,024	4,241	2,185	--	--	4,241	2,185
Totals				96,397					87,332	72,273

[a] Does not include PCB-contaminated mineral oils.

MONS 028334

Table 5-4 (continued)

Years	To Incineration, Per Year				To Landfill, Per Year				Totals	
	PCB Mixtures (Transformer Fluids) (10^3 lb)	Transformer Flushing Solvents (10^3 lb)	Undrained Capacitors (10^3 lb)	Total Weight (10^3 lb)	Transformer Shells Weight (10^3 lb)	Transformer Shells Volume (m^3)	Incinerator Residue Weight (10^3 lb)	Incinerator Residue Volume (m^3)	Weight (10^3 lb)	Volume (m^3)
Region V										
1978	795.0	633.7	8,295	9,528	1,723	888	6,224	6,293	7,947	7,181
1979	795.0	633.7	8,534	9,763	1,723	888	6,401	6,472	8,124	7,360
1980-1983	795.0	633.7	8,358	9,587	1,723	888	6,268	6,338	7,991	7,226
1984	795.0	633.7	11,948	13,175	1,723	888	8,959	9,059	10,682	9,947
1985-1989	795.0	633.7	14,070	15,299	1,723	888	10,553	10,670	12,276	11,558
1990	795.0	633.7	7,113	8,342	1,723	888	5,335	5,394	7,058	6,282
1991-1996	795.0	633.7	10,943	12,172	1,723	888	8,207	8,298	9,930	9,186
1997	2,260	1,233	4,284	7,777	6,097	2,623	3,213	3,249	8,110	5,772
1998-2002	1,378	751.8	--	2,130	2,906	1,539	--	--	2,906	1,539
2003-2007	1,587	821.9	--	2,329	3,266	1,683	--	--	3,266	1,683
2008-2012	2,487	1,313	--	3,720	5,214	2,687	--	--	5,214	2,687
2013-2017	1,966	1,072	--	3,038	4,261	2,196	--	--	4,261	2,196
Totals				96,860					87,845	72,617

[a] Does not include PCB-contaminated mineral oils.

MONS 028335

Table 5-4 (continued)

Region VI

Years	To Incineration, Per Year				To Landfill, Per Year				Totals	
	PCB Mixtures (Transformer Fluids) (10^3 lb)	Transformer Flushing Solvents (10^3 lb)	Undrained Capacitors (10^3 lb)	Total Weight (10^3 lb)	Transformer Shells Weight (10^3 lb)	Transformer Shells Volume (m^3)	Incinerator Residue Weight (10^3 lb)	Incinerator Residue Volume (m^3)	Weight (10^3 lb)	Volume (m^3)
1978	320	450	4,703	5,473	980	503.1	3,527	3,566	4,507	4,069.1
1979	320	450	4,836	5,606	980	503.1	3,627	3,667	4,607	4,170.1
1980-1983	320	450	4,736	5,506	980	503.1	3,552	3,591	4,532	4,094.1
1984	320	450	6,769	7,539	980	503.1	5,077	5,133	6,057	5,636.1
1985-1989	320	450	7,973	8,743	980	503.1	5,980	6,046	6,960	6,509.1
1990	320	450	4,031	4,801	980	503.1	3,023	3,057	4,003	3,560.1
1991-1996	320	450	6,201	6,971	980	503.1	4,651	4,702	5,631	5,205.1
1997	920	1,280	2,428	4,628	2,780	1,429.9	1,823	1,844	4,601	2,344.1
1998-2002	560	780	--	1,340	1,690	872.3	--	--	1,690	872.3
2003-2007	610	850	--	1,460	1,850	953.6	--	--	1,850	953.6
2008-2012	900	1,360	--	2,340	2,950	1,522.8	--	--	2,950	1,522.8
2013-2017	800	1,110	--	1,910	2,410	1,244.1	--	--	2,410	1,244.1
Totals				56,317					49,798	40,181

[a]Does not include PCB-contaminated mineral oils.

MONS 028336

Table 5-4 (continued)

Region VII

Years	To Incineration, Per Year: PCB Mixtures (Transformer Fluids) (10^3 lb)	To Incineration, Per Year: Transformer Flushing Solvents* (10^3 lb)	To Incineration, Per Year: Undrained Capacitors (10^3 lb)	To Incineration, Per Year: Total Weight (10^3 lb)	To Landfill, Per Year: Transformer Shells Weight (10^3 lb)	To Landfill, Per Year: Transformer Shells Volume (m^3)	To Landfill, Per Year: Incinerator Residue Weight (10^3 lb)	To Landfill, Per Year: Incinerator Residue Volume (m^3)	Totals: Weight (10^3 lb)	Totals: Volume (m^3)
1978	120	170	1,778	2,068	370	190.3	1,334	1,369	1,704	1,559.3
1979	120	170	1,829	2,119	370	190.3	1,372	1,387	1,742	1,577.3
1980-1983	120	170	1,791	2,081	370	190.3	1,343	1,358	713	1,548.3
1984	120	170	2,568	2,858	370	190.3	1,920	1,941	2,290	2,131.3
1985-1989	120	170	1,815	2,105	370	190.3	2,261	2,286	2,631	2,476.3
1990	120	170	1,524	1,814	370	190.3	1,143	1,156	1,513	1,346.3
1991-1996	120	170	2,345	2,635	370	190.3	1,759	1,778	2,129	1,968.3
1997	360	480	918	1,740	1,050	540.7	688	696	1,738	1,236.7
1998-2002	210	300	--	510	640	329.8	--	--	640	329.8
2003-2007	230	320	--	550	708	369.6	--	--	708	369.6
2008-2012	370	520	--	890	1,120	575.9	--	--	1,120	575.9
2013-2017	300	420		720	910	470.5	--	--	910	470.5
Totals				21,290					17,830	15,561

*Does not include PCB-contaminated mineral oils.

MONS 028337

Table 5-4 (continued)

Region VIII

Years	To Incineration, Per Year				To Landfill, Per Year				Totals	
	PCB Mixtures (Transformer Fluids) (10^3 lb)	Transformer Flushing Solvents (10^3 lb)	Undrained Capacitors (10^3 lb)	Total Weight (10^3 lb)	Transformer Shells Weight (10^3 lb)	Transformer Shells Volume (m^3)	Incinerator Residue Weight (10^3 lb)	Incinerator Residue Volume (m^3)	Weight (10^3 lb)	Volume (m^3)
1978	60	90	909	1,059	190	97.2	682	689	872	786.2
1979	60	90	935	1,085	190	97.2	701	709	891	806.2
1980-1983	60	90	915	1,065	190	97.2	687	694	877	791.2
1984	60	90	1,308	1,458	190	97.2	981	992	1,171	1,089.2
1985-1989	60	90	1,541	1,691	190	97.2	1,156	1,169	1,346	1,266.2
1990	60	90	779	929	190	97.2	584	591	774	688.2
1991-1996	60	90	1,198	1,348	190	97.2	899	909	1,089	1,006.2
1997	180	250	469	899	540	276.4	352	356	892	632.4
1998-2002	110	150	--	260	330	168.6	--	--	330	168.6
2003-2007	120	170	--	290	360	184.3	--	--	360	184.3
2008-2012	190	280	--	470	570	294.3	--	--	570	294.3
2013-2017	150	220	--	370	470	240.5	--	--	470	240.5
Totals				10,904					9,662	7,954

[a] Does not include PCB-contaminated mineral oils.

MONS 028338

Table 5-4 (continued)

Region 1X

Years	To Incineration, Per Year				To Landfill, Per Year					
	PCB Mixtures (Transformer Fluids) (10^3 lb)	Transformer Flushing Solvents* (10^3 lb)	Contaminated Waters (10^3 lb)	Total Weight (10^3 lb)	Transformer Shells Weight (10^3 lb)	Transformer Shells Volume (m^3)	Incinerator Residue Weight (10^3 lb)	Incinerator Residue Volume (m^3)	Totals Weight (10^3 lb)	Totals Volume (m^3)
1978	280	390	4,110	4,780	850	439.7	3,082	3,117	3,932	3,556.7
1979	280	390	4,226	4,896	850	439.7	3,170	3,205	4,020	3,644.7
1980-1983	280	390	4,139	4,809	850	439.7	3,104	3,139	3,954	3,578.7
1984	280	390	5,916	6,586	850	439.7	4,437	4,486	5,287	4,925.7
1985-1989	280	390	6,968	7,638	850	439.7	5,226	5,284	6,076	5,723.7
1990	280	390	3,523	4,193	850	439.7	2,642	2,671	3,492	3,110.7
1991-1996	280	390	5,419	6,089	850	439.7	4,064	4,110	4,914	4,549.7
1997	980	1,120	2,122	4,042	2,430	1,250	1,591	1,609	4,021	2,859.0
1998-2002	490	680	--	1,170	1,480	762.3	--	--	1,480	762.3
2003-2007	530	750	--	1,280	1,620	833.3	--	--	1,620	833.3
2008-2012	850	1,190	--	2,040	2,580	1,331	--	--	2,580	1,331
2013-2017	700	970	--	1,670	2,110	1,087.3	--	--	2,110	1,087.3
Totals				49,193					43,486	35,963

*Does not include PCB-contaminated mineral oils.

MONS 028339

Table 5-4 (continued)

Region I

Years	To Incineration, Per Year: PCB Mixtures (Transformer Fluids) (10^3 lb)	To Incineration, Per Year: Transformer Flushing Solvents[a] (10^3 lb)	To Incineration, Per Year: Undrained Capacitors (10^3 lb)	To Incineration, Per Year: Total Weight (10^3 lb)	To Landfill, Per Year: Transformer Shells Weight (10^3 lb)	To Landfill, Per Year: Transformer Shells Volume (m^3)	To Landfill, Per Year: Incinerator Residue Weight (10^3 lb)	To Landfill, Per Year: Incinerator Residue Volume (m^3)	Totals: Weight (10^3 lb)	Totals: Volume (m^3)
1978	160	220	2,292	2,672	480	245.2	1,719	1,738	2,199	1,983.2
1979	160	220	2,357	2,737	480	245.2	1,768	1,787	2,248	2,032.2
1980-1983	160	220	2,308	2,688	480	245.2	1,731	1,750	2,211	1,995.2
1984	160	220	3,299	3,679	480	245.2	2,474	2,502	2,954	2,747.2
1985-1989	160	220	3,886	4,266	480	245.2	2,915	2,947	3,395	3,192.0
1990	160	220	1,964	2,344	480	245.2	1,473	1,490	1,953	1,735.0
1991-1996	160	220	3,022	3,402	480	245.2	2,267	2,292	2,747	2,537.0
1997	330	620	1,183	2,253	1,350	696.9	887	897	2,237	1,593.9
1998-2002	270	380	--	650	820	425.1	--	--	820	4,251.0
2003-2007	300	620	--	720	900	466.7	--	--	90	466.7
2008-2012	480	660	--	1,140	1,440	702.2	--	--	1,440	702.2
2013-2017	400	540	--	940	1,180	606.4	--	--	1,180	606.4
Totals				27,491					23,474	23,880.0

[a]Does not include PCB-contaminated mineral oils.

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this writing, no combustion facilities and only six landfill sites have been approved for PCB materials disposal. Figures 5-1 and 5-2 present the geographical distribution of PCB incinerator and landfill sites, respectively, and indicate the status of implementation for each. Several of the sites were visited to obtain information on anticipated handling and disposal procedures. The results of these site visits are presented in Appendices E and I.

At this time, projecting PCB disposal capacity involves a considerable amount of speculation. Besides some uncertainty in projecting the total yearly* capacity of certain planned sites, there are competing sources of PCB materials which constitute an unknown variable when assessing disposal availability.

The following pages summarize the PCB disposal capacity/demand relationships by EPA region, along with projections for future capacity construction.

Region I

Demand for waste PCB material disposal within this region is expected to be small. Approximately 40.764×10^6 lb of capacitors and 3300 transformers will be generated by the utility industry through the year 2017. At this time there is no PCB disposal capacity within Region I (either landfill or incineration), nor is any future capacity planned.

Region II

Utility demand for waste PCB disposal within Region II is expected to be moderate. An estimated 93 million lb of capacitors and 7700 transformers will require disposal through 2017. Two approved PCB landfill sites are presently in operation in Region II: SCS Chemical Waste Services in Model City, New York, and NEWCO Chemical Waste Systems in Niagara Falls, New York. The Model City site has a PCB capacity of 35,500 [m^3], while the Niagara Falls site has a capacity of 26,600 [m^3]. There is also an existing chemical waste incinerator facility located in Bridgeport, New Jersey, and operated by Rollins Environmental Services. This facility has a potential PCB combustion capacity of 81 million lb/yr of combined PCB solids and liquids.

*Promulgated regulations limit storage of utility PCB materials to a maximum of 1 yr.

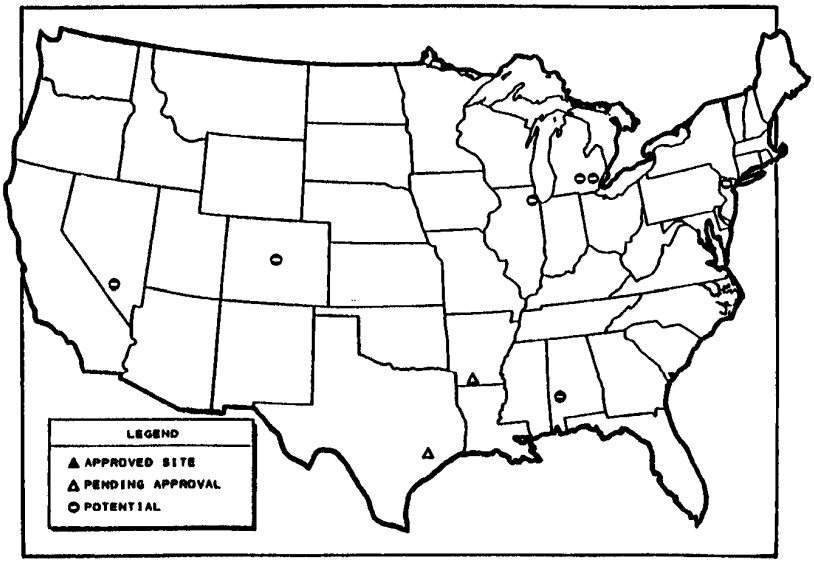

Figure 5-1. Location and Status of Possible PCB Incineration Sites

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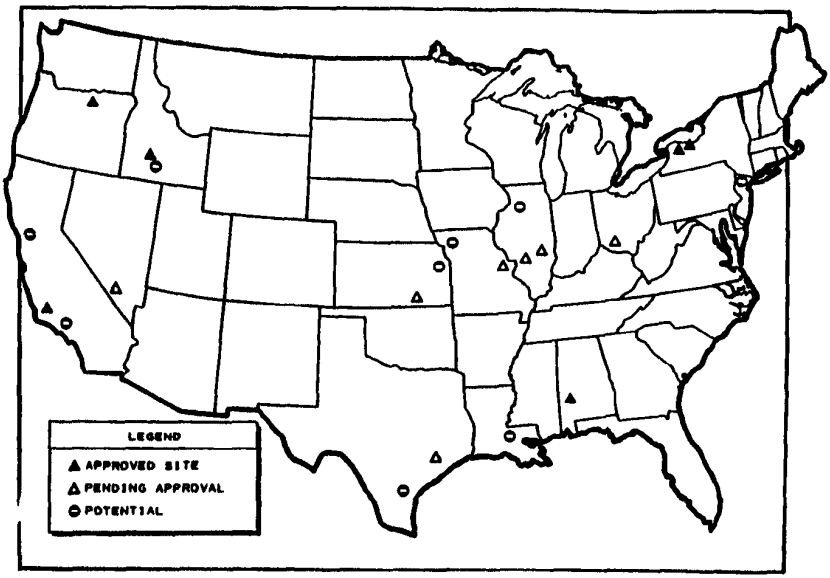

Figure 5-2. Location and Status of Possible PCB Landfill Sites

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Region III

Demand for utility PCB waste disposal in this region is moderate. PCB disposal requirements through 2017 are a projected 113 million lb of capacitors and 9200 transformers. No PCB disposal sites currently exist in Region III, and no known future capacity is planned.

Region IV

The second highest regional demand for utility PCB waste disposal is expected to occur in Region IV. An estimated 209 million lb of capacitors and 17,500 transformers will require disposal by 2017. A PCB landfill site is presently operated by Waste Management Company of Alabama in Emelle, Alabama. No PCB incineration sites currently exist in Region IV, although Waste Management is considering the construction of a facility at their Alabama landfill site.

Region V

Region V is projected to have the greatest demand for utility PCB disposal capacity of all EPA regions. An estimated 222 million lb of PCB capacitors and 18,000 PCB transformers will require disposal over the next 40 yr.

There currently are no approved PCB disposal sites (either landfill or incineration) in Region V. Several sites currently planned, however, are awaiting approval. These are as follows:

- A and F Materials Company has applied for a permit to operate a PCB landfill site in Illinois.
- Clermont Environmental Reclamation Company in Ohio has also applied for a PCB landfill permit.
- The State of Michigan, Department of Natural Resources (MDNR), has announced plans to construct and operate a PCB incineration and landfill facility within the state of Michigan. A preliminary design for the MDNR site has been developed, but no construction has taken place to date.
- An existing chemical waste combustion facility in the Chicago area, operated by Hyon Waste Management Corporation, has applied for a PCB test burn, but is reportedly encountering financial problems.
- Prenco Manufacturing Company of Madison Heights, Michigan, has also applied to EPA for a PCB test-burn permit, but is expected to encounter difficulties in obtaining state permission.

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Region VI

Only a moderate utility PCB disposal demand is forecast for this region. Utility disposal requirements are estimated at 115 million lb of capacitors and 9200 PCB transformers through 2017.

Two existing incinerator sites have applied for (and are expected to receive) PCB disposal permits. One incinerator is operated by Energy Systems Company in El Dorado, Arkansas, and the other is operated by Rollins Environmental Services Company in Deer Park, Texas. Rollins is also planning on applying for a PCB solids landfill permit. At least one other Region VI landfill operation has also shown interest in PCB disposal.

Region VII

The demand for PCB disposal capacity in this region is low. An estimated 45 million lb of utility PCB capacitors and 3800 transformers are destined for disposal over the next 40 yr. Two landfill operators, Kansas Industrial and Environmental Services, and Chem-Dyne Corporation, have applied for PCB landfill permits in Region VII.

No existing or potential commercial PCB combustion facilities were identified in Region VII.

Region VIII

Of all EPA regions, Region VIII has the lowest estimated demand for utility PCB disposal capacity. An estimated 22 million lb of utility PCB capacitors and 1800 PCB transformers will require disposal in this region over the next 40 yr. No existing or proposed PCB landfills are located in Region VIII. Aerr Company, of Denver, Colorado, is planning to construct a chemical waste incinerator capable of handling PCB materials and intends to apply for an operating permit in the near future.

Region IX

A moderate demand for PCB disposal capacity is forecast for this region, where approximately 105 million lb of utility PCB capacitors and 8700 utility PCB transformers are expected to require disposal. The Casmalia landfill site in Santa Barbara County and the Nuclear Engineering site in Beatty, Nevada, were recently permitted to accept PCB materials, and several other PCB landfill applications are pending. No PCB combustion facilities exist or are planned for this region.

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Region X

Projected utility PCB disposal demand in Region X is low. An estimated 62 million lb of utility PCB capacitors and 4500 utility PCB transformers are expected to require disposal. Two existing landfills are currently approved to accept PCBs. Wes-Con Corporation operates a PCB burial site in an abandoned missile silo near Twin Falls, Idaho. Chemical Nuclear Systems operates a conventional PCB landfill near Arlington, Oregon. No existing or proposed PCB combustion disposal sites were identified in Region X.

SUMMARY OF THE CAPACITY/DEMAND RELATIONSHIP

Table 5-5 presents a summary of the demand for PCB disposal capacity and a comparison of that demand with existing and proposed disposal capacity. The table indicates that even the most optimistic projections for capacity do not approach the demand beginning in 1980. Assuming the average lead time for permitting and constructing an incineration facility exceeds 3 yr, the demand for PCB liquids disposal capacity cannot be met until at least the mid-1980s. The inventory of PCBs which accumulate during the waiting period will also increase demand in later years.

Utilities will need to both (1) establish their own PCB disposal capacity and (2) provide long-term commitments to the waste disposal industry for facility construction and operation, if the utility industry is to comply with EPA storage and disposal requirements. Even so, it will not be possible to meet the current EPA compliance schedule due to disposal capacity limitations.

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Table 5-5

COMPARISON OF REGIONAL PCB DISPOSAL CAPACITY WITH PROJECTED DEMAND

EPA Region	PCB Disposal Capacity[a]: Total 10^3 (m^3) Solids (Landfill) Approved[b]	Total 10^3 (m^3) Solids (Landfill) Potential[c]	Solids and Liquids 10^6 lb/yr (Incineration) Potential[c]	Solids and Liquids 10^6 lb/yr (Incineration) Proposed[d]	Average Annual PCB Waste Generation Rate, 1980-1990: To Incineration Liquids (10^6 lb)	To Incineration Solids (10^6 lb)	To Landfill Solids (10^3 (m^3)	Capacity as a Percent of Demand: PCB Incineration Potential[c]	Capacity as a Percent of Demand: PCB Incineration Proposed[d]	Number of Years to Fill Landfill Sites with PCB Solids: Approved[b]	Number of Years to Fill Landfill Sites with PCB Solids: Potential[c]
I	0	0	0	0	.220	2.613	2.147	0	0	0	0
II	62	0	66	0	.532	6.097	5.009	>100	0	29	0
III	0	0	0	0	.632	7.236	5.945	0	0	0	0
IV	34	0	0	50	1.223	14.00	11.50	0	>100	3.0	0
V	0	4,400	0	50	1.229	14.07	11.56	0	>100	0	>50
VI	0	8,600	147	0	.770	7.973	6.549	>100	0	0	>50
VII	0	16,000	0	0	.290	3.015	2.476	0	0	0	>50
VIII	0	0	0	50	.150	1.541	1.266	0	>100	0	0
IX	200	8,400	0	50	.670	6.960	5.724	0	>100	35	>50
X	64	700	0	0	.300	3.086	3.182	-	0	17	>50
Totals	360	38,100	213	200	6.104	67.00	55.360	241[f]	272[f]	6.3[f]	>50[f]

[a] Total disposal site capacity - 100 percent of capacity may not be dedicated solely to utility PCB disposal.
[b] Approved: Sites which have obtained PCB disposal permits.
[c] Potential: Existing sites pending approval or considered capable of meeting EPA design criteria for PCB disposal.
[d] Proposed: PCB disposal sites which are being planned but do not yet exist.
[e] Totals represent capacity/demand relationship if all regions utilize all sites.

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Section 6

TECHNOLOGY FOR PCB DISPOSAL BY COMBUSTION

DESIGN CRITERIA FOR PCB COMBUSTION

Introduction

Most of the engineering principles which are normally used to design an efficient combustion system for a fuel such as oil or coal, are applicable to the design of combustion systems for PCB solids and liquids. For example, liquid fuels must be atomized mechanically, with steam or with air, to ensure rapid combustion and a stable flame. Combustion chambers must be sized for the desired heat release capacity to avoid damage to the refractory. Sufficient excess air must be provided to insure complete combustion of the fuel. However, the design of a PCB combustion system or incinerator must also take into account several unique factors, such as the extreme stability and the high chlorine content of PCBs, as well as the problems which they create if they escape into the environment.

Because of the hazards associated with PCB management, PCB disposal by combustion is controlled by specific existing regulations (150), as well as by proposed regulations for all hazardous materials (143). Certain combustion systems which show promise for the disposal of PCBs, such as cement kilns and utility boilers, may be exempted from some of the general requirements.

PCB Physical Properties and Combustion Characteristics

The physical properties of Aroclor 1016 are given in Table 6-1. This grade of Aroclor was introduced in 1971, and replaced Aroclor 1242 as the principle capacitor impregnant.

Chlorine Content. With the exception of Aroclor 1016 (which contains 41.3 weight percent fixed or organic chlorine), the last two digits of the Aroclor grade designation correspond to the approximate weight percent of chlorine. For the purposes of combustion design, Aroclor 1016 or 1242 can be assumed to account for most PCBs used in capacitors. Aroclors 1242 through 1260 were used to fill transformers.

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Table 6-1

TYPICAL PROPERTIES OF AROCLOR 1016

Property	Test Method (see note)	Typical Values
Color	APHA*	40, max
Condition		Clear
Specific Gravity at 25/1.5°C	ANSI C59.68-1965(R1973)	1.362-1.372
Acidity (mg KOH/g)	ANSI Z11.131-1964(R1974) ANSI Z11.59-1958(R1971)	0.010, max
Moisture		35 ppm, max
Refractive index at 25°C	ASTM D 1817-66(1972)	1.6215-1.6235
Inorganic (free) chlorides	ANSI C59.55-1963(R1973)	0.05 ppm, max
Pour Point	ANSI Z11.5-1966(R1972)	-14°C or lower
Dielectric constant (100 Hz at 100°C)	ANSI C59.22-1967(R1973)	4.70-4.90
Resistivity (500 V dc at 100°C, 0.1-inch gap)	ANSI C59.51-1965(R1973)	500 x 10^9 ohm cm, min
Hydrolysis stability test (as chlorides)	ANSI C59.106-1970	0.5 ppm, max
Thermal stability test (as chlorides)	ANSI C59.111-1970	0.4 ppm, max
Distillation range (corrected) 10% distilled by weight 90% distilled by weight	ANSI A37.9-1974	 323°C, min 356°C, max
Higher-Boiling Homologues	ASTM D 3303-74	0.4%, max
Sulfates	ANSI C59.2-1974	None
Dielectric strength at 25°C	ANSI C59.19-1968(R1973)	35 kV, min
Flash point, Cleveland Open Cup	ANSI Z11.6-1973	338°F, min
Fire point		None to boiling point

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Table 6-1 (continued)

Property	Test Method (see note)	Typical Values
Corrosion test (6 hours at 210°C with bright aluminum foil), change in weight of aluminum		0.10%
Viscosity at 100°F (SUS)†	ANSI Z11.2-1956(R1970)	71.81
Specific heat at 25°C		0.30
Coefficient of expansion	ANSI C59.57-1963(R1973)	0.00068 $cm^3/cm^3/°C$
Fixed chlorine	Carius	41.3 ± 0.5%
Power factor at 100°C, 60 Hz	Munch	
Bulk		1%, max
Drums		4%, max

*American Public Health Association
†Saybolt Universal seconds.

Source: American National Standard C107.1-1974 (Ref. 25)

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Aroclor 1254 can be used as the design point for transformer combustion. The average chlorine content of all PCBs is about 53 percent by weight.

Heating Value. The following formulae for approximating the heating value of chlorinated chemical waste have been developed:

Lower heating value, Btu/lb =
14,100 C + 45,000 (H-O/8) -760 (Cl) + 4,500 (S)
Higher heating value, Btu/lb =
14,100 C + 54,500 (H-O/8) -150 (Cl) + 4,500 (S)
where
C = weight fraction carbon
H = weight fraction hydrogen
O = weight fraction oxygen
CL = weight fraction chlorine
S = weight fraction sulfur

For example, trichlorobiphenyl has the formula $C_{12}H_7Cl_3$, and its ultimate analysis is as follows:

C - 56.0 percent
H - 2.7 percent
Cl - 41.3 percent
Total 100.0 percent

The lower heating value calculated by the formula is 8800 Btu/lb, whereas Komamiya (67) cites a value of 8950 Btu/lb for the net calorific value. The higher heating value by the formula is 9430 Btu/lb, whereas Komamiya gives a value of 9972 Btu/lb.

Combustion Theory. The combustion of PCBs can be illustrated by considering a specific example. The formula for the combustion of pure trichlorobiphenyl with 92.3 percent excess air is shown below:

$$C_{12}H_7Cl_3 + 25\ O_2 + 25\ (79/21)\ N_2 \rightarrow 12\ O_2 + 12\ CO_2 + 3\ HCl + 2\ H_2O + 25\ (79/21)\ N_2$$

This level of excess air will produce a temperature of approximately 1200°C (2200°F), assuming no heat losses from the combustion chamber. The composition of the combustion exhaust gases at equilibrium is as follows:

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Component	Volume Fraction
O_2	0.098
CO_2	0.098
HCl	0.024
H_2O	0.016
N_2	0.764
Total	1.000

Free Chlorine in the Combustion Gases. The previous example equation assumes that all the chlorine in the trichlorobiphenyl is converted to hydrochloric acid. Actually, some of the chlorine appears as free chlorine, which is less soluble and more difficult to remove with wet scrubbers. The quantity of free chlorine can be calculated by the equilibrium relation:

$$K_p = \frac{(P_{HCl})^2 (P_{O_2})^{1/2}}{P_{H_2O} P_{Cl_2}}$$

where K_p is given by Figure 6-1, and the pressures are in atmospheres, e.g., P_{HCl} is the partial pressure of hydrochloric acid in atmospheres or the volume fraction in the gas if the total pressure is one atmosphere.

For example, the partial pressure of free chlorine in the combustion gases of the previous example is calculated as follows - (K_p = 30 at 1,200°C):

$$P_{Cl_2} = \frac{(0.024)^2 (0.098)^{1/2}}{(30)\ (0.016)}$$

$$= 0.000376 \text{ atmospheres}$$

The partial pressure of 376 x 10^{-6} atmospheres corresponds to 376 ppm by volume of free chlorine, which is unacceptably high. A value of less than 10 ppm is desirable, and can be achieved by a combination of the following steps:

1. Increase combustion temperature (increases K_p)
2. Dilute feed with a light solvent such as kerosene, xylene, or a No. 2 fuel oil (supplies hydrogen and dilutes the chlorine content of the feed stream)
3. Reduce the excess air (reduces P_{O_2})
4. Inject water into the combustion chamber (increases P_{H_2O})

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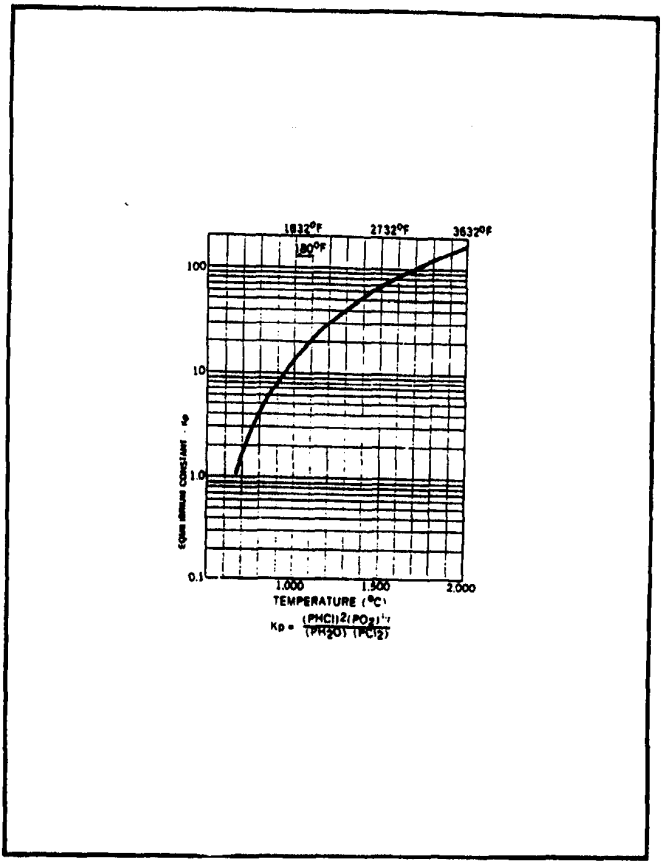

Figure 6-1. Equilibrium Constant Versus Temperature

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For example, if the chlorine content is diluted to 25 percent by weight with fuel oil, 0.5 lb of water is injected per pound of diluted PCB, and the excess air is reduced to 72.2 percent, then combustion temperature will still be (1200°C) (2200°F) but the free chlorine will be reduced to about 10 ppm. If the excess air is reduced to 25 percent, then 1.65 lb of water can be injected with each pound of diluted PCB, and the free chlorine is reduced to about 4 ppm.

If the PCB molecule contains more than 5 chlorine atoms (more than 54 percent chlorine by weight), then there is not enough hydrogen in the molecule to convert all the chlorine to hydrochloric acid. It is then absolutely essential to dilute with a light solvent and/or to inject water. The diluent does not need to be mixed with the PCBs before combustion, i.e., the PCBs and the diluent can be burned through separate burners into a common combustion chamber where all the combustion gases are well mixed.

Flame Stability. Flame stability is influenced primarily by the heating value, flash point, and viscosity of the waste material. Modern high-intensity burners, such as the Vortex Burner of Trane Thermal Research (119), can maintain a stable flame with chlorine contents as high as 70 weight percent and heating values as low as 4500 Btu/lb. Furthermore, external atomizing nozzles are available which have large fluid openings (1/8 to 1/2 in minimum clearance, necessary for waste fuels), and can atomize fuels with viscosities as high as 4500 SSU (120). Theors as low as 4500 Btu/lb. Furthermore, external atomizing nozzles are available which have large fluid openings (1/8 to 1/2 in minimum clearance, necessary for waste fuels), and can atomize fuels with viscosities as high as 4500 SSU (120). Theoretically, stable combustion can be maintained for most PCBs without dilution and little or no heating to reduce viscosity; however, a review of existing literature indicates that demonstration of such has never been documented.

Light solvents will be used to flush transformers and for general cleanup of work areas (150). These contaminated solvents will require disposal along with the liquid PCBs. Sufficient contaminated solvent will in many cases be available to dilute liquid PCBs to 25 percent chlorine or less. No flame stability problems are expected under these conditions.

Combustion Criteria

Performance Criteria (Combustion Efficiency). The regulations specify three different types of combustion efficiency, which together define the performance required.

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First, a combustion efficiency of 99.9 percent, based on the conversion of carbon to carbon dioxide versus carbon monoxide, is required:

$$\frac{P_{CO_2}}{P_{CO_2} + P_{CO}} > 0.99$$

This means that CO levels should be below about 100 ppm, assuming that CO_2 levels will normally be 10 percent or greater. Second, the combustion efficiency should also be at least 99.99 percent, based on a comparison of chlorinated hydrocarbon emissions (decomposition products of PCBs) with the feed rate of PCBs, i.e.,

$$\frac{\text{weight of chlorinated hydrocarbons out}}{\text{weight of PCBs in}} < 0.0001$$

Finally, the air emissions of PCBs must be less than 0.0001 mg/kg of PCBs fed to the incinerator. This equates to 99.9999 percent destruction of airborne PCBs.

The PCB content of the residue is not directly specified. However, the current acceptable standard for PCBs is 500 ppm of PCBs. It is therefore desirable to reduce the PCB content in the residue (or its elutriate) to below 50 ppm.

Design Criteria. Acceptable PCB combustion systems must hold the combustion gases at 1200°C (2200°F) for 2 sec with 3 percent excess oxygen (about 15 percent excess air) or, alternately, at 1600°C (2900°F) for 1-1/2 sec with 2 percent excess oxygen (about 10 percent excess air) (150). Available research findings indicate that these criteria are more than adequate for meeting emission limits for CO and total chlorinated hydrocarbons. They are probably also adequate for meeting PCB emission limits, but this point requires more careful examination and consideration of other factors.

The following combustion performance data for destruction of PCBs are available:

- 99.995 percent destruction at 1000°C (1832°F) and 1 sec residence time. Excess air not known. If the reaction is first order in PCB concentration, the expected results for 2 sec at 1000°F would be 99.99999975 percent destruction (13).
- 99.999994 percent destruction at 2.0 to 2.9 sec residence time, 10 to 70 percent excess oxygen, and 1300°C (2372°F) to 1400°C (2552°F) (67).
- At least 99.999 percent destruction (no PCBs detected in combustion gases) at 1230°C (2246°F), 3.2 sec total (2.3 sec in afterburner), 80 percent excess air (1).

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These data indicate that the regulatory design criteria for PCB destruction are adequate.

The following additional qualitative guidelines will further ensure adequate destruction efficiency:

- The residence time should be that of the "afterburner," i.e., excluding the volume of any device used to volatize PCBs out of solid wastes or the volume which might contain dispersed liquid droplets.
- Proper combustion chamber shape and gas flow pattern will help to avoid "channeling" or "bypassing." A long cylinder is ideal.
- High levels of turbulence are recommended, preferably a "vortex" type of flow within the combustion chamber.

Design criteria for the removal of PCBs from solid wastes (such as capacitors) have not been proposed by EPA. However, general guidelines can be developed from existing test data. For example, solid wastes such as capacitors must be shredded so that all interior surfaces are exposed, i.e., no pieces with interior voids are left. Shredding to a maximum particle size of 1-1/2 in is adequate for utility-type capacitors. Whole capacitors cannot be properly incinerated (0.5 percent or more of the PCBs may remain in the ash unburned), but shredded capacitors have been incinerated efficiently, with less than 0.1 ppm of PCBs remaining in the ash (1).

The incinerator must also retain the solids for 15 min to 1 hr in order to heat the solids to a temperature adequate to vaporize, decompose, or otherwise volatize the PCBs. Temperatures of 800°C (1500°F) are considered adequate to volatize PCBs within the specified residence time.

Continuous or periodic agitation is extremely helpful in promoting rapid and uniform heating of the solids. A rotary kiln is ideal in this respect, as it continuously agitates the contaminated solids for better exposure to the combustion gases.

Air Emissions Criteria

Hydrochloric Acid. Essentially all the chlorine in PCBs is converted to hydrochloric acid during combustion. If the chlorine content of a waste stream is less than 0.5 percent, no scrubbing is required (143). If PCBs were burned in a utility boiler, the chlorine content of the boiler feed would be less than 0.5 percent. Such a process might be exempted from the scrubbing requirement.

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If the waste liquid contains more than 0.5 percent chlorine, then a scrubbing efficiency of 99 percent is required (143). This can readily be achieved in high-energy wet scrubbers using caustic or lime for neutralization. A high-energy venturi scrubber (40-60 in of water), followed by a valve tray (1) or two sieve trays (131), can produce collection efficiencies of 99.8 percent and 99.7 percent, respectively. A venturi alone may provide the required collection efficiency. Packed towers will also achieve the required collection efficiency with less pressure drop, but are susceptible to plugging and are not efficient for removing small particulates or aerosols.

Free Chlorine. With proper attention to combustion conditions, the concentration of free chlorine will be low, as noted above. Whatever the methods used to control hydrochloric acid emissions will be more than adequate to control the relatively small amounts of free chlorine.

Particulates. The proposed regulations limit particulate emissions to a maximum of 270 mg/dry m^3 (0.12 grains/dry scf) at zero excess air. This is essentially the same as the current federal standard of 0.08 grains/dry scf at 12 percent CO_2 (or 50 percent excess air) for incinerators with capacities greater than 50 tons/day. This emission level can be met by a variety of control devices, such as baghouses, dry electrostatic precipitators, high-energy venturi scrubbers with pressure drops of 40 to 60 in of water, or a low-energy venturi scrubber followed by a wet electrostatic precipitator. The last two choices will provide adequate control of both hydrochloric acid and particulate.

Monitoring and Automatic Shutdown of PCB Feed

The regulations require that the following parameters be monitored and recorded continuously:

- Combustion temperature.
- Oxygen in the flue gas.
- Carbon monoxide in the flue gas.
- Carbon dioxide in the flue gas.

Automatic interlocks must be provided to stop the flow of PCBs feed whenever:

- Combustion temperature is too low.
- Excess oxygen is too low.

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The rate of PCB feed must be measured and recorded at least every 15 min. A contingency plan approved by the regional administrator of the EPA can be substituted to serve essentially the same purpose as automatic interlocks if such equipment is not feasible.

The flow of PCBs must be stopped immediately upon:

- Failure of any monitoring instrument.
- Failure to measure the rate of PCB feed.
- Failure to maintain specified residence time.

Conclusions

Although much remains to be learned about PCB combustion kinetics, research has defined the combustion parameters required for PCB destruction. Adequate combustion conditions can be met using available combustion technology, including cement kilns, incinerators, and utility boilers. The control of solid, liquid, and gaseous emissions from these units is well within the capabilities of present technology. Existing PCB incineration regulations ensure adequate destruction.

PROFILE OF PCB COMBUSTION RESEARCH AND AVAILABLE COMBUSTION OPTIONS

Overview of PCB Combustion Research

Since the early 1970s, when PCBs were first identified as a serious environmental hazard, considerable research effort has gone into development of safe disposal techniques. Incineration has received the most attention, as a number of combustion studies have sought to determine optimum combustion conditions for PCB destruction. Thermal degradation of PCBs in cement kilns, utility boilers, hazardous waste incinerators, and sludge incinerators have all been investigated. Results have shown that PCBs are among the most thermally stable hazardous wastes in widespread use. EPA regulations for PCB combustion specify temperature and residence time requirements much greater than those commonly encountered in most routine combustion operations.

Several test burns using PCB wastes have been conducted at commercial incinerator facilities, and several more are presently scheduled. The most comprehensive analysis to date was conducted at the Rollins Environmental Services facility in Deer Park, Texas (1). Both shredded and unshredded PCB-bearing capacitors were used as

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feed. Combustion parameters, exhaust gas analysis, residue characteristics and destruction efficiency were determined. Capital and operating costs for a complete PCB disposal system were also estimated based on the Rollins system.

Results of the Deer Park tests indicated that PCB destruction efficiencies for shredded capacitors were significantly higher than for whole capacitors. Shredding however, increases facility cost and complexity. The study demonstrated that safe disposal of solid PCB wastes is possible via incineration, although at considerable cost.

The temperature and residence time characteristics of cement kilns render them suitable as is for PCB liquids incineration. Considerable testing at a cement kiln owned and operated by the St. Lawrence Cement Company (55) showed excellent PCB destruction efficiencies, surpassing the U.S. EPA requirements in every area. Emission testing indicated that the PCB concentration in the cement kiln exhaust gas was in fact less than the background concentration in the ambient air. Testing at the St. Lawrence Plant also indicated that the PCB chlorine input reacted with the alkali present in cement clinker to produce a product of improved quality.

At the St. Lawrence plant, a small quantity of fossil fuel was saved due to the addition of the PCB wastes. Some operational problems were attributed to the addition of PCBs. Procedural modifications, however, were reported to have mitigated those difficulties considerably. The St. Lawrence report concluded that PCB destruction in cement kilns was an environmentally and economically acceptable method of PCB disposal.

The results of full-scale testing were so favorable that the cement company management decided to blend PCB liquids into their kiln fuel on a permanent basis. When plans to do this were made public, local opposition grew to such a level that the company management withdrew its application for an operating permit. At the present time, no cement company is disposing of PCB materials on either a trial or permanent basis.

Testing was performed by Florida Power and Light Company (35) to determine the feasibility of burning liquid PCBs in an oil-fired utility boiler. Results indicated that PCB transformer drainings (including flushing liquids), when diluted to low-chlorine concentrations, could be disposed of in an environmentally acceptable manner. Further effort to more closely define optimum operating conditions for PCB disposal in utility boilers is currently planned (60).

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The only other full-scale investigation involving the thermal destruction of PCB wastes was conducted in a sewage sludge incinerator (171). Because the concentration of PCBs in the sludge feed was at the ppm level, the findings are not directly applicable to utility PCB waste disposal.

Other PCB combustion research has been limited to laboratory-scale studies investigating thermal destruction of various PCB compounds (18, 30, 2, 91, 126, 182, 127).

Several PCB test burns are presently scheduled, pending resolution of regulatory impediments. One detailed combustion test is to be performed by TRW Systems (EPA sponsorship) in Connecticut. The Electric Power Research Institute, in conjunction with Acurex Corporation, is attempting to conduct a full-scale capacitor test burn at the Energy Systems Company incineration facility in El Dorado, Arkansas. Acurex and the EPA are also planning to conduct a full-scale cement kiln test burn.

It is unlikely that additional combustion research will shed much new light on PCB disposal characteristics. Waste PCB materials have been successfully incinerated at a number of sites both in this country and Canada. At this time, social and political considerations bear much more heavily on disposal facility siting and operation than do technical factors.

Review of Available PCB Combustion Options

Several viable alternatives for the thermal destruction of PCB liquids exist. Coincineration in utility boilers (diluted to a very low chlorine concentration) or in cement kilns are two methods which show promise. The decontamination of high-concentration PCB solids, e.g., capacitors, is limited to specialized waste incinerators due to (1) the necessity to shred before combustion, and (2) problems encountered with feed mechanics and residue handling.

Because of the limited amount of testing which has been performed on PCB destruction, it is important to look at available combustion systems and to assess their potential for meeting the required combustion guidelines for PCBs. This section presents a brief review of these alternatives, and a qualitative evaluation of their potential as PCB disposal systems. A more detailed discussion of technically viable alternatives is presented in subsequent sections of this chapter.

System Description by Configuration. Existing combustion systems can be classified according to the method by which liquid and solid fuels are injected and contained

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until completely burned. At least 12 basic configurations can be identified: open-pit incinerators, open burning, stack flares, gas and fume combustors, catalytic combustors, the multiple-hearth or Herreshoff furnace, the rotary kiln, the fluidized bed, liquid injection, molten salt baths, multiple-chamber incinerators with fixed hearths or grates, and reciprocating or traveling-grate furnaces.

The first three can be eliminated from further consideration, because (1) the combustion conditions (excess air, temperature, residence time) cannot be controlled, and (2) the products of combustion enter the environment uncontrolled.

The last two can be eliminated because they are not designed for incinerating liquids and are not adequate for incinerating solid PCB waste. The multiple-chamber incinerator with a fixed hearth or grate is typically used for municipal and industrial solid waste; proper combustion conditions cannot be maintained because it is batch fed. The burning solids are not agitated, so unburned combustibles can also remain in the ash. Oscillating or traveling-grate furnaces do not provide sufficient retention of the ash to ensure destruction of all combustible materials. Gas and fume combustors and catalytic combustors are designed primarily to burn gases. They could be used for liquid incineration in some cases, but existing full-scale systems are inferior to the other configurations listed above. These systems are not designed for solid waste combustion.

The types of combustion systems which remain as possible candidates for PCB combustion systems are: rotary kiln, multiple-hearth or Herreshoff furnace, fluidized bed, molten salt bath and liquid injection. All five merit a more detailed analysis of their ability to meet the regulatory criteria. They all contain the combustion gases, provide good control of the combustion conditions, can be followed by afterburner chambers, and can be equipped with adequate emission controls. The first four options provide positive retention of shredded combustible solids for periods as long as several hours.

System Description by Waste Type. Combustion systems can also be classified by the type of waste which they burn or the heating service which they perform. The current use of the combustion system and its ownership (private, private vendor, local government, electrical utility, etc.) will be important factors in determining whether it can meet the stated design criteria. These same factors will also determine the probability that the owners would make the facility available for PCB disposal after considering the legal, political, and technical problems involved. Combustion systems can be classified according to the following categories: electrical

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utility boilers, industrial boilers, process heaters, cement kilns, lime kilns, municipal sewage or industrial sludge incinerators, wood waste incinerators or charcoal kilns, liquid chemical waste incinerators, and integrated solid and liquid chemical waste incinerators.

Some of these systems can be eliminated from further consideration due to certain basic design limitations. Industrial boilers and process heaters are not likely to be large enough to burn PCBs at an economical rate. Boiler tube corrosion potential and resulting hydrochloric acid emissions will limit PCB feed rates to less than one percent by weight of the total fuel (see Appendix A). Only electrical utility boilers and larger industrial boilers would be worth considering due to this limitation.

Lime kilns are not good candidates because the lime product is often used in the treatment of potable water. The risk of contaminating the lime with PCBs or heavy metals could not be tolerated. The lime will also absorb hydrochloric acid, and the resulting contamination by calcium chloride would not be acceptable for most users of the lime.

Municipal solid waste incinerators have been listed as possible combustion systems for pesticides (175). None of these systems, however, provide positive containment of the solids for long enough time to ensure complete removal of PCBs. The variability of the basic waste stream also makes it difficult to maintain the stable combustion conditions required for PCB destruction. Additionally, the owners (local governments) would not be prepared to weather the public outcry which would arise if a municipal incinerator were considered for PCB disposal.

Wood waste incinerators and charcoal kilns are designed for a material which is nontoxic and free of chlorine. They are not likely to be equipped with wet scrubbers or, if they are, would not have the materials of construction to resist the hydrochloric acid. The owners will not be familiar with toxic wastes, and are not likely to be interested in using their facilities for its disposal.

The remaining serious candidates for PCB disposal are: electrical utility boilers, cement kilns, municipal sewage or industrial sludge incinerators, liquid chemical waste incinerators, and integrated solid and liquid chemical waste incinerators. These are considered in the remaining parts of this section.

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Electrical Utility Boilers

Combustion Conditions. Typical combustion data for utility boilers are summarized in Table 6-2.

The residence times in the table are calculated by the formula:

$$t = \frac{3600}{(Qr)\ (TCP)\ (1 + (\frac{EA}{100}))\ \frac{T_f + T_e + 460}{2}}{520}$$

where t = Residence Time, sec

Qr = Heat Release Rate, Btu/hr.ft^3

TCP = Theoretical Combustion Products, scf/Btu

EA = Percent Excess Air

T_f = Combustion Zone Temperature, °F

T_e = Furnace Exit Temperature, °F

Based on these data, it appears that some utility boilers do achieve the required 2-sec residence time at 1204°C (2200°F), and 15 percent excess air. One test burn of liquid PCBs in a utility boiler has shown no detectable PCBs in the flue gases (35). Because of detection limits, however, the destruction efficiency was not shown to be higher than 99.9997 percent for PCBs. Residues of other chlorinated hydrocarbons were not analyzed.

Utility boilers appear to meet the combustion requirements for liquid PCBs, or as an "afterburner" for solid PCB combustion devices. Additional tests are needed to confirm the performance of utility boilers, and some are known to be planned (60).

It does not appear feasible to burn shredded capacitors in a utility boiler, e.g., by injecting the material onto the grates using a coal stoker. The grates cannot provide the assured retention time to completely remove the PCBs from the ash. There is a significant risk of producing large volumes of contaminated ash, the disposal of which would be a greater problem than the original waste material.

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Table 6-2

COMBUSTION DATA FOR COAL AND FUEL OIL IN ELECTRICAL UTILITY BOILERS

	Coal	Fuel Oil
Theoretical Combustion Air, scf/Btu	0.0100	0.0095
Theoretical Combustion Products, scf/Btu	0.0101	0.0101
Typical Analysis, Weight Percent		
Moisture	3.7	0.0
Carbon	78.3	87.6
Hydrogen	4.5	10.5
Sulfur	1.3	1.0
Oxygen	3.7	0.6
Nitrogen	1.4	0.3
Ash	7.1	0.0
	100.0%	100.0%
Higher Heating Value, Btu/lb	13,800	18,080
Lower Heating Value, Btu/lb	13,350	17,090
* Typical Excess Air, Percent	15 to 40	15 to 30
* Typical Heat Release Rates, $Btu/hr.ft^3$	15,000 to 40,000	20,000 to 50,000
* Typical Flame Temperatures at 15 Percent Excess Air, ^{0}C	1,460 to 1,600	1,460 to 1,600
Typical Residence Time, sec	1.2 to 3.7	1.0 to 2.8

* In central utility power plant boilers.

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Air Emission Controls. Boilers with electrostatic precipitators can readily meet the particulate emission standards. Other factors (see Appendix A) limit the feed rate of PCBs so that the total feed to the boiler will contain less than 0.15 weight percent chlorine. Wet scrubbers would probably not be required at these levels, but this requires interpretation of the regulations (143) to allow "dilution" of the waste to less than 0.5 percent chlorine.

Conclusion. Utility boilers should be considered for disposal of liquid PCBs. They should not be used for the disposal of solid wastes, however, except as an afterburner for the offgases from a solid waste combustion device.

Cement Kilns

Combustion Conditions. Cement kilns provide combustion conditions which are more than adequate to meet the design requirements for PCB incinerators. Most maximum gas temperatures range from 1538°C to 1649°C (2800°F to 3000°F), with total residence times on the order of 20 sec.

Two tests have shown destruction of PCBs to be below detectable limits, but the actual percent destruction was not calculated. Destruction efficiency based on all chlorinated hydrocarbon emissions was at least 99.986 percent (75).

Solid wastes containing PCBs cannot be incinerated in a cement kiln because the flow of solids is countercurrent to that of the gases. PCBs volatized from the solids feed would pass directly to the pollution control equipment, and not through the hot zone of the kiln. In the tests at Peerless Cement (7), PCBs were inadvertently introduced via the river water used to process the cement, and were detected in the kiln exhaust.

Air Emission Controls. HCL emissions are effectively controlled by adsorption into the cement clinker. In fact, a beneficial effect on product quality is experienced via the reduction of alkali in the clinker (44). Particulate emissions are effectively controlled if the kiln is equipped with either baghouses or electrostatic precipitators.

Conclusion. Cement kilns should be considered for incineration of liquid PCBs, but not for solid wastes except as an afterburner for the offgases from a solid waste combustion device.

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Sludge Incinerators

Municipal sewage sludges and various industrial sludges are incinerated primarily in multiple-hearth furnaces, although rotary kilns are also used for this purpose. Both are used because of their ability to contain and agitate the semisolid sludges until combustion is complete. Each is considered separately in the following sections.

Multiple Hearth. Multiple-hearth furnace applicability to hazardous waste disposal (pesticides) was extensively studied by Wilkerson (174), upon whose work the following is based. Applicability to PCB incineration is extrapolated from operating experience at the ENSCO El Dorado disposal facility.

Combustion conditions. The multiple-hearth incinerator (commonly called a Herreshoff furnace) was originally developed to incinerate sewage sludges. The versatility of multiple-hearth incinerators has allowed operators to process not only sludges, but other combustible tars, liquids, gases, and solids. Today a wide variety of industrial and municipal wastes are disposed of by incineration in multiple-hearth incinerators. They are also widely used to produce charcoal from wood wastes.

The multiple-hearth furnace consists of a refractory-lined circular steel shell with refractory hearths stacked vertically. Solid wastes are fed through the furnace roof, and moved across the top hearth with horizontal plows. The wastes fall through the top hearth drop holes and then through holes in each successive hearth until they reach the furnace floor as ash. Residence time may be up to several hours for some solids. Liquid and gaseous wastes are injected into the furnace through side ports. Waste flow is countercurrent to the flow of gases. A typical multiple-hearth incinerator system is shown in Figure 6-2.

The furnace has three operating zones: the top hearths operate at temperatures between 310 to 540°C (600 to 1000°F) and dry the sludge feed to about 48 percent moisture; the incineration/deodorizing zone operates at temperatures from 760 to 980°C (1400 to 1800°F); and the cooling zone, where hot ash is cooled by giving up heat to incoming combustion air, operates at temperatures from 200 to 320°C (400 to 600°F).

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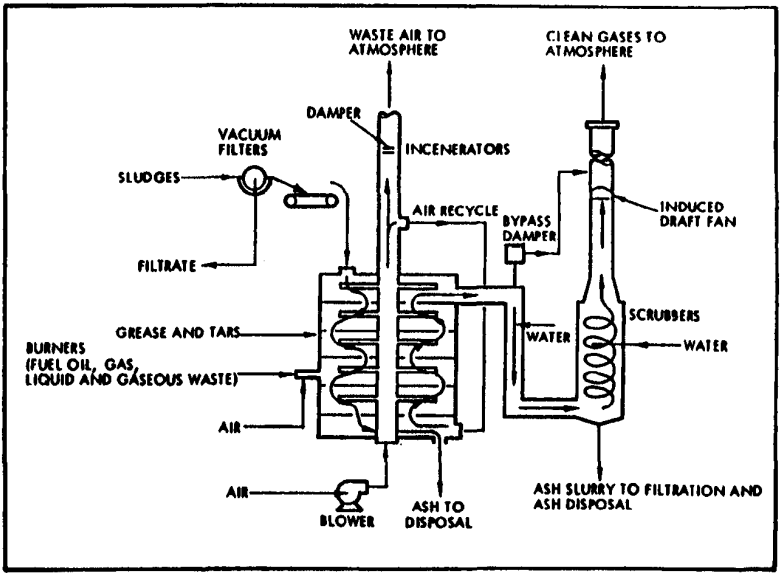

Figure 6-2. Multiple Hearth Incineration System

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Combustion air and combustion products flow vertically through the furnace and exit at 260 to 540°C (500 to 1000°F). Exhaust gases normally pass through an emission control system prior to discharge. A fired afterburner will be needed, however, in order to bring the offgases to the temperature required for destruction of PCBs. Otherwise, PCBs volatized from solid waste on the top hearth would pass into the scrubber system without complete destruction. Whitmore (173) found destruction efficiencies as low as 99.95 percent for 2,4,5-T, and 99.97 percent for DDT. Efficiencies were improved to better than 99.99 percent when an afterburner was used, even though the afterburner temperature was only 660°C (1200°F).

Whitmore (171) also tested the destruction of PCBs in sewage sludge. The pertinent results are as follows:

- About 50 ppm of PCBs was added to the sludge.
- The top hearth and short duct to the scrubbing system operated at about 615°C (1140°F). Residence time was about 0.1 sec.
- Maximum temperature of the ash was about 790°C (1450°F).
- No PCBs were found in the ash. Thus, temperatures of 790°C (1450°F) were sufficient to completely volatize the PCBs.
- Destruction efficiency was between 91.7 and 97.1 percent, with all the undestructed PCBs appearing in the stack gases. Thus, the "afterburner" temperature of 616°C (1140°F) at 0.1-sec residence time was not adequate to destroy the volatized PCBs.

Conclusion. The residence time on the hearths is long enough and the temperatures are high enough to volatize PCBs from shredded capacitors or other solid waste. With the addition of an adequate scrubbing system and a fired afterburner with adequate combustion conditions for destroying PCBs, a multiple-hearth furnace can be used to dispose of solid and liquid PCB waste. However, the internals of the multiple-hearth furnace are complicated, and seem more susceptible to damage or clogging due to variations in feed composition, temperature, presence of hydrochloric acid, etc., than a rotary kiln. The multiple-hearth furnace offers no particular advantage for disposal of liquid waste materials including PCBs.

Rotary Kiln. Rotary kilns are the preferred type of combustion system for disposal of solid PCB wastes. This conclusion is valid for kilns designed for sludges, as well as for those designed for chemical wastes. Rotary kilns will be discussed in more detail in the section on Chemical Waste Incinerators.

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An example of a package, skid-mounted rotary kiln is shown in Figures 6-3 and 6-4. This unit is manufactured by Met-Pro, Inc. (81). The largest unit is capable of handling up to 600 lb/hr (81) of solids contained in 300 gal/hr of sludge. A pre-processing system (shredders and material handling equipment) will be needed to prepare solid wastes for feeding to the kiln, and a scrubbing system must be added to control emissions in order to form a complete facility for processing solid PCB waste.

Chemical Waste Incinerators

Chemical waste incinerators are usually designed to burn chlorinated materials. Their owners are usually familiar with the problems of handling toxic materials. They are, therefore, the logical choice for PCB disposal among existing combustion systems.

Liquid-Injection Incinerators. Wilkerson, et al., have presented an excellent review of liquid-injection incinerators (175). The following discussion is taken from their report.

This type of incinerator is quite versatile and can incinerate virtually any combustible liquid waste. These units are widely used in manufacturing industries, and vary widely in operating conditions and applicability. Some wastes currently disposed of in industry with these units are separator sludges, skimmer refuse, oily wastes, detergent sludges, digester sludges, cutting oils, coolants, strippers, phenols, wine wastes, potato starch, vegetable oils, washer liquids, still and reactor bottoms, soap and detergent cleaners, animal oils and rendering fats, plating wastes, lubricating oils, soluble oils, polyester paint, polyvinyl chloride (PVC) paint, latex paint, thinners, solvents, polymers, resins, cheese wastes, inks, and dyes.

Operating conditions in liquid-injection units vary widely. Temperatures vary from 650 to 1650°C (1200 to 3000°F), with a typical temperature of 870°C (1600°F), and residence times vary from 0.5 to 1.0 sec. Most units have a heat release of approximately 9.3×10^8 J/hr-m^3 (25,000 Btu/hr-ft^3), with the exception of the Vortex Type Liquid Combustor, which has an unusually high heat release of about 3.7×10^9 J/hr-m^3 (100,000 Btu/hr-ft^3).

Liquid waste incineration requires atomization of the liquid and violent turbulence and mixing of the droplets to effect rapid vaporization and good combustion. The

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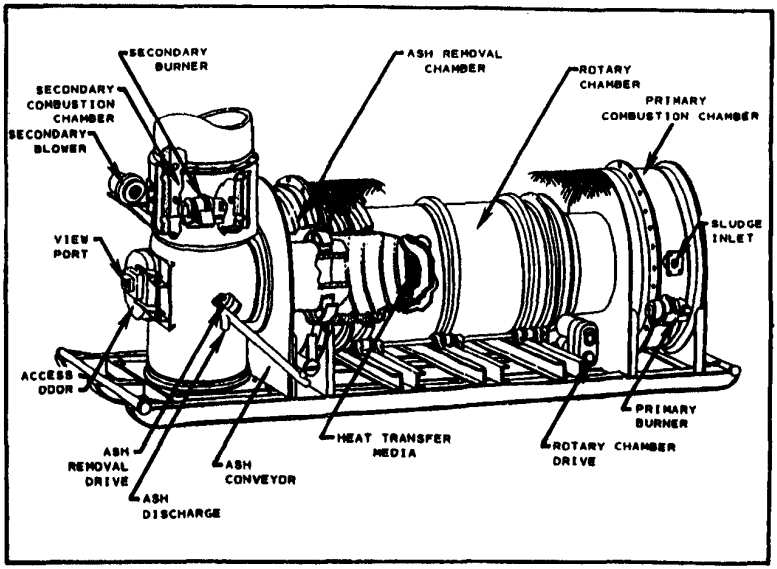

Figure 6-3. React-O-Therm® Rotary-Kiln Sludge Incinerator (cutaway view)

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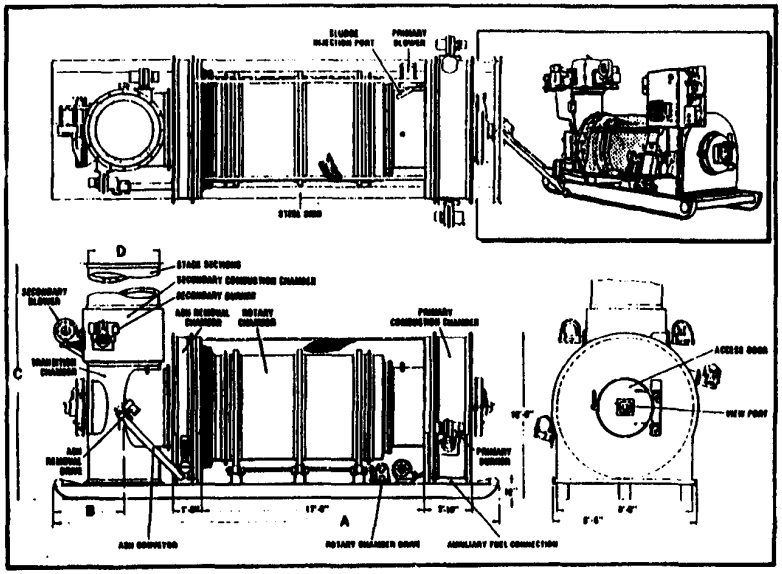

Figure 6-4. React-O-Therm® Rotary-Kiln Sludge Incinerator (side and plan view)

viscosity of the liquid is reduced by heating, or by mixing a low-viscosity fluid into the waste liquid. The liquid is then atomized by rotary-cup atomization or pressure atomization through a single orifice nozzle or through a two-fluid nozzle, which may be an internal mix, external mix, or sonic-type nozzle. Turbulent mixing is achieved in many cases by supplying a forced draft to the combustion chamber.

Liquid injection incinerators are classified as horizontally fired or vertically fired units. A typical horizontally fired liquid waste incineration system is shown in Figure 6-5, and a typical vertically fired system is shown in Figure 6-6. The horizontal unit is identical to one operated by Dow Chemical Company at their Midland, Michigan, plant. The vertical unit is one designed and marketed by the Prenco Division of Pickands Mather and Company. Figure 6-7 shows a unique type of unit called the Vortex combustor. This unit is unusual in that its heat release capability is four times higher than other commercial units.

The horizontally fired incineration system operates by feeding the waste to the unit through a combination of four dual-fired nozzles. Combustion gases pass through a spray chamber, a venturi scrubber, and a cooler/mist-eliminator prior to exhaustion through a stack.

The vertically fired incineration system operates by first heating the vertical retort up to the desired temperature with a mixture of high-pressure air and auxiliary fuel. When the retort attains the proper temperature, the waste is fed into the air waste entrainment compartment for aeration, and then into the turbulence compartment for mixing with high-pressure air. The mixture is then fed into the bottom of the vertical decomposition chamber, where the waste is broken down by oxidation, ionization, and molecular dissociation. The combustion gases flow vertically through the air cone, which serves as a fuel saver and an afterburner, and out the top of the retort. The exhaust gases are reduced to 340°C (650°F) by the air cone, and can be passed through scrubbers if desired. These incineration systems operate between 870 and 1650°C (1600 and 3000°F).

The Vortex combustor is a cylindrical furnace in which the liquid waste is fired tangentially by a modified oil burner into the bottom of the ignition chamber. Tangential firing creates a vortex of hot gases which flow upward through the combustion chamber, which is preheated to between 430 and 540°C (800 to 1000°F) for 1 hr prior to injecting the wastes. Preheated high-velocity secondary air is introduced

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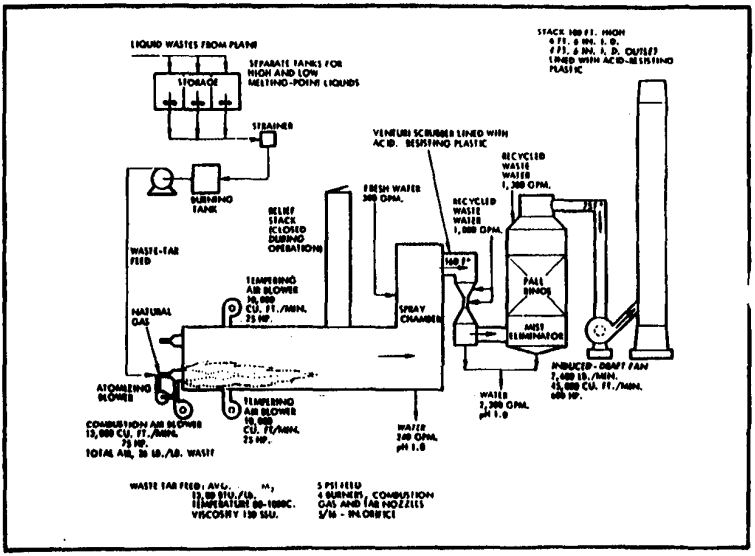

Figure 6-5. Horizontally Fired Liquid Waste Incineration System

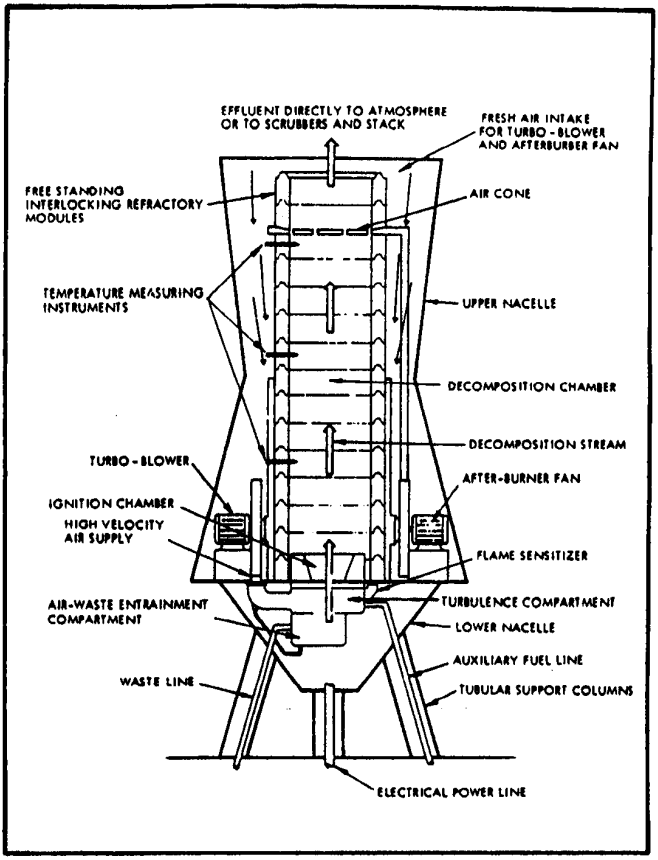

Figure 6-6. Typical Vertically Fired Liquid Waste Incinerator

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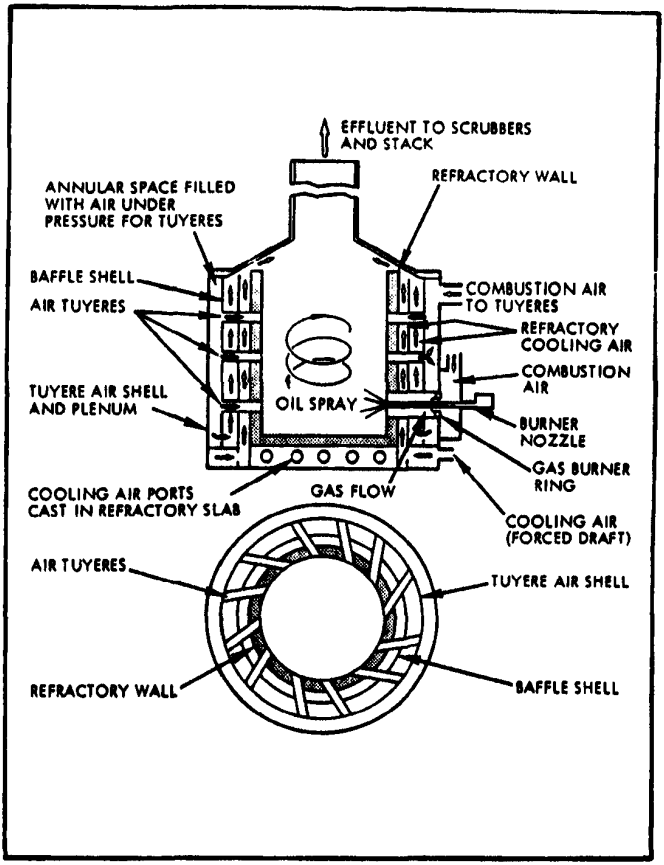

Figure 6-7. Vortex Liquid Waste cinerator

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from tangential tuyeres to maintain the vortex as the gases rise in the unit. Operating temperatures range between 650 and 870°C (1200 and 1600°F), with 20 percent excess air.

An example of a liquid-injection incinerator facility used in central disposal operations of hazardous wastes is the Rollins Environmental Services, Inc., plant at Bridgeport, New Jersey. The General Electric plant at Pittsfield, Massachusetts, and the Dow Chemical Company plant at Midland, Michigan, process in-house wastes with liquid-injection incinerators. TRW Systems has developed a liquid-injection incinerator capable of high destruction efficiencies and short dwell times for some pesticides, and the Marquardt Company of Van Nuys, California, has developed the Sudden Expansion (SUE®) Burner. Liquid-injection-type incinerators have also been placed on ships for shipboard incineration of liquid wastes. Two examples are the ships, Vulcanus and Mathias III.

In summary, liquid-injection chemical waste incinerators are well suited to the disposal of liquid PCB wastes. As noted previously, it may be feasible to burn pure PCBs; certainly a 1:1 dilution with a light solvent is adequate to allow incineration without flame stability problems or excessive free chlorine. Temperature and excess air levels are adequate; and although many existing incinerators have residence times of 0.5 to 1 sec, there is no technical limitation to the resident time which can be achieved by reducing firing rates or increasing the size of the combustion chamber.

Liquid-injection incinerators can be modified to serve as a fired afterburner for rotary kilns, multiple-hearth furnaces, or other devices for combusting solid PCB wastes. The gases from the solid waste combustor are mixed with the combustion gases from the liquid burner within the afterburner chamber. This combination forms what is referred to as an integrated solid-liquid chemical waste incinerator, and is discussed in the next section.

Integrated Solid-Liquid Incinerators. Several different types of solid waste combustors can be combined with fired afterburners to form systems capable of handling both liquid and solid PCB wastes. Multiple-hearth sludge incinerators can be used as the solids combustor. Three other types of solids combustors are considered below.

Molten salt bath incinerators. Wilkinson, et al., (175) discuss molten salt bath incinerators in some detail. They conclude that such are acceptable as

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pesticide incinerators. However, they should not be considered for PCB disposal for the following reasons. First, they have primarily been used at the research level, but have not been commercialized and proven in full-scale, long-term operations. Secondly, they are limited to temperatures of 1000°C (1832°F) or less, because higher temperatures will vaporize the salts. As the gases cool, a submicron salt fume is produced which is difficult to scrub. Finally, it is possible that problems would occur when trying to burn a shredded solid waste with a high fraction of noncombustibles such as a utility capacitor. The noncombustibles have to be removed from the molten salt by flowing the salt out of the combustion chamber and then dissolving it in water. The process seems overly complicated compared to other systems.

At least one test burn using liquid PCBs has been performed using a bench-scale molten salt bath incinerator (182). Destruction was reported to be 99.9999 percent.

Fluidized-bed incinerators. Wilkinson, et al., have reviewed fluidized-bed incinerators for pesticide disposal (175). As was the case with molten salt bath incinerators, fluidized-bed incinerators do not appear suitable for disposal of PCBs.

Fluidized-bed incinerators suffer the same limitations as molten salt bed incinerators. High temperatures cannot be used because of the danger of fusing the sand bed with molten ash from the waste. Removal of noncombustibles from the bed is difficult, particularly if they do not form sand-like particles. Metal pieces from shredded capacitors would create such problems.

Because of the large thermal inertia associated with the bed, these units are advantageous to use when incinerating heterogeneous waste streams. Particularly if water or some other noncombustible contaminates the waste, fluidized-bed units can prevent flameouts from catastrophically terminating the combustion process. This would seldom be the case for utility PCB waste disposal. It is unlikely that shredded capacitor or transformer liquid incineration operations could make use of fluidized-bed advantages.

Rotary-kiln incinerators. Rotary-kiln incinerators have been used extensively to incinerate a wide variety of chemical wastes, including chlorinated hydrocarbons, explosives, etc. Rotary kilns are usually designed to handle all physical forms of wastes, including gases, liquids, sludges, tars, and solids.

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A rotary kiln used in large installations is a cylindrical, horizontal, refractory-lined shell which is positioned on a slight incline. Solid waste is fed into the upper end of the kiln, and liquid waste is fired horizontally into the kiln. The kiln rotates with peripheral speed of rotation in the range of 0.3 to 1.5 m (1 to 5 ft) per min (typically 12 revolutions per hour), and mixes the waste with combustion air as the waste passes through the kiln. The length-to-diameter ratio of these kilns usually varies from 2 to 10. Typically these units are 9 m (30 ft) long and 3 m (10 ft) in internal diameter (ID). The combustion temperatures normally range from 870 to 1650°C (1600 to 3000°F), and residence times vary from a few seconds to several hours, depending upon the type of waste.

Fixed-unit installations normally include a sophisticated feed system for introducing sludge and solids, a fired afterburner where additional liquid waste is burned, and wet scrubber emission controls. This combination forms a very versatile facility which is well suited to the disposal of both liquid and solid PCB wastes. Figure 6-8 shows a typical major industrial rotary-kiln facility which is operated by Dow Chemical Company at its Midland, Michigan, plant. More modern versions of this basic design use high-energy venturi scrubbers in place of the water sprays. Such systems are operated by Minnesota Mining and Manufacturing Corporation at their St. Paul, Minnesota, and Decatur, Alabama, chemical production complexes; and by Eastman Kodak at their Rochester, New York, facility. These facilities incinerate captive industrial wastes, and do not normally accept wastes from outside sources.

Rollins Environmental Services, Inc., Deer Park, Texas, operates a similar system which is shown in Figure 6-9. They accept solid and liquid chemical wastes for disposal by incineration. Rollins has successfully incinerated shredded electronics capacitors which contained PCBs (1) as well as liquid PCBs.

Energy Systems Company (ENSCO) also operates a versatile solid-liquid incinerator in El Dorado, Arkansas. They have installed shredders and other facilities required to process electronic and utility capacitors as well as liquid PCBs.

Among the portable rotary-kiln units, the portable sludge incinerator manufactured by Met-Pro, Inc., was discussed previously and illustrated in Figures 6-3 and 6-4. Another example of this type of unit is the Tumble Burner (100),

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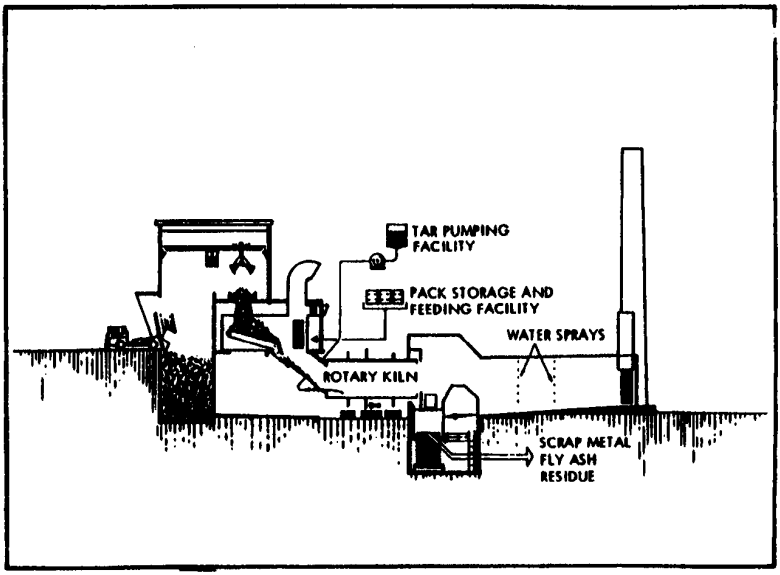

Figure 6-8. Typical Major Industrial Rotary-Kiln Incineration Facility

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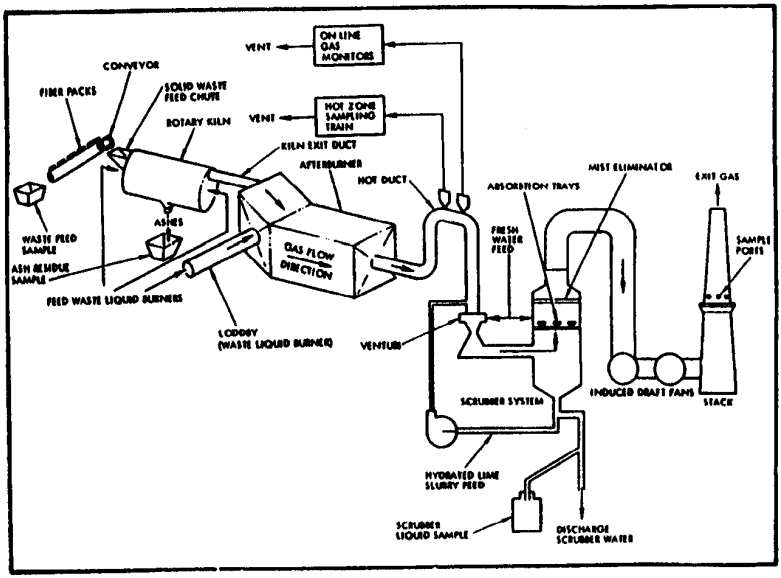

Figure 6-9. Schematic of Rollins Environmental Services' Incinerator

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designed by Bartlett-Snow and shown in Figure 6-10. This unit is not as versatile as large rotary-kiln installations, since no pretreatment facilities for the waste are available. This requires that the waste to be incinerated must be properly sized and relatively homogeneous. The unit can incinerate solid waste material with a heat content of 2.3×10^6 to 3.5×10^7 J/kg (1000 to 15,000 Btu/lb), and can also incinerate liquid and gaseous wastes when they are injected into the auxiliary burner used for temperature control in the incinerator. The unit can incinerate between 45 kg (100 lb) and 1.8 metric tons (2 tons) of waste per hour, with a corresponding system size of 1.5 x 1.5 x 4.6 m (5 x 5 x 15 ft) to 4.3 x 4.6 x 10.4 m (14 x 15 x 34 ft).

MB Associates, Inc., of San Ramon, California, has designed a portable unit under EPA Contract No. 68-03-2515. The system consists of a rotary kiln, followed by an afterburner, followed by gas stream cleaning equipment which utilizes induced draft in order to avoid vapor and dust leakage at seals and connections. Heat energy is supplied by oil-fired burners in the kiln and afterburner.

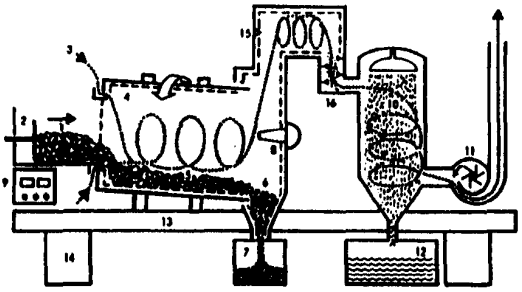
The 132-cm (52-in) ID by 5-m (16-ft) long kiln can be fed solids by means of a ram stoker, or sludge and liquids by means of a positive displacement pump system. Solids are first shredded in a shear-type shredder which is capable of shredding 55-gal steel drums, small logs, and steel belted radial tires. The kiln is designed for direct firing and includes standard heat transfer mixing chains. The refractory lining has been selected for thermal cycling, heat resistance, corrosion resistance, and over-the-road capability.

The refractory-lined afterburner is sized for the optimum kiln throughput of hazardous materials in soil with 10 percent moisture. It is a tubular unit 132 cm (52 in) ID by 11 m (36 ft) in length. The design incorporates road shock considerations by utilizing rubber in shear supports, as well as air-ride suspension on the trailer. The gas stream cleaning equipment includes both particle and mass transfer scrubbing equipment necessary to control P_2O_5 from organic phosphates and SO_2 from sulfur-bearing compounds.

The operating parameters of the MB design are:

Kiln: 15 to 980°C (1500 to 1800°F)
-hr residence time for solids

MONS 028381



1 WASTE TO INCINERATOR
2 AUTO-CYCLE FEEDING SYSTEM: FEED HOPPER, PNEUMATIC FEEDER, SLIDE GATES
3 COMBUSTION AIR IN
4 REFRACTORY-LINED, ROTATING CYLINDER
5 TUMBLE-BURNING ACTION
6 INCOMBUSTIBLE ASH
7 ASH BIN
8 AUTO-CONTROL PACKAGE: PROGRAMMED PILOT BURNER
9 SELF-COMPENSATING INSTRUMENTATION-CONTROLS
10 WET-SCRUBBER PACKAGE: STAINLESS STEEL, CORROSION-FREE WET SCRUBBER, GAS QUENCH
11 EXHAUST FAN AND STACK
12 RECYCLE WATER, FLY-ASH SLUDGE COLLECTOR
13 SUPPORT FRAME
14 SUPPORT PIERS
15 AFTERBURNER CHAMBER
16 PRECOOLER

Figure 6-10. Portable Rotary-Kiln Incineration Unit

MONS 028382

Afterburner: 1100°C (2012°F) minimum temperature
2-sec gas residence time

Gas effluent: P_2O_5 - maximum permanent plume opacity - 10 percent
SO_2 - 200 ppm maximum
HCl - 200 ppm maximum

Feed rates: 1361 kg/hr (3000 lb/hr) hazardous material-bearing soil with 10 percent moisture.

A preliminary rendering of the proposed system is shown in Figure 6-11. This system meets all of the criteria for incineration of liquid and solid PCB wastes.

A cost estimate for this system has been provided by MB Associates and is given in Appendix H.

Wet Oxidation. Wet oxidation systems have been moderately successful in the destruction of organic sludges and chemical wastes. A new process, developed by Hydroscience, Inc., employs a patented catalyzed wet oxidation system which uses an anionic co-catalyst system for air oxidation of organics in an acidic aqueous medium, at elevated temperatures. The anionic co-catalyst is a combination of nitrate ion and either bromide or iodide ion. Bench-scale feasibility tests have shown the capability of the catalyst system to rapidly oxidize a variety of toxic and hazardous organics, including highly chlorinated organic residues.

The process applies to organic liquids and/or aqueous wastes, and is based upon a water-soluble, single-phase (homogenous) catalyst system. In simplest form, strong aqueous wastes or organic residues are pumped into a continuously stirred tank reactor (CSTR) containing a solution of HBr and HNO_3. Air is sparged in and the organics are oxidized with the heat of reaction driving off water. Any solids formed have to be removed eventually, but the catalyst solution stays in the reactor. The only gases leaving the reactor are CO_2, water vapor, any volatile organics formed, and any solids formed. The most important features of this process concept are that nonvolatile organics remain in the reactor until consumed, and that there is no aqueous bottoms product. Typical operating conditions for destruction of PCBs are 165 to 200°C, and 175 to 500 psia. Destruction rates of 50 lb/hr/1000 gal of reactor volume have been measured. PCB concentrations have been reduced to less than 50

MONS 028383

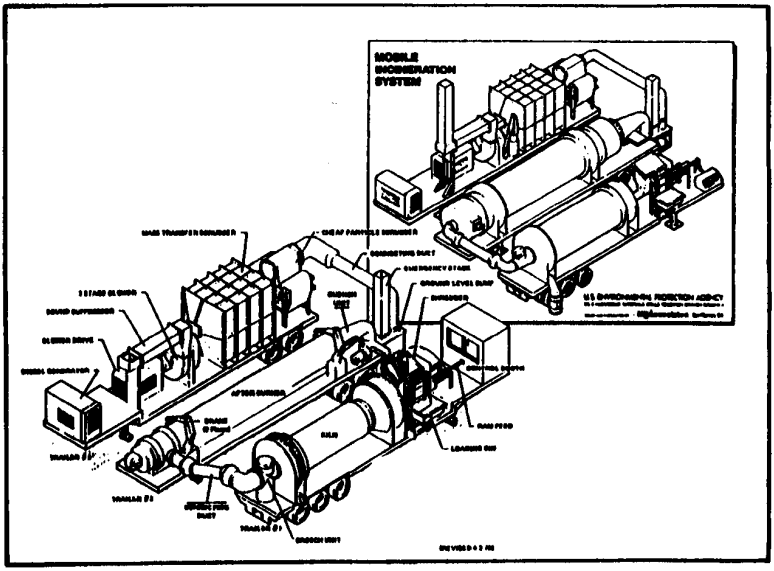


Figure 6-11. Mobile Environmental Restoration Incinerator Complex

MONS 028384

ppb. Catalyst modifications to improve oxidation rates for organic residues have resulted in a second patent application.

Existing PCB Combustion Facilities

The preceding section presented a brief review of the state of the art in solid and liquid waste combustion technology. The incineration of PCB materials in an environmentally acceptable manner has been demonstrated in several of these configurations, and has in recent years been performed routinely at a number of commercial incineration facilities around the country. Present difficulties lie not in technical performance areas, but in the political aspects of facility siting, testing, and approval.

This section presents a survey of existing and proposed commercial PCB combustion facilities in the United States. The information presented herein represents the results of both site visits and interviews with facility operators. This information is accurate as of April 1979.

Commercial Disposal Facilities. Table 6-3 lists existing and proposed commercial incineration facilities which have applied for permits to burn PCBs. As of this writing, only three existing facilities have sought approval; these are the Rollins Environmental Services facility, both in Deer Park, Texas (which is near Houston), and in Bridgeport, New Jersey, and the Energy Systems Company (ENSCO) facility in El Dorado, Arkansas. Site visits were conducted at two facilities (Houston and El Dorado). Appendix E summarizes the relevant information concerning these two facilities. The following is a discussion of how these facilities may interface with utility PCB disposal.

Rollins Environmental Services - Deer Park, Texas (1). Rollins Environmental Services, which operates waste disposal facilities in Deer Park, Texas, Baton Rouge, Louisiana, and Bridgeport, New Jersey, has applied for PCB disposal permits for their Deer Park and Bridgeport plants. Company officials have indicated that if the Deer Park plant is approved, and PCB disposal at that plant proves to be profitable, they may attempt to have their Baton Rouge, Louisiana, facility approved as well.

MONS 028385

Table 6-3

POTENTIAL COMMERCIAL PCB INCINERATION SITES

EPA Region	Facility Location	Facility Type (Mono)	Annual Capacity (gal)	Operational Status	Status of Approval for PCB Disposal	Comments
II	Rollins Environmental Services Bridgeport, NJ Mr. Ashby (609) 467-3100	Incinerator	1,900 gal/hr (8.6 x 10⁶)	Not in service	Submitted application	Could be approved by November 1979. Test burn completed
III		(None)				
IV	Waste Management of Alabama Emelle, AL Jim Parsons (205) 652-9529			Design stage		May be constructed on site of an existing approved landfill
V	Nyon Waste Management Services Chicago, IL Robert Bruns (201) 329-2361 (312) 646-0016			Shut down	Application submitted for test burn	Non-operational; legal problems may limit future operations
	Preaco Manufacturing Co. Madison Heights, MI John Brofo (313) 399-6262	Liquid and solids incinerator		Operational	Application submitted	Original application not adequate; must be resubmitted. Will require a test burn. Problems with state certification and located in a residential area
	State Dept. of Natural Resources Water Quality Div. Lansing, MI (517) 373-2794	Incinerator		Design stage	Have not applied	The facility will handle all dangerous materials made or used in state. Could be operational in two years
VI	Energy Systems Co. El Dorado, AR Charlie Robertson (501) 863-7173	Modified petroleum boiler		Boiler operational; shredder not yet operational	Application submitted	Combustion in solids and possibly in liquids. Pending test burn and public opposition. Public ordinance prohibits PCB storage, transport, and disposal

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Table 6-3 (continued)

EPA Region	Facility Location	Facility Type	Annual Capacity (all)	Operational Status	Status of Approval for PCB Disposal	Comments
VI	Rollins Environmental Services Deer Park, TX Edgar Henry (713) 479-5001	Liquids and solids incinerator	5,000 t/yr solids 1,000 gal/hr liquids (9.0×10^6)	Operational	Final application to be submitted	Facility is located near a landfill which is also being considered by EPA for approval. Shredding capacity to be added.
VII		(None)				
VIII	Aerr Co. 5001 Federal Bldg. Denver, CO Don Gunn (303) 477-2764	Incinerator (extremely high temperature)		Under construction	Potential facility, will apply.	Site selected adjacent to Rocky Flats Plant, Denver, on 12-1-78.
IX	BKK Beatty, NV	Incinerator		Concept stage	F... facility	Under consideration. BKK would like to construct this facility on site of an approved landfill
X		(None)				

MONS 028387

The Rollins incineration facility process in Deer Park is shown schematically in Figure 6-9. Basic system components include:

- Rotary-kiln incinerator.
- Waste liquid burner.
- Afterburner.
- Waste feed systems.
- Auxiliary fuel feed systems.
- Instrumentation.
- Emission control system.

The Rollins facility in Bridgeport, New Jersey, is similar in its configuration.

The incineration system consists of a rotary kiln and a liquid-injection burner, both feeding a common afterburner. Total heat release is 28 million kcal/hr. The kiln is 4.9 m in length and 3.2 m in diameter. Flame temperature in the kiln is nominally 1300°C (2372°F).

The waste liquid burner (Loddby type) measures 4.9 m in length by 1.6 m in diameter. Loddby flame temperature is typically 1300°C (2372°F). Afterburner dimensions are 10.6 m overall length, 4.0 m high, and 4.3 m wide. Overall retention time of the incineration system is from 2 to 3 sec at 1300°C (2372°F).

Solid wastes, usually packed in fiber drums, are fed into the rotary kiln by a conveyor. Liquids and sludges may also be pumped into the kiln. Liquid wastes that are to be burned in the Loddby can be fed directly from tank trucks or from blending tanks.

Both the kiln and the Loddby are equipped with natural gas ignitors and gas burners for initial refractory heat-up, flame stability, and supplemental heat, if necessary. Number 2 fuel oil can also be used as auxiliary fuel.

MONS 028388

Atmospheric emissions from the combustion of solid and liquid wastes are controlled by a venturi scrubber, as shown on Figure 6-9. Lime is injected to neutralize the scrubber water. Used scrubber water enters settling ponds, where it is analyzed and further treated, if necessary, before discharge.

Exhaust gases also pass through absorption trays and a mist eliminator before entering the stack. The exhaust stack is 30 m high with standard sampling ports and a platform about 16 m above ground level.

Rollins has the capability to dispose of both solid and liquid PCB materials. Waste can be shipped to the Deer Park facility either by rail, truck, or barge (the facility is located adjacent to the Houst hip Channel). Rollins also operates a chemical waste landfill on the same as the incinerator, where combustion residues and decontaminated transfor rs can be disposed of.

Disposing of PCB materials at a Rollins plant is a four-stage procedure which is representative of procedures followed at other hazardous waste disposal facilities. These stages are:

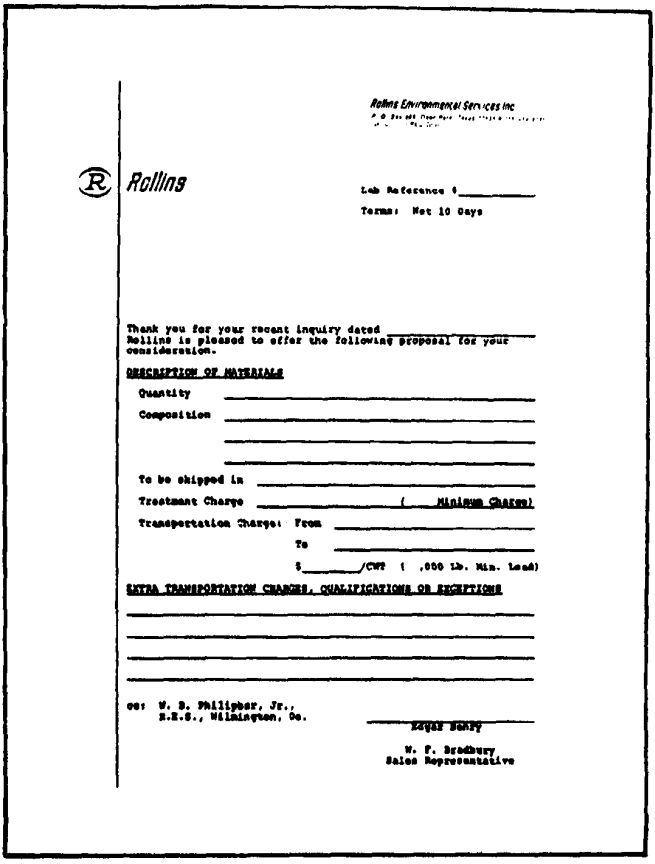
- Initial contact and agreement.
- Shipper compliance with applicable handling and marking regulations.
- Transportation to disposal site.
- Receipt at site and authority to treat.

The first step involves the initial contact with Rollins, which results in a detailed estimate of anticipated handling, transportation, and disposal charges. A written estimate would be provided on the form shown in Figure 6-12.

Charges for the transportation services offered by Rollins are summarized in Table 6-4. Other disposal firms offer a similar service, although generally not as comprehensive.

The second step involves determination and compliance with all applicable handling and marking regulations. In Texas, the Department of Water Resources is the agency which monitors hazardous waste transportation. Additionally, the handling of PCB materials, in particular, is governed by federal regulations.

MONS 028389



Rollins Environmental Services Inc

Rollins

Lab Reference #_____

Terms: Net 10 Days

Thank you for your recent inquiry dated _____
Rollins is pleased to offer the following proposal for your consideration.

DESCRIPTION OF MATERIALS

Quantity _____

Composition _____

_____

_____

To be shipped in _____

Treatment Charge _____ (Minimum Charge)

Transportation Charge: From _____

To _____

$_____/CWT (,000 Lb. Min. Load)

EXTRA TRANSPORTATION CHARGES, QUALIFICATIONS OR EXCEPTIONS

_____

_____

_____

_____

cc: W. B. Philipbar, Jr.,
R.R.S., Wilmington, Oe.

_____
Legal Entity

W. F. Bradbury
Sales Representative

Figure 6-12 Rollins Proposal Form (Courtesy of Rollins Env. Serv., Inc.)

MONS 028390

Table 6-4

EXAMPLE OF AVAILABLE HAZARDOUS WASTE TRANSPORT SERVICES PROVIDED BY DISPOSAL COMPANIES*

TRANSPORTATION CHARGES†

Type Vehicle	Capacity	Free Time	Demurrage	Minimum Load
Pickup Truck	1,000 lb	None	$25.00/hr 2 hour minimum	None
Small Vacuum Truck	2,000 gal	None	$25.00/hr While in your plant	16,000 lb
	From Portal to Portal		$30.00/hr For in-plant service only	
Large Vacuum Truck	5,150 gal	None	$30.00/hr While in your plant	42,000 lb
	From Portal to Portal		$35.00/hr For in-plant service only	
Tank Truck	6,000 gal	1.5 hr	$18.00/hr	42,000 lb
L.P.G. Trailers	10,000 gal	1.5 hr	$18.00/hr	36,000 lb
Flatbed	72 x 55 gal Steel Drums	1.5 hr	$18.00/hr	42,000 lb
	72 x 55 gal Fibre Drums	1.5 hr	$18.00/hr	42,000 lb
Ram-e-jec Dump Trucks	28 cu yd	1.5 hr	$18.00/hr	42,000 lb
Roll-Off Bins	20&30 cu yd		Rates furnished on request	

*Courtesy of Rollins Environmental Services, Inc.
†Effective October 17, 1978 - Subject to change without notice.

MONS 028391

An example shipping ticket is shown in Figure 6-13. Handling guidelines specific to Rollins (which are similar to those of other waste handlers) are presented in Figure 6-14.

The third step involves contracting for and transporting the waste material to the disposal site. Representative service charges and regulatory requirements were discussed above. Several states (e.g., Michigan) have considerably more restrictive PCB shipping regulations than the rest of the country, resulting in large regional variations in compliance requirements.

Once the waste material is received by Rollins, a laboratory analysis is performed which is sufficiently detailed to fill out the waste characterization summary form shown in Figure 6-15. If the analysis indicates that the waste material is similar to that indicated on the proposal form (Figure 6-12), authorization to dispose is granted. Alternatively, if significant differences exist between the waste as received and the material described in the proposal form, Rollins will store it pending renegotiation of the disposal contract. This practice is common to the waste disposal industry.

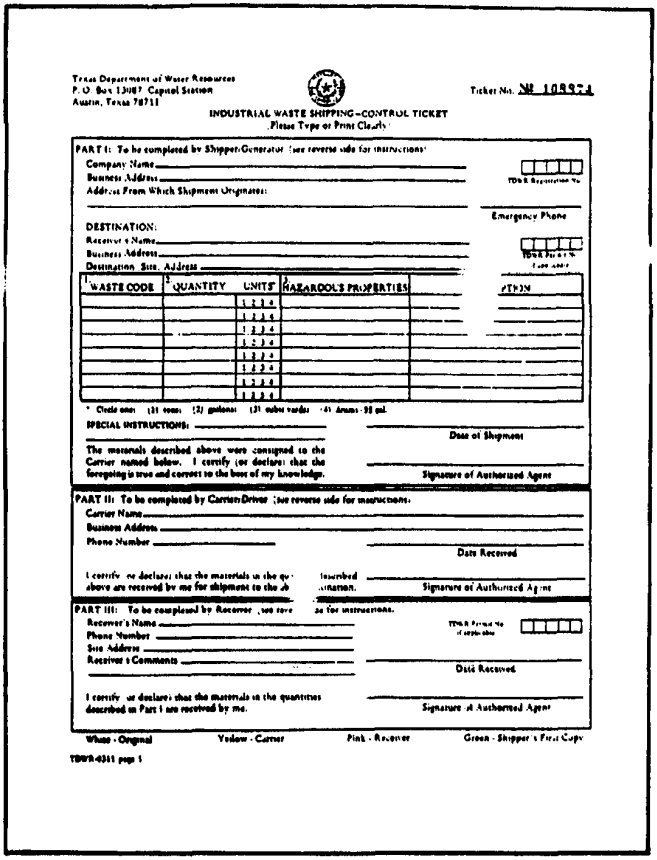
Energy Systems Company (ENSCO), El Dorado, Arkansas. ENSCO is the only other existing chemical waste incineration service which has demonstrated an interest in burning utility PCBs. The ENSCO incineration facility is shown schematically in Figure 6-16. Major system components include the following:

- Solids shredder (bypassed when combusting liquids only).
- Rotary kiln (bypassed when combusting liquids only).
- Afterburner.
- Scrubber.
- Effluent treatment.

As can be seen by comparing Figures 6-9 and 6-16, the Rollins and ENSCO systems employ similar unit operations and process flows.

One innovation incorporated in the ENSCO system is the total enclosure of the solids shredder. By utilizing the combustion air fan to induce a negative draft in the shredder enclosure, fugitive PCB emissions during shredding are prevented. In addition, any PCB aerosols escaping the shredders are drawn into the combustion chamber.

MONS 028392



Texas Department of Water Resources
P. O. Box 13087 Capitol Station
Austin, Texas 78711

Ticket No. NW 108924

INDUSTRIAL WASTE SHIPPING–CONTROL TICKET
Please Type or Print Clearly

PART I: To be completed by Shipper/Generator (see reverse side for instructions)

Company Name
Business Address
Address From Which Shipment Originates:
Emergency Phone
DESTINATION:
Receiver's Name
Business Address
Destination Site Address

1 WASTE CODE	2 QUANTITY	UNITS*	3 HAZARDOUS PROPERTIES		4 PCB'S
		1 2 3 4			
		1 2 3 4			
		1 2 3 4			
		1 2 3 4			
		1 2 3 4			
		1 2 3 4			
		1 2 3 4			
		1 2 3 4			

* Circle one: (1) tons (2) gallons (3) cubic yards (4) drums (5) gal.

SPECIAL INSTRUCTIONS:

Date of Shipment

The materials described above were consigned to the Carrier named below. I certify (or declare) that the foregoing is true and correct to the best of my knowledge.

Signature of Authorized Agent

PART II: To be completed by Carrier/Driver (see reverse side for instructions)

Carrier Name
Business Address
Phone Number

Date Received

I certify (or declare) that the materials in the quantities described above are received by me for shipment to the Destination.

Signature of Authorized Agent

PART III: To be completed by Receiver (see reverse side for instructions)

Receiver's Name
Phone Number
Site Address
Receiver's Comments

Date Received

I certify (or declare) that the materials in the quantities described on Part I are received by me.

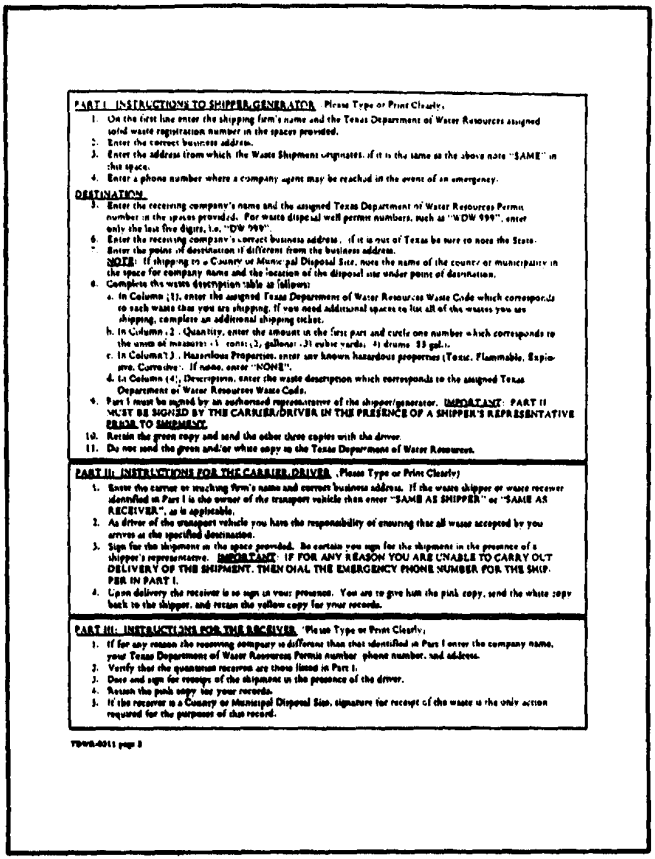
Signature of Authorized Agent

White - Original Yellow - Carrier Pink - Receiver Green - Shipper's First Copy

TDWR-0311 page 1

Figure 6-13. Industrial waste s ing ticket (Texas Department of Water Resources).

MONS 028393



PART I: INSTRUCTIONS TO SHIPPER/GENERATOR (Please Type or Print Clearly)

1. On the first line enter the shipping firm's name and the Texas Department of Water Resources assigned solid waste registration number in the spaces provided.
2. Enter the correct business address.
3. Enter the address from which the Waste Shipment originates. If it is the same as the above note "SAME" in this space.
4. Enter a phone number where a company agent may be reached in the event of an emergency.

DESTINATION

5. Enter the receiving company's name and the assigned Texas Department of Water Resources Permit number in the spaces provided. For waste disposal well permit numbers, such as "WDW 999", enter only the last five digits, i.e. "DW 999".
6. Enter the receiving company's correct business address. If it is out of Texas be sure to note the State.
7. Enter the points of destination if different from the business address.
   NOTE: If shipping to a County or Municipal Disposal Site, note the name of the county or municipality in the space for company name and the location of the disposal site under point of destination.
8. Complete the waste description table as follows:
   a. In Column (1), enter the assigned Texas Department of Water Resources Waste Code which corresponds to each waste that you are shipping. If you need additional spaces to list all of the wastes you are shipping, complete an additional shipping ticket.
   b. In Column (2), Quantity, enter the amount in the first part and circle one number which corresponds to the units of measure (1 cans; 2, gallons; 3) cubic yards; 4) drums 55 gal.).
   c. In Column (3), Hazardous Properties, enter any known hazardous properties (Toxic, Flammable, Explosive, Corrosive). If none, enter "NONE".
   d. In Column (4), Description, enter the waste description which corresponds to the assigned Texas Department of Water Resources Waste Code.
9. Part I must be signed by an authorized representative of the shipper/generator. IMPORTANT: PART II MUST BE SIGNED BY THE CARRIER/DRIVER IN THE PRESENCE OF A SHIPPER'S REPRESENTATIVE PRIOR TO SHIPMENT.
10. Retain the green copy and send the other three copies with the driver.
11. Do not send the green and/or white copy to the Texas Department of Water Resources.

PART II: INSTRUCTIONS FOR THE CARRIER/DRIVER (Please Type or Print Clearly)

1. Enter the carrier or trucking firm's name and correct business address. If the waste shipper or waste receiver identified in Part I is the owner of the transport vehicle then enter "SAME AS SHIPPER" or "SAME AS RECEIVER", as is applicable.
2. As driver of the transport vehicle you have the responsibility of ensuring that all waste accepted by you arrives at the specified destination.
3. Sign for the shipment in the space provided. Be certain you sign for the shipment in the presence of a shipper's representative. IMPORTANT: IF FOR ANY REASON YOU ARE UNABLE TO CARRY OUT DELIVERY OF THE SHIPMENT, THEN DIAL THE EMERGENCY PHONE NUMBER FOR THE SHIPPER IN PART I.
4. Upon delivery the receiver is to sign in your presence. You are to give him the pink copy, send the white copy back to the shipper, and retain the yellow copy for your records.

PART III: INSTRUCTIONS FOR THE RECEIVER (Please Type or Print Clearly)

1. If for any reason the receiving company is different than that identified in Part I enter the company name, your Texas Department of Water Resources Permit number, phone number, and address.
2. Verify that the quantities received are those listed in Part I.
3. Date and sign for receipt of the shipment in the presence of the driver.
4. Retain the pink copy for your records.
5. If the receiver is a County or Municipal Disposal Site, signature for receipt of the waste is the only action required for the purposes of this record.

TDWR-0011 page 3

Figure 6-13 (continued)

MONS 028394

Rollins Environmental Services Inc.

Rollins

GUIDELINES TO PACKAGING AND IDENTIFICATION
OF WASTE MATERIALS IN DRUMS,
FIBER/PAKS, CARTONS AND CASES *

Proper packaging and identification of waste products is essential to assure their intact arrival at RES, to assure safety for all personnel handling the material, to assure compliance with governmental rules and regulations regarding material shipments, and to avoid delays, rejections and additional laboratory handling and transportation charges.

Drums, fiber/paks, cartons and cases must comply with ICC/DOT container and marking specifications:

(1) Closed-top drums must have both bungs in place and tightly secured.

(2) Open-top drums must have a gasket between drum and lid, a useable sealing ring in place and tightened securely.

(3) Closed-top drums with head cut out or open-top drums with no lid will not be accepted by RES drivers.

(4) Leaking or damaged containers will not be accepted by RES drivers.

(5) Each container must be clearly and indelibly marked with the proper RES code number (RD-XXXX) on the side of the container near the top.

(6) Caution labels and placards and/or precautionary statements (poison, corrosive, etc.) must be applied as defined and required by the ICC.

(7) Pallets, when used, must meet material handling association specifications, and the same or equivalent will be returned provided that prior arrangements have been made with RES.

(8) Cartons and cases on pallets must be covered with an overlay of plastic and banded or strapped.

(9) Only material covered by one RD-number will be put on one pallet.

(10) Each container on a pallet must be marked as in 5 above.

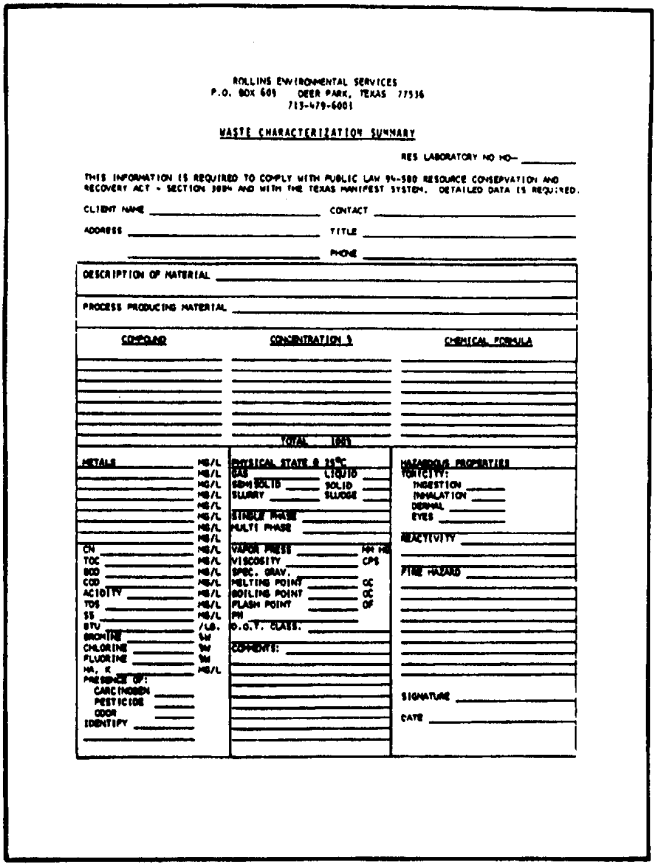
(11) Fiber drums are to have metal lids with locking rings and may not exceed 35 gallons in size unless other arrangements have been made prior to shipment.

(12) In addition to the Bill of Lading each shipment originating in Texas should be accompanied by a TWCB trip-ticket properly filled in.

*Effective October 17, 1978 - Subject to Change without Notice.

Figure 6-14. Rollins Packaging Guidelines

MONS 028395



ROLLINS ENVIRONMENTAL SERVICES
P.O. BOX 609 DEER PARK, TEXAS 77536
713-479-6001

WASTE CHARACTERIZATION SUMMARY

RES LABORATORY NO NO- _____

THIS INFORMATION IS REQUIRED TO COMPLY WITH PUBLIC LAW 94-580 RESOURCE CONSERVATION AND RECOVERY ACT - SECTION 3004 AND WITH THE TEXAS MANIFEST SYSTEM. DETAILED DATA IS REQUIRED.

CLIENT NAME _____ CONTACT _____

ADDRESS _____ TITLE _____

_____ PHONE _____

DESCRIPTION OF MATERIAL _____

PROCESS PRODUCING MATERIAL _____

COMPOUND	CONCENTRATION %	CHEMICAL FORMULA
	TOTAL 100%	

METALS _____ MG/L
_____ MG/L
_____ MG/L
_____ MG/L
_____ MG/L
_____ MG/L
_____ MG/L
_____ MG/L
CN _____ MG/L
TOC _____ MG/L
BOD _____ MG/L
COD _____ MG/L
ACTIVITY _____ MG/L
TOX _____ MG/L
SS _____ MG/L
BTU _____ /LB.
BROMINE _____ %
CHLORINE _____ %
FLUORINE _____ %
NA, K _____ MG/L
PRESENCE OF:
CARCINOGEN _____
PESTICIDE _____
ODOR _____
IDENTIFY _____
_____

PHYSICAL STATE @ 25°C
GAS _____ LIQUID _____
SEMI SOLIDS _____ SOLID _____
SLURRY _____ SLUDGE _____
SINGLE PHASE _____
MULTI PHASE _____
VAPOR PRESS _____ MM HG
VISCOSITY _____ CPS
SPEC. GRAV. _____
MELTING POINT _____ °C
BOILING POINT _____ °C
FLASH POINT _____ °F
PH _____
D.O.T. CLASS. _____
COMMENTS: _____

HAZARDOUS PROPERTIES
TOXICITY:
INGESTION _____
INHALATION _____
DERMAL _____
EYES _____
REACTIVITY _____
FIRE HAZARD _____
SIGNATURE _____
DATE _____

Figure 6-15. Rollins waste characterization summary (courtesy of Rollins Environmental Services, Inc.).

MONS 028396

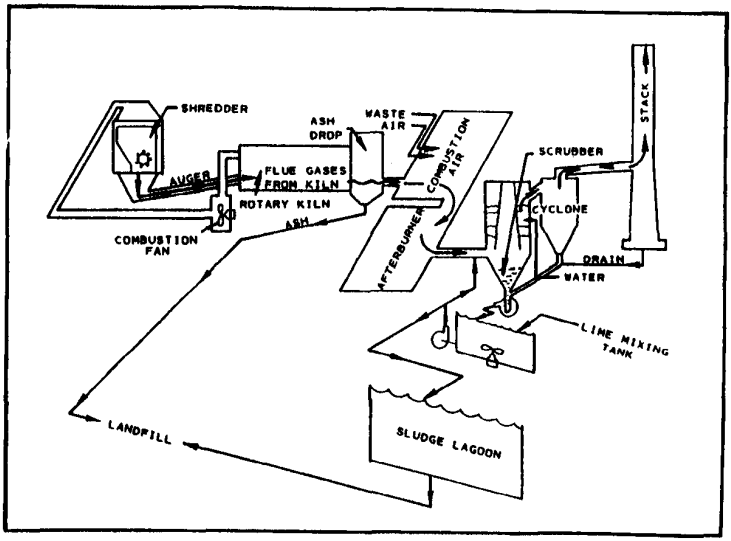


Figure 6-16. ENSCO Incineration Facility Schematic (Thermal Oxidation Unit)

MONS 028397

In general, the same PCB handling and transport procedures which are in effect for Rollins Environmental Service are also applicable to ENSCO. ENSCO has the capability of burning both solid and liquid materials, and waste can be received by either truck or rail. Pending outcome of regulatory impediments, ENSCO, like Rollins, is not accepting any PCB materials at this time. However, should approval be granted, ENSCO will accept contaminated PCB materials for either decontamination or disposal.

Proposed PCB Combustion Facilities. The demand for PCB combustion facilities has encouraged several firms to consider establishing incinerator operations. Three firms were identified as having made initial steps toward the construction of PCB incinerators. These firms were identified previously in Table 6-12. Additionally, the State of Michigan Department of Natural Resources, Water Quality Division, has announced plans to construct a facility for the disposal of hazardous wastes, including PCB materials. Should all announced facilities obtain approval for PCB combustion, only EPA Regions I, III, VII, and X will lack PCB combustion capability. It is unlikely, however, given the present regulatory climate, that any of the existing or proposed facilities will be accepting PCB wastes for disposal in the near future. Considering the difficulties encountered by experienced waste disposal companies such as Rollins and ENSCO, it is improbable that a newcomer to the field would fare better. Once one or two PCB combustion facilities are approved and log more extensive operating experience, the regulatory climate, as well as public opinion, should improve.

As an alternative to immediate disposal of PCBs, BKK Corporation is currently accepting utility PCB materials for storage on a consignment basis pending completion and certification of their proposed combustion disposal facility. BKK operates a storage facility at the site of their proposed incinerator, located in Beatty, Nevada. Table 6-5 presents the terms and conditions under which BKK will presently accept PCB wastes; Table 6-6 presents their current (December 1978) rate schedule.

CONCEPTUAL DESIGN AND COST ANALYSIS OF PCB PREPROCESSING AND COMBUSTION SYSTEMS

The establishment of regional PCB combustion facilities by utilities or other industries is desirable in regions where such capability does not exist. The previous section described (1) combustion technology and its applicability to PCB thermal destruction, and (2) the present and future availability of approved PCB incineration sites in the United States.

MONS 028398

Table 6-5

TERMS AND CONDITIONS FOR ACCEPTING PCB WASTES

PCB Waste Management Services*

1. BKK will accept for transportation (to BKK storage or disposal facilities) only physical, sealed, and non-leaking PCB articles or PCB containers.

2. The PCB waste producer (i.e., the "customer") is responsible for proper marking or labeling of each article and container, pursuant to Federal regulations, prior to BKK acceptance.

3. Each drum or other container, each pallet (with several articles banded or wired thereto), and each unpackaged article (e.g., large transformers) shall be tagged or stenciled to show: (a) a unique numerical identifier (such as SCE-006, APS-093, SRP-14, etc.), (b) the date of scheduled pickup by BKK truck, (c) simple word description of contents (such as PCB oil, debris, 3 capacitors, etc.), and (d) gross weight of container, article, or pallet. (Note: Such date shall serve as basis of storage and disposal record-keeping by BKK and for information reports by BKK to customer).

4. Customer will deliver to, and BKK will accept custody (or ownership, as later specified) of, all PCB waste materials at the tailgate of the BKK transport vehicle; or at the receiving station of a BKK storage facility or disposal site, should the customer (the waste producer) elect to transport such in his own vehicle. (Note: BKK will not accept wastes from any "third party," i.e., other than from primary waste producer.

5. All PCB waste loads shall be transported only when accompanied by a properly completed and signed "California Liquid Waste Hauler Record" form (or equivalent manifest), irrespective of whether such transport shall be outside of the State of California. (Note: This document shall also serve as a basis of record-keeping and inter-communication by BKK and the customer).

6. Until such time as BKK can/will accept "ownership" (for ultimate disposal) of any PCB wastes, as later defined, BKK will accept such materials from the customer only on a temporary "custody" basis. Under such arrangement, BKK shall provide for the transportation and/or storage of all PCB materials placed in BKK custody in: (a) an efficient, safe and workmanlike manner, and (b) compliance with all local, state and federal regulations applicable thereto.

*Courtesy of BKK Corporation

MONS 028399

Table 6-5 (continued)

7. BKK shall and hereby agrees to indemnify and hold the customer harmless from and against any and all liability, actions, damages, costs, fines, penalties, and expense whatsoever character that may be claimed or asserted, or suite brought, against the customer by any person, firm, corporation or governmental agency on account of any actual or alleged illness, bodily injury, or death occuring to any person or for loss or damage to property arising out of, in connection with, or resulting from the actual or alleged activities of BKK, its officers, agents, or employees in the performance of services associated with the custody (or ownership assumption, as later defined) of the PCB materials.

8. The customer may at any time, at its own discretion, direct BKK to remove any or all of its PCB wastes from the BKK storage facility and to transport such materials to any other facility not owned or operated by BKK. The customer shall provide such direction only in writing; and in such communication, shall acknowledge that custody of, and responsibility for, the materials involved shall revert to the customer, or his designated agent, upon delivery of such materials by BKK.

9. BKK shall and hereby agrees, to the best of its abilities and at the earliest date possible, to obtain EPA approval of the existing BKK chemical waste landfill (West Covina, CA) for diaposal of those PCB wastes which may be landfilled. Further, BKK shall and hereby agrees, to the best of its abilities and at the earliest date possible, develop and construct a federally-compliant PCB waste incinerator (at BKK's Beatty, Nevada facility) and to obtain EPA certification for such.

10. Should BKK for any reason whatsoever elect not, or be unable, to obtain necessary governmental permits for its disposal facilities for any of the PCB materials being held in storage by (and within the custody of) BKK, then BKK shall promptly notify the customer in writing of such election or failure to obtain necessary permits. The customer shall, within 30 days after receipt of such notification, communicate to BKK instructions regarding disposition of PCB materials involved, e.g., retain in storage, or deliver to another party's disposal facility, or return to customer, etc.

11. Upon BKK's receipt of EPA approval (for PCB disposal) of the BKK landfill and/or incinerator facility, BKK shall notify the customer thereof, in writing, within 30 days after receipt of such approval. At such time, BKK shall inform the customer of the rates established by BKK for the landfill (or incineration) form of disposal; and shall request authority (via purchase order amendment, or equivalent) to accomplish movement and disposal of any or all of the customer's PCB

MONS 028400

Table 6-5 (continued)

wastes in BKK storage. If the customer shall authorize such movement and disposal by BKK, then BKK shall then notify the customer in writing that BKK will and has accepted ownership of the PCB wastes concerned.

12. Assumption of ownership of PCB wastes by BKK shall not relieve BKK of the customers indemnification set forth in paragraph 7 above.

MONS 028401

Table 6-6

BKK PRELIMINARY RATE SCHEDULE FOR PCB RECEIVERSHIP
(BKK WASTE MANAGEMENT SERVICES*)

- TRANSPORTATION

  Intrastate (Trip originates, remains within and terminates in California).

  $41.00 per hour (portal-to-portal), with 4-hour minimum.

  Interstate

  $1.10 per mile (round trip) includes 2-hour loading/standby time and 2-hour unloading time, $41.00 per hour for extra time.

- WASTE STORAGE (@ BKK Beatty, Nevada facility)

  Reserved Storage Space

  1,000 sq. ft. - $2,500 per year
  500 - $1,500
  250 - $1,000

  Annual pre-payment required. Rates guaranteed two years from date of initial rental.

  Per Article Storage

  $.25/cubic foot per month

  Six months pre-payment required at time material accepted for storage, with semi-annual billing thereafter.

*Courtesy of BKK Corporation

MONS 028402

Table 6-6 (continued)

- LANDFILL DISPOSAL (BKK-West Covina, CA)

  Rates to be established after EPA approves site and defines permit conditions.

- INCINERATION OF PCB LIQUIDS (BKK-Beatty, NV)

  Rates to be established after facility construction completed and EPA approval received.

- FLUSHING/DRAINING OF TRANSFORMERS AND CONTAINERS

  Rates not yet determined. Will vary according to size and configuration of transformer.

MONS 028403

Table 6-7 summarizes the applicability of various combustion technologies to the destruction of PCBs. Multiple-hearth, or Herreshoff, furnaces are acceptable for thermal treatment of solids, but the solids must first be finely shredded. The effect of acid gases on combustion unit internals may be a problem. Electrical utility boilers, cement kilns, and liquid-injection incinerators all appear to be suitable for combusting liquid PCBs and PCB-contaminated solvents. They can also be used as afterburners for the solids combustors.

Based upon these conclusions, a series of viable conceptual PCB preprocessing and combustion systems are presented in the following pages. These systems are intended to represent alternative PCB disposal systems for utility (or private) ownership and operation.

The following systems are included in the discussion:

- An integrated incineration facility capable of burning both liquid- and solid-borne PCBs.
- A utility boiler or cement kiln fitted with liquid PCB combustion capability.
- A utility boiler or cement kiln fitted with liquid and solid PCB combustion capability.

Each system description includes flow diagrams, process descriptions, relevant operating parameters, and capital and operating cost estimates.

Integrated Facility for Processing and Incineration Liquid PCBs and PCB Capacitors

Basic Design Premises. This facility is designed to receive, process, and incinerate liquid PCBs and wash solvents from transformers along with undrained PCB capacitors. It is similar in design to several existing chemical waste disposal facilities discussed previously. It provides combustion conditions, scrubbing efficiencies, and instrumentation to meet all applicable criteria.

The design capacity of the incinerator is 72.5×10^6 Btu/hr. This capacity is within the range of proven incinerator designs, and is a reasonable size for a regional utility disposal facility. Certain basic assumptions have been made for design purposes:

- The facility will be dedicated to the disposal of liquid PCBs, wash solvents containing PCBs, and PCB capacitors.

MONS 028404

Table 6-7

SELECTION OF COMBUSTION SYSTEMS FOR PCBs

Type of Combustion System	Acceptable for PCBs?	Conditions or Reasons for Rejection	Typical Current Use or Materials Burned
Open pit; open burning; stack flares	No	No control of combustion conditions or emissions	Trash and construction debris
Catalytic Combustors; gas and fume combustors	No	Primarily designed for fumes and vapors. Not suitable for solids or liquids	fume and vapors
Multiple chamber incinerators with fixed hearths or grates; reciprocating or traveling grate furnace	Liquids-Yes Solids-No	Solids not positively retained and agitated for complete combustion. Liquids could be burned in separate burners above the grates.	Municipal solid waste, wood wastes, coal, most solid fuels.
Liquid Injection	Liquids-Yes Solids-No[a]	Excellent for liquid PCBs. Can be used as an afterburner for a solids combustor.	Pumpable liquids with heating values over 5,000 Btu/lb
Molten Salt Bath	No	Temperatures too low--requires an afterburner. Removal of shredded non-combustibles is difficult. Not proven for commercial use.	Research level studies on pesticides and other chemical wastes.
Fluidized Bed	Liquids-? Solids-No	Temperatures too low, may require an afterburner. Removal of shredded non-combustibles may be difficult	Liquids, sludges, tars, some types of solids
Herreshoff or multiple hearth furnace	Liquids-Yes Solids-Yes	Requires an afterburner. Suitable but not the top choice.	Municipal and industrial sludges, wood waste
Rotary kiln	Liquids-Yes Solids-Yes	Requires an afterburner. The best choice for solids.	All types of liquids, sludges, tars, solids
Electrical Utility Boilers	Liquids-Yes Solids-No[a]	Solids may fall through grates before combustion is completed.	Coal and fuel oil
Cement kilns	Liquids-Yes Solids-No[a]	Solids enter the cold end of the kiln, and volatized PCBs would enter the emissions control devices.	Fuel oil, natural gas

[a]But can be used as a fired afterburner for one of the solids combustors such as a multiple hearth furnace or a rotary kiln

MONS 028405

- It will also be capable of handling contaminated soil, rags, containers, and other contaminated solids.
- Liquids will be received in 55-gal barrels on pallets.
- Capacitors will be received in 55-gal drums on pallets or lined wooden boxes which are designed for movement by forklift.
- Approximately equal weights of (1) capacitors, (2) liquid PCBs from transformers, and (3) wash solvents from transformers will be received for disposal.

The basic properties of the three waste types accepted are summarized in Table 6-8. The composition data shown were obtained by adjusting the data reported for small electronics capacitors (1), in which the capacitors contained 29 percent by weight PCB and 39 percent other combustibles (the latter assumed to be paper). The percentage of PCBs was reduced to 25 percent by weight, which should be more typical of larger capacitors; the percent paper was reduced proportionately to 33 percent. The last four lines of Table 6-8 list the properties of each of the three feed streams to the incinerator, and the properties of the total feed if these three streams were "blended" together.

The total capacity of the incinerator is 7000 lb/hr (2333 lb/hr of capacitors, 2333 lb/hr liquid PCBs, and 2333 lb/hr of wash solvents). This is obtained by dividing the heat release capacity by the higher heating value of the total feed.

$$\frac{72.5 \times 10^6 \text{ Btu/hr}}{10.353 \text{ Btu/lb}} = 7{,}000 \text{ lb/hr}$$

In like manner, all other flow rates are related to the basic heat release capacity of the incinerator.

Flow Diagram and Process Description. A schematic flow diagram of the incineration system is given in Figure 6-17. The system has been divided into a number of modules which perform specific functions. Each module has been given a name and a letter symbol for convenient reference. The description, flow rate, and characteristics of each stream are given in Table 6-9.

Water is injected into the kiln at a rate of 5830 lb/hr (700 gal/hr), Stream 7, in order to suppress the production of free chlorine and to control the temperature in the kiln. The design rate of water addition is equivalent to 1 lb of water per pound of combustibles fed to the incinerator, although a water-to-combustibles ratio

MONS 028406

Table 6-8

PROPERTIES OF PCB INCINERATOR DESIGN FEED

Waste	Wt Percent	% Chlorine	Properties of Waste Types Sp Gravity	LHV,Btu/lb	HHV,Btu/lb
Capacitors					
PCBs (1016 or 1242)	25	42.5	1.40	8,950	9,430
Paper	33	0.0	--	7,570	8,200
Ash	42*	0.0	--	0	0
Subtotal, Capacitor Components		10.5	--	4,740	5,060
Liquid PCBs from Transformers		54.0	1.50	7,100	7,500
Wash Solvents		0.0	0.88	17,700	18,500
Total Feed to Incineratort		21.5#	--	9,847	10,353

*Equals 14 percent of the total feed
†Assumes equal weights of capacitors, liquid PCBs, and wash solvents
#Equals 25.0 percent of the combustibles in the total feed

MONS 028407

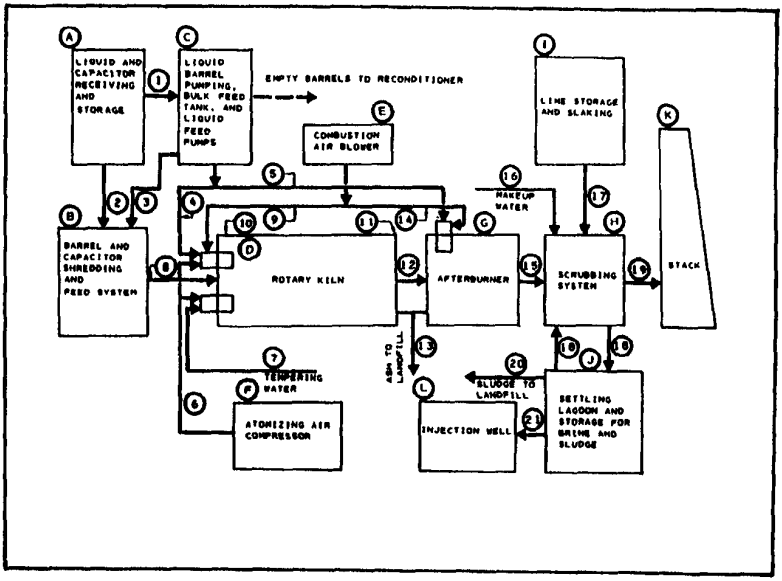


Figure 6-17. Schematic Flow Diagram of an Integrated Solid-Liquid Incinerator

MONS 028408

Table 6-9

FLOW STREAMS - DESIGN FLOW RATES AND PROPERTIES

Description	Stream Number	Rate	Characteristics
Liquid PCBs and wash solvent to pump station	1	10 Bbl/hr	1:1 Mixture by weight of Aroclor 1254 and wash solvents in 55-gal barrels
Capacitors to shredder	2	2330 lb/hr	Undrained capacitors
Empty barrels to shredder	3	500 lb/hr (10 Bbl/hr)	Empty 55-gal barrels
Liquid feed to kiln burner	4	951 lb/hr (106 gal/hr)	1:1 Mixture by weight of Aroclor 1254 and wash solvent
Liquid feed to afterburner	5	3715 lb/hr (412 gal/hr)	Same as 4
Atomizing air to kiln burner and water nozzle	6	360 scfm	110 psig
Tempering water	7	5830 lb/hr (700 gal/hr)	Water from any source (can be contaminated with PCBs).
Shredded capacitors and barrels to kiln	8	2830 lb/hr	Shredded to 1-1/2" chunks or smaller
Combustion air to kiln burner	9	2290 scfm	110 Percent of theoretical air for the burner at 16 in. H_2O
Infiltration at front seal	10	3800 scfm	Combustion air (150 percent of theoretical air and 1800 °F in kiln

MONS 028409

Table 6-9 (continued)

Description	Stream Number	Rate	Characteristics
Infiltration at rear seal	11	2080 scfm	Combustion Air
Combustion gas from kiln	12	38,500 acfm	200 percent of theoretical air and 1350 °F
Ash to landfill	13	1330 lb/hr	Steel and other inorganics
Combustion air to afterburner	14	8880 scfm	110 percent of theoretical air for the burner
Combustion gases to scrubber	15	105,000 acfm	140 percent of theoretical air and 2200 °F
Makeup water	16	51,250 lb/hr (102 gpm)	Organic-free water from any source
Lime	17	1320 lb/hr of quicklime	Bulk quicklime
Scrubber water flow to and from lagoon	18	500-1000 gpm	30 percent $CaCl_2$ brine at 185 °F
Scrubbed gases to stack	19	48,000 acfm	Flue gases saturated with water at 185 °F
Sludge to landfill	20	500 lb/hr	30 weight percent solids
Calcium Chloride brine to disposal	21	7856 lb/hr (736 gal/hr)	30 weight percent $CaCl_2$ brine, specific gravity = 1.282

MONS 028410

of 0.5 to 1.5 is technically feasible. The water could be drawn from any source, including contaminated surface water from the incinerator site. For example, if the incinerator operates 85 percent of the time, 16 ac ft of water would be required per year. This demand would probably exceed the total surface runoff from the incinerator site, and would eliminate any need for discharging surface water to streams. Excess air requirements vary within the system. For example, the design excess air level is 40 percent in the afterburner, but values from 15 percent to 75 percent are acceptable. The burners receive only 10 percent excess air. Leakage at the ends of the kiln supplies additional combustion air so that the following levels of excess air are attained:

	Percent Excess Air	Temperature
Kiln	50	981°C (1797°F)
Connecting duct	100	732°C (1349°F)
Afterburner	40	1204°C (2199°F)

The afterburner temperature is 1204°C (2200°F), and the residence time is 2.5 sec. The incinerator is to be operated at the lower end of the temperature range allowed by the regulations because of:

- Less severe conditions for refractory materials.
- Less production of nitrogen oxides.
- More flexibility to burn wastes which contain water.

A residence time larger than required by the regulations (2.5 versus 2 sec) is used because the residence time is moderately dependent upon the combustion conditions. For example, if a greater amount of excess air is used, and the water injection rate is reduced, the volume of combustion gases generated per pound of waste will be increased, and the residence time will be reduced at the same burning rate.

Disposal of Residues. Residue disposal requirements are an important consideration when siting a PCB incinerator. Significant quantities of ash, sludge, and calcium chloride brine are produced by the incineration system. The sludge and ash will likely have to be deposited in a chemical waste landfill due to regulatory requirements. An on-site landfill for residue disposal would probably be too small to be cost-effective. However, it is desirable to locate as close as possible to an existing chemical landfill site with a long remaining life. It is assumed later in the cost analysis that an outside landfill is used for disposal of ash and sludge.

MONS 028411

Included in the design is an injection well for disposal of the calcium chloride brine. Thus, the site needs to be located where geological formations and regulatory policies permit salt water injection. It may be more economical to use an existing commercial injection well, but the volume of brine generated by this size of facility should justify an on-site well. If the site can be located on a coast where salt water can be discharged to the surface waters, then the cost of brine disposal will be minimized.

Capital Cost. The detailed characteristics of each module in the system are discussed in Appendix G. Cost estimates for both the large (72.5×10^6 Btu/hr) and small (11×10^6 Btu/hr) incineration systems are summarized in Table 6-10. A cost estimate for a similar facility with a heat release capacity of 95×10^6 Btu/hr is documented (1). The updated cost for that system, as of January 1979, is $4,300,000.

The two derived and one documented cost estimates for integrated solid-liquid incinerators are plotted together in Figure 6-18. The derived capital cost estimates are approximated by the following equation:

$$\text{Total Capital Investment (\$)} = 1760 \left(\text{Heat Release}, \frac{\text{Btu}}{\text{hr}}\right)^{0.42}$$

The documented cost estimate for a 95×10^6 Btu/hr facility is 9 percent larger than given by this formula.

Operating Costs. Operating costs for the two different plant capacities are presented in Tables 6-11 and 6-12. All basic cost data or assumptions are given in the tables. The following additional assumptions may not be obvious by inspection:

- The incinerators operate on a 4-shift, 7-day per wk schedule, with an estimated 15 percent downtime for maintenance and inspection.
- The receiving and storage facility operates on a standard 40-hr wk.
- Fuel oil consumption is for warm-up and maintaining combustion temperatures when the waste feed is temporarily interrupted. The amount shown is for one 24-hr day per mo.
- The gas consumption is 1 Mscf/hr for pilot lights.
- Lime is specified as the neutralizing agent because of its tremendous cost advantage over caustic. With lime at $40/ton and caustic at $160/ton, caustic would cost 5.7 times more than lime for equivalent neutralization capacity.

MONS 028412

Table 6-10

CAPITAL INVESTMENT FOR AN INTEGRATED SOLID-LIQUID INCINERATOR

Module	Installed Cost	
	72.5×10^6 Btu/hr	11×10^6 Btu/hr
A - Receiving and storage	208,900	42,200
B - Barrel and capacitor shredding and feed system	147,700	117,700
C - Barrel pumping, liquid storage, and feed pumps	142,000	45,800
D - Rotary kiln with ash removal system and burner	529,000	176,300
E - Combustion air blower	32,500	9,000
F - Atomizing air compressor	15,900	9,400
G - Afterburner with burner and accessories	205,300	66,200
H - Scrubbing system with pumps, i d all accessories	678,[illegible]	146,50[illegible]
I - Lime storage and slaking	150,800	112,000
J - Settling and sludge lagoon	26,800	13,400
K - Stack	43,200	27,600
L - Injection well	276,600	276,600
M - Instrumentation and controls	145,000	145,000
N - Laboratory	81,200	81,200
O - Offices, maintenance shop, change room	157,800	61,300

MONS 028413

Table 6-10 (continued)

Module	Installed Cost	
	72.5×10^6 Btu/hr	11×10^6 Btu/hr
P - Ground water, surface runoff and ambient air monitoring	50,000	30,000
Q - Land (60 ac at $5000/ac)	300,000	75,000
R - Permitting and Test Burn	55,000	55,000
S - Preproduction labor costs (1 mo)	69,550	25,750
T - Fuel inventory (1 mo)	5,850	850
U - Allowance for funds during construction (AFDC) (9 mo at 8 percent annual interest)	199,250	91,000
Total Capital Investment	$3,520,350	$1,607,800

MONS 028414

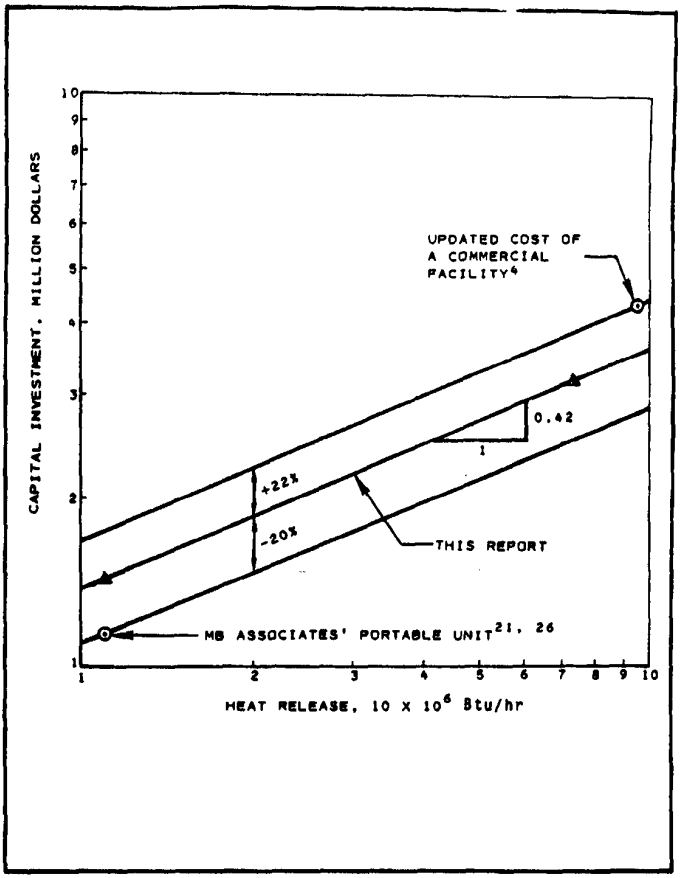


Figure 6-18. Capital investment versus heat release capacity for solid-liquid incinerators.

MONS 028415

Table 6-11

ANNUAL OPERATING COST FOR A SOLID-LIQUID INCINERATOR
WITH A CAPACITY OF 72.5 x 10^6 Btu/hr

Item		Cost/Yr ($)	
Cost of Capital*			809,700
Maintenance (9 percent of Capital Investment*)		260,200	
Utilities		262,700	
Electric Power [960kw(24)(310)]x [0.025 $/kw hr]	= 178,560		
Water [125 gpm (1440) (310)]x [0.25 $/1000 gal]	= 13,950		
Fuel Oil, No. 2 [158,000 gal]x [0.35 $/gal]	= 55,300		
Natural Gas [7,440 mscf]x [2.00 $/mscf]	= 14,880		
Solid Waste Disposal (1830 lb/hr) (24) (310) (20 $/2000 lb) (Included Transport)		136,200	
Chemicals-Bulk Quicklime-(1320 lb/hr) (24) (310) (40 $/2000 lb)		196,400	
Labor		834,400	
Plant Supervisor, Plant Engineer, Plant Chemist	$80,000		
Secretaries-(3) (8) (260) (6.00 $/hr)	37,440		
Lab Technician-(1)(8)(260) (7.00 $/hr)	14,560		
Chief Operator-(1)(24)(365)(8.00 $/hr)	70,080		
Operators-(5) (24) (365) (7.00 $/hr)	306,600		
Receiving & Storage-(4)(8)(260)(7.00$/hr)	58,240		
Supplies (20 percent of Operating Labor)	97,384		
Payroll Related Expenses (30 percent of Payroll)	170,076		
Subtotal Operating Costs		$1,689,900	
Levelized Operating Costs (Using 10 Year Levelizing Factor of 1.335)			2,256,000
Total Levelized Annual Costs			$3,065,700

*Includes weighted cost of capital, depreciation, income and property taxes, and insurance. This employ's a 10-year levelized fixed charge rate of 23 percent per EPRI Technical Assessment Guide.

MONS 028416

Table 6-12

ANNUAL OPERATING COST FOR A SOLID-LIQUID INCINERATOR
WITH A CAPACITY OF 11 x 10^6 Btu/hr

Item		Cost/Yr ($)	
Cost of Capital*			369,800
Maintenance (9 percent of Capital Investment*)		122,400	
Utilities		39,700	
Electric Power [146kw(24)(310)]x [0.025 $/kw hr]	= 27,156		
Water [19 gpm(1440)(310)]x [0.25 $/1000 gal]	= 2,120		
Fuel Oil No. 2 [21,850 gal]x [0.35 $/gal]	= 7,647		
Natural Gas [1,130 mscf]x [2.00 $/mscf]	= 2,260		
Solid Waste Disposal (278 lb/hr)(24)(310) (20 $/2000 lb)(Includes Transport)		20,700	
Chemicals-Bulk Quicklime (200 lb/hr)(24) (310)(40 $/2000 lb)		29,800	
Labor		309,200	
Plant Supervisor, Plant Chemist	55,000		
Secretary (1)(8)(6.00 $/hr)	12,480		
Chief Operator (1)(24)(365) (8.00 $/hr)	70,080		
Operator (1)(24)(365)(7.00 $/hr)	61,320		
Receiving & Storage (1)(8) (260) (7.00 $/hr)	14,560		
Supplies (20 percent of Operating Labor)	31,688		
Payroll Related Expenses (30 percent of Payroll)	64,032		
Subtotal Operating Costs		$521,800	
Levelized Operating Costs (Using 10 Year Levelizing Factor of 1.335)			696,600
Total Levelized Annual Costs			$ 1,066,400

*Includes weighted cost of capital, depreciation, income and property taxes and insurance. This employs 1-yr levelized fixed charge rate of 23 percent per EPRI Technical Assessment Guide.

MONS 028417

The total annual operating cost can be related to the heat release capacity by the formula:

$$\text{Total Annual Operating Cost, \$} = 122 \left(\text{Heat Release, } \frac{\text{Btu}}{\text{hr}}\right)^{0.56}$$

All the cost data and the amount of waste burned are summarized in Table 6-13 for the two plants. The annual rate of waste destruction is calculated for 310 days per year of operation, or 85 percent utilization. The costs per pound of waste are strongly dependent upon the size of the unit. For example, the cost per pound is $0.059 for the larger incinerator versus $0.135 for the smaller incinerator.

Systems for Preprocessing of PCBs, and Their Destruction in Utility Boilers and Cement Kilns

Both utility boilers and cement kilns appear to meet the criteria required to affect PCB destruction by combustion. Because neither system can be hampered from performing its primary function, however, the compatibility of PCB combustion with each system configuration must be assessed. Of particular interest in the assessment are:

- The resistance of the system internals to corrosion from HCl.
- The ability of the system to accept solids and/or liquids as fuel.

The following discussion of boiler and cement kiln use begins with an analysis of system suitability for PCB combustion according to the above two criteria. Based on the analysis results, several preprocessing systems are proposed which meet boiler and kiln feed condition and rate restrictions. Conceptual designs and cost estimates are then provided for the preprocessing systems and combustion system modifications.

The Mechanics of PCB Destruction in Electric Utility Boilers.

Selection of boilers suitable for PCB destruction. PCB combustion efficiencies and air emissions must meet or surpass the regulatory criteria. For many utility boilers, it is not anticipated that these requirements present a problem. However, before a boiler unit is selected for PCB combustion, its ability to meet these criteria should be checked.

MONS 028418

Table 6-13

SUMMARY OF INVESTMENT, COMBUSTION RATES, AND OPERATING COSTS

Size of Incinerator, Btu/hr	72.5×10^6	11×10^6
Waste Burned, lb/yr		
Capacitors	17.4×10^6	2.64×10^6
Liquid PCBs	17.4×10^6	2.64×10^6
Wash Solvents	17.4×10^6	2.64×10^6
Total	52.1×10^6	7.92×10^6
Capital Investment, $	$3,520,350	$1,607,800
Total Levelized Annual Costs, $	$3,065,700	$1,066,403
Cost per Pound, $/lb	0.059	0.135

MONS 028419

The characteristics of boilers which most affect their suitability for the destruction of PCBs are residence time, combustion efficiency, temperature, excess oxygen (under normal operation), type of air pollution control equipment, construction materials, location, and boiler size. The required residence time, temperature, and excess oxygen are interrelated, as was discussed previously (note Table 6-2 and associated equation).

Nominal residence time in utility boilers generally ranges from 1.0 to 3.7 sec. In order for nominal residence time to be fully effective, however, "channelling" or "bypassing" must be avoided, and complete mixing must be achieved in the combustion chamber. For example, a wall-fired unit with banks of coal guns on opposite walls would be preferable to a corner-fired unit, in that the latter produces a relatively lazy flame while the former imparts high turbulent mixing.

Combustion zone temperatures range from 1430°C (2606°F) to 1675°C (3047°F); furnace exit temperatures are 1090°C (1994°F) to 1402°C (2556°F); while excess O_2 at economizer exit varies from 0.9 to 4.0 percent. Many boilers, therefore, will not meet design criteria. Careful boiler selection must be made to ensure proper temperature, O_2, and residence times. (See Figure D-1, Appendix D). Further testing of the efficiency of PCB destruction in selected boiler configurations to ensure 99.9999 percent destruction should be performed before routine use of utility boilers for this purpose can be recommended.

The effect of increased chloride levels from PCB combustion on the boiler and wet scrubber surfaces must also be considered. Since nearly all chlorine in PCBs is converted to hydrochloric acid, boilers chosen for afterburners should be composed of construction materials that are resistant to corrosive attack from dry acid gases. In general, coal-fired units are less susceptible to HCl attack at the concentrations anticipated (based on recommended PCB feed rates). On the other hand, fuel oil is almost always low in chlorine content; oil-fired units would likely be adversely affected by the introduction of HCl. If the selected installation is equipped with wet scrubbers, the effect of chlorides on the corrosion resistance of the construction materials should also be assessed.

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Allowable feed rate of PCBs. Based on the previous discussion, the principal criterion to be used in selecting a boiler for PCB destruction is its resistance to acid corrosion. Coal-fired units are generally more resistant due to the normal levels of chloride encountered in most coals.

The PCB feed rate in most coal-fired boilers should not exceed 350 lb/hr of pure PCBs, based on the calculations shown in Appendix A. Site-specific factors will dictate the actual maximum PCB feed rate. Since older boilers tend to be smaller and operate at lower temperatures than newer units, the smaller boilers will be able to accept larger percentages of chlorine. Thus, in most cases, the size of combustion unit will not affect maximum feed rate of PCBs. The actual feed rate will depend on the chlorine content of the feed, which is a function of the source of the waste.

For the purposes of conceptual design, a PCB waste stream and its characteristics was assumed. The following four-step procedure was used to compute the overall chlorine content of the askarels contained in the waste:

1. Four categories of waste are to be destroyed. These are:

   --Capacitors, which typically contain Aroclor 1016 (although, before 1971, Aroclors 1242 and 1254 were also used).

   --Transformer and tramp magnet askarels, which contain several Aroclors of various chlorine content along with trichlorobenzene and tetrachlorobenzene.

   --Solid wastes, consisting largely of PCB-contaminated transformers, floor sweepings, and other spill cleanup debris.

   --Mineral oil and flushing solvents contaminated with trace amounts of PCBs.

2. The percent chlorine in each of the above waste streams is estimated as follows:

   --Capacitors: Aroclor 1016 (80 percent).

   Aroclor 1242 (15 percent).

   Aroclor 1254 (5 percent).

   Estimated weight percent Cl = 42 percent.

   --Transformers: Aroclor 1242 (33 percent).

   Aroclor 1260 (67 percent).

   Estimated weight percent Cl = 54 percent.

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--Solid wastes, contaminated oil and solvents; estimated Cl content of askarels = 50 percent.

3. The following distribution of askarels was assumed for the individual and total waste streams:

Origin	PCBs (%)	Others (%)	Total Askarel (%)
Capacitors	12.07	0	12.07
Transformers	61.01	26.15	87.16
Magnets	0.54	0.23	0.77
Total	73.62	26.38	100.00

4. The data were combined to compute a weighted average chlorine content for the waste stream, as follows:

Origin	Askarel	Chlorine Content (%)	Product
Capacitors	12.07	42.0	507
Transformers and Magnets	87.93	54.0	4748
Total	100.00		5255

From the right-hand column, the average chlorine content of the askarels in the waste is 52.55 percent, or approximately 53 percent.

Should such a detailed inventory of askarels be available to a utility, a similar computation can be performed. A lower computed chlorine content would permit a higher feed rate, thereby reducing the per unit cost of mixing and disposal. The validity of this calculation depends on the controlled addition of PCBs; liquid PCBs can be thoroughly mixed with the fuel in proper proportion, while PCBs volatized from the solid waste must be metered into the boiler separately as a gaseous mixture. Addition of the PCB liquids to the solids would help to stabilize the rate of volatilization. The front-end solids incineration concept is discussed later in this section.

The Mechanics of PCB Destruction in Cement Kilns.

Selection of cement kilns suitable for PCB incineration. Cement kilns are nearly ideal for the destruction of all chlorinated hydrocarbons for the following reasons: They are not subject to corrosion problems; residence time and temperature are more than adequate for complete destruction of the waste; air

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emissions are negligible; the quality of clinker (cement product) is increased due to the introdution of the chlorinated materials; and a slight fuel saving (approximately 65 percent of the heating value of the waste) is obtained (75).

The selection of a cement kiln to dispose of PCBs should be based, for the most part, on the anticipated level of public opposition. The cement-producing industry recognizes that it possesses the state-of-the-art technology to destroy PCBs and other chlorinated hydrocarbons. Most plant managers, however, are also acutely aware of the many political, emotional, and environmental problems that are associated with an attempt to operate a disposal facility (1). Most industry representatives also feel that the demand for PCBs disposal capacity will be short-lived, since PCB production ceased in 1977. The PCB waste generation data presented in Chapter V should serve to overcome this problem by demonstrating the long-term demand for disposal. The cement industry was one of the first to be severely burdened by air pollution control regulations during the 1950s, causing increased capital and operating expenditures and other compliance-related administration requirements. Most cement companies would prefer to avoid any additional regulation of their operations, particularly those brought on by reclassification as a hazardous waste disposal site.

Allowable feed rate of PCBs. It is common practice in the cement industry to add chloride compounds (usually calcium chloride or waste hydrochloric acid) to the kiln to reduce the alkali concentration of the final product. Therefore, the necessary corrosion resistance and acid neutralizing capability are built into most existing cement kilns. When excessive quantities of chlorine are introduced into the kiln, however, scale buildup occurs on the inside of the kiln. This buildup, called a "ring," restricts the gravity-induced flow of solid materials and can force a shutdown of the kiln.

For this reason, the chlorine input should be limited to approximately 0.4 percent by weight of the clinker production rate. Using a 550,000 ton/yr cement plant for conceptual design purposes, the allowable chlorine input to the kiln is 500 lb/hr. Based on an estimated 53 percent chlorine content of the PCB waste, the design feed rate for this particular kiln is approximately 950 lb/hr of pure PCBs.

Review of cement kiln configurations. A rotary cement kiln consists of a long steel refractory-lined cylinder inclined slightly from the horizontal. Kilns are supported on two or more externally powered girth foundation rings with

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rotating peripheral speeds in the range of 25 to 45 ft/min. Design dimensions have a ratio of kiln length to the square of the shell diameter of between 1 and 5. Some kilns have two or three diameters, part of its length being one diameter, the remainder being of another diameter. The enlargement is claimed to increase kiln capacity, decrease fuel consumption, and improve the cement product (clinker) quality. Rotary kilns vary in size from 1.5 m to 11.6 m in diameter and 18.3 m to 292.6 m in length.

Cement process kilns use either a wet or dry process. Both types are used throughout the world and effectively give uniform drying characteristics with continuous operations. Kilns vary considerably in production capacity (90,000 to 2,250,000 tons/yr/facility), maximum gas temperatures (1400° to 1650°C), and residence times (2 to 20 sec). The wet and dry kiln configurations are displayed in Figures 6-19 and 6-20, respectively.

In 1975, there were 168 cement-producing facilities in the United States, 98 facilities using wet-process kilns, 64 using dry-process kilns, and 6 using wet- and dry-process kilns. The recent trend, however, has been toward the use of dry kilns with preheaters. Presently, there is a reported total of 470 cement kilns operating in this country. Summary lists of cement-producing facilities are available in the literature (93).

Most cement kilns are of the countercurrent flow design, wherein the feed is introduced into the upper end of the kiln by various methods, e.g., inclined chutes, screw conveyors, slurry pipes, while heated air enters at the lower end. A combustion chamber is often used for more thorough premixing of heated gases prior to entering the kiln. (This feature would be particularly useful when injecting chlorinated hydrocarbons.) The hot gases then move across the continuously agitated feed and exit through the dust collection system. In many wet processes, the collected dust is returned to the kiln with the feed. In the dry process, the dust is often split into separate streams for reuse or disposal. Sometimes secondary air is admitted and distributed along the length of the kiln to promote complete combustion while the kiln operates under a negative pressure.

Even though both wet- and dry-process kilns have shown effective destruction of PCB waste, the wet process is recommended for several reasons. Most dry kilns already have preheaters (to conserve fuel) which are quite difficult to operate continuously due to scaling at normal chloride and alkali levels. This problem

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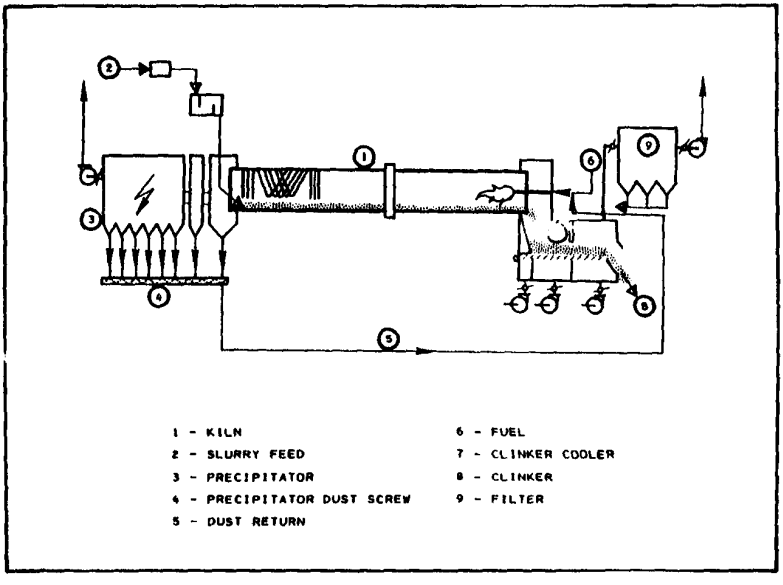

Figure 6-19. Schematic Diagram for Wet Process Cement Kiln

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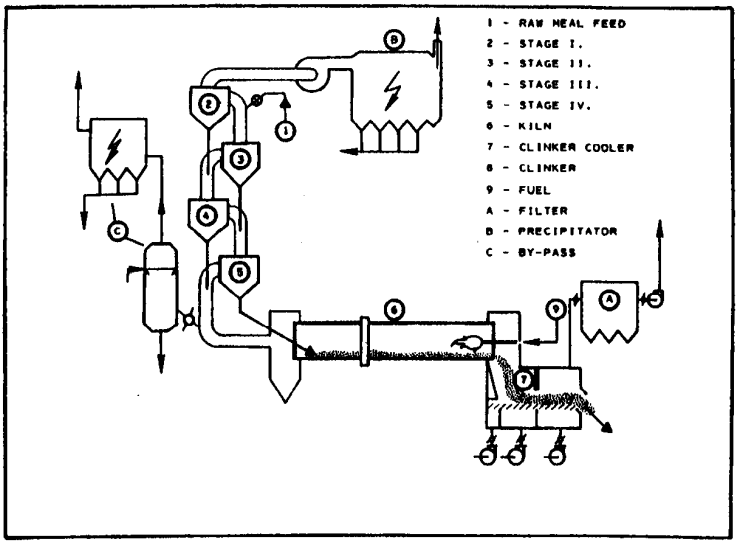

Figure 6-20. Schematic Diagram for Dry Process Cement Kiln

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has been partia solved by the use of bypass syste s or mechanical-scale scrappers. Wet cess kilns have greater heat transfer efficiency than dry kilns, but are expensive and consume more fuel per unit of product. Fossil fuel consumption can be reduced by the offsetting fuel value of the chlorinated hydrocarbons.

Solid PCB articles cannot be handled effectively by conventional cement kilns. The flow of solid PCB articles (shredded or nonshredded) would be countercurrent to the direction of hot gas flow, and the vaporized PCBs would be carried off without passing through the hot zone of the kiln. Furthermore, the shredded PCB articles would contaminate the clinker product. However, with the dition of the proposed supplemental solid PCB disposal system (see Figure 6-2.) to many cement kilns, both liquid and solid PCB waste streams could be incinerated.

Systems for PCB Combustion in Boilers and Cement Kilns. It was shown in the preceding discussion that selected utility boilers and cement kilns are capable of destroying PCBs without affecting the primary function of the system. In order to do so, however, the PCBs must be introduced (1) as a liquid or vapor, and (2) at a rate which is limited by the chlorine resistance of the system internals. PCB waste preprocessing and feed metering subsystems must be added to the base combustion systems before PCB combustion can be performed on a routine basis.

Two types of PCB combustion systems warrant consideration here: a system burning only liquids (PCB liquids, flushing solvents, and contaminated mineral oils), and a system burning both liquids and contaminated solids (shredded capacitors, transformers, and spill cleanup debris).

Combustion of PCB liquids. The PCB liquids combustion system consists of the following modules:

- Liquids receiving and storage.
- Bulk storage and pumping system.
- Combustion chamber, burner, and appurtenances.

In this system, liquid PCBs are received in barrels and stored in the appropriate facilities. The PCB liquids are then pumped to the combustion unit at an acceptable

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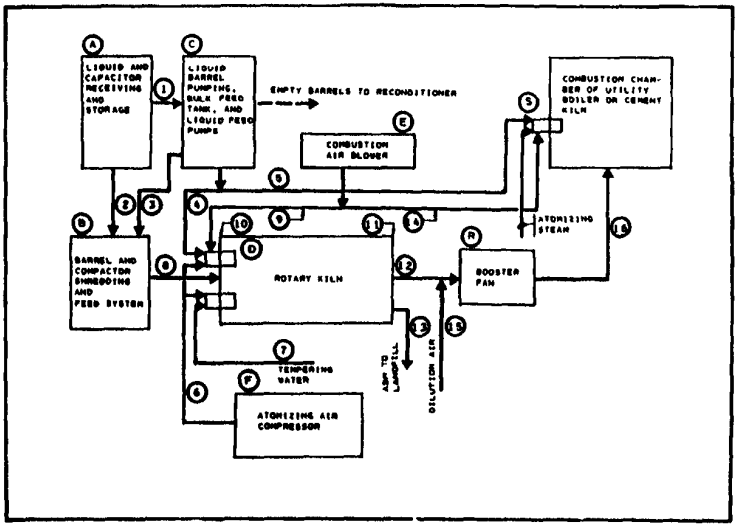

Figure 21. Schematic flow diagram of a system for burning solid PCBs into a utility boiler or cement kiln.

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rate (based on chlorine content) and steam-atomized during injection into the combustion chamber of the boiler or cement kiln.

Due to impurities in the waste feed, mechanical atomization equipment must be protected by a filtration system if plugging is to be avoided. This results in a waste sludge requiring disposal, exposes workers to PCB materials, and adds other costs to the system. For these reasons, steam atomization was selected as the most desirable alternative.

The overall process flow is shown schematically in Figure 6-22. A description of the associated flow streams for utility boilers and cement kilns is presented in Tables 6-14 and 6-15, respectively. The parameters used in these tables are in accordance with those used for the integrated liquids/solids disposal system presented previously.

The chlorine content of the waste may vary from 1 to 54 percent, depending upon the relative percentage of mineral oil (0 percent Cl), transformer fluid (Aroclor 1254), and flushing solvents in the mixture. For this conceptual system, a 1:1 ratio of low-chlorine and high-chlorine wastes is assumed, thereby producing a feed material containing approximately 27 percent chlorine and a heating value of approximately 13,000 Btu/lb. Adjusting the feed rate in inverse proportion to chlorine content results in a maximum feed rate for the conceptual boiler and kiln systems of 685 lb/hr and 1860 lb/hr, respectively.

The estimated capital (installed) cost of the liquid PCB handling and combustion system is presented in Table 6-16. Tables 6-17 and 6-18 display the estimated annual operating costs for the boiler and kiln PCB combustion systems, respectively.

Preprocessing and combustion of PCB liquids and PCB-contaminated solids. This system is designed to destroy both liquid PCBs and PCBs deposited on or absorbed within solid wastes. The thermal preprocessing system also serves to decontaminate the solid wastes for disposal to an approved landfill.

The processing system consists of the following modules:

- Liquids and solids receiving and storage.
- Bulk liquids storage and pumping system.
- Totally enclosed solids shredding system.

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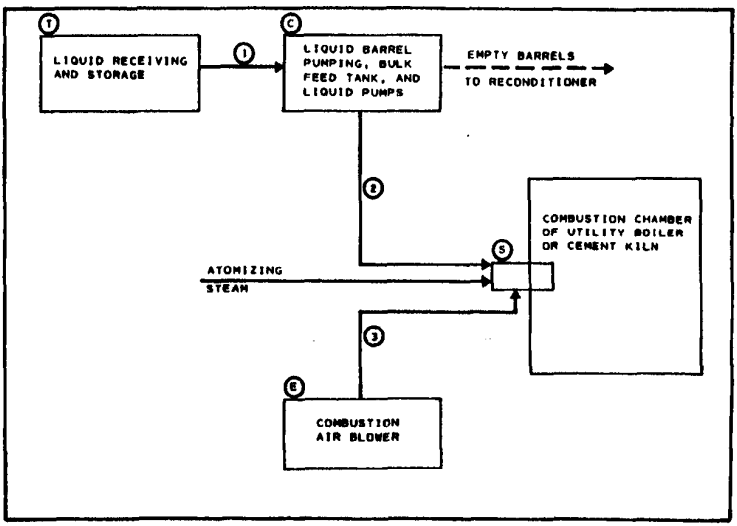

Figure 6-22. Schematic flow diagram flow system for burning liquid PCBs into a utility boiler or cement kiln.

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Table 6-14

FLOW STREAMS -- DESIGN FLOW RATES AND PROPERTIES
(SYSTEM FOR BURNING LIQUID PBCs INTO A UTILITY BOILER)

Description	Stream No.	Rate	Characteristics
Liquid PCBs and wash solvent to pump station	1	1.0 Bbl/hr	1:1 mixture w/w Aroclor 1254 and wash solvents in 55-gallon barrels
Liquid feed to burner at combustion chamber of utility boiler	2	685 lbs/hr (74 gal/hr)	1:1 mixture w/w Aroclor 1254 and wash solvents
Combustion air to burner at combustion chamber of utility boiler	3	1650 scfm	110 percent theoretical air for the burner at 16 in H_2O

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Table 6-15

FLOW STREAMS -- DESIGN FLOW RATES AND PROPERTIES
(SYSTEM FOR BURNING LIQUID PCBs INTO A CEMENT KILN)

Description	Stream No.	Rate	Characteristics
Liquid PCBs and wash solvent to pump station	1	2.7 Bbls/hr	1:1 mixture w/w Aroclor 1254 and wash solvents in 55-gallon barrels
Liquid feed to burner at combustion chamber of cement kiln	2	1860 lb/hr (201 gal/hr)	1:1 mixture w/w Aroclor 1254 and wash solvents
Combustion air to burner at combustion chamber of cement kiln	3	4500 scfm	110 percent of theoretical air for the buerner at 16 in. H_2O

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Table 6-16

CAPITAL COST ESTIMATE FOR A SYSTEM TO BURN LIQUID PCBs INTO A UTILITY BOILER OR A CEMENT KILN

Module	Installed Cost	
	Utility Boiler (8.9×10^6 Btu/hr)	Cement Kiln (24.2×10^6 Btu/hr)
C--Barrel pumping, liquid storage and feed pumps	40,300	73,500
E--Combustion air blower	7,800	15,400
S--Liquid burner	7,200	10,250
M--Instrumentation and controls	145,000	145,000
N--Laboratory	81,200	81,200
O--Offices, maintenance shop and change room	9,700	25,400
P--Groundwater, surface runoff and ambient air monitoring	30,000	30,000
T--Receiving and storage, liquids only	40,000	75,000
Permitting and Test Burn	55,000	55,000
Allowance for funds during construction (AFDC) (6 months at 8 percent annual interest)	16,650	20,450
Total Capital Investment	$432,850	1,200

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Table 6-17

ANNUAL OPERATING COST FOR A SYSTEM TO BURN
LIQUID PCBs INTO A UTILITY BOILER

Item		Cost/Yr ($)	
Cost of Capital*			99,550
Maintenance (9 percent of Capital Investment*)		32,500	
Utilities			
Electric Power [24kw (24)(310)] [0.025 $kw · hr]		4,500	
Credit for Heating Value [8.9(24)(310)] [1$/mmBtu]		(66,200)	
Labor		100,200	
Plant Supervisor (20 percent of direct labor)	11,400		
Lab Technician-(1)(8)(26)(7.00 $/hr)	14,600		
Chief Operator-(1/2)(24)(365)(8.00 $/hr)	35,000		
Receiving & Storage-(1/2)(8)(260)(7.00 $/hr)	7,300		
Supplies (20 percent of Operating Labor)	11,400		
Payroll Related Expenses(30 percent of Payroll)	20,500		
Subtotal Operating Costs		71,000	
Levelized Operating Costs (Using 10-Year Levelizing Factor of 1.335)			94,800
Total Levelized Annual Costs			$194,350

*Employ Technical Assessment Guide

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Table 6-18

ANNUAL OPERATING COST FOR A SYSTEM TO BURN
LIQUID PCBs INTO A CEMENT KILN

Item		Cost/Yr ($)	
Cost of Capital*			122,200
Maintenance (9 percent of Capital Investment*)		41,000	
Utilities			
Electric Power [65Kw(24)(310)] [0.025 $/kw · hr]		12,100	
Credit for Heating Value [(24.2)(24)(310)][2.07 $/mmBtu] [0.65 **]		(242,300)	
Labor		180,300	
Plant Supervisor (20 percent Direct Labor)	20,500		
Plant Chemist	25,000		
Chief of Operator-(1)(24)(365)(8.00 $/hr)	70,100		
Receiving & Storage-(1/2)(8)(260)(7.00 $/hr)	7,300		
Supplies (20 percent of Operating Labor)	20,500		
Payroll Related Expenses(30 percent of Payroll)	36,900		
Subtotal Operating Costs		(8,900)	
Levelized Operating Costs (Using 10-Year Levelizing Factor of 1.335)			(11,900)
Total Levelized Annual Costs			$110,300

*Employs a 10-yr levelized fixed charge rate of 23 percent per EPRI Technical Assessment Guide.
**65 percent utilization of heating value.

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- Rotary kiln incinerator.
- Combustion chamber (afterburner), berms, and appurtenances.

The overall process flow for the preprocessing and combustion system is shown in Figure 6-21; a description of associated flow streams for utility boiler and cement kiln application are described in Tables 6-19 and 6-20, respectively.

The rotary kiln concept is state of the art for PCB vaporization and combustion. Its purpose in this system is primarily to separate PCBs from shredded capacitors, transformers, and other PCB-contaminated solids. The rotary kiln itself is not intended to destroy the PCBs, but is instead intended to serve as the primary combustion chamber with the boiler or coment kiln used as the afterburner.

The afterburners have a limited PCB combustion rate for reasons noted previously. The rotary kiln must be sized, therefore, so as not to exceed this rate in its exhaust. Because the volume of PCBs removed from the solids will vary with the source of the solid waste, the liquid PCBs are added to the rotary kiln along with the solids in order to stabilize the afterburner feed rate. These liquids also serve as fuel for the rotary kiln. The capability for direct injection of PCB liquids into the afterburner is included in the conceptual system, but is intended for secondary use.

The conceptual PCB solids/liquids preprocessing system is designed to accept the same proportion and type of waste materials as the integrated system which was presented previously in this chapter. Again using the limiting pure PCB injection rates of 350 lb/hr for boilers and 950 lb/hr for cement kilns, the system capacity can be computed by adjusting for the 21.5 percent chlorine content of the solid/liquid PCB blend.

The design heat release rate is computed as follows:

Total Heat Release Rate =

$$\text{Pure PCB Capacity} \times \frac{\text{Percent Cl in Pure PCB}}{\text{Percent Cl in Design Feed}} \times \text{Heating Value of Design Feed}$$

= (350 lb/hr) x (53/21.5) x (10,353 Btu/lb)

= 8.9×10^6 Btu/hr for the Boiler Preprocessing System.

A total design heat release rate of 24.2×10^6 Btu/hr was similarly computed for the cement kiln system.

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Table 6-19

FLOW STREAMS -- DESIGN FLOW RATES AND PROPERTIES (SYSTEM FOR BURNING SOLID/LIQUID PCBs INTO A UTILITY BOILER)

Description	Stream No.	Rate	Characteristics
Liquid PCB's and wash solvent to pump station	1	1.2 Bbls/hr	1:1 mixture w/w Aroclor 1254 and wash solvents in 55-gal. barrels.
Capacitors to shredder	2	286 lb/hr	Undrained capacitors
Empty barrels to shredder	3	61 lb/hr (1.2 Bbl/hr)	Empty 55-gallon barrels
Liquid feed kiln burner	4	117 lb/hr (13 gal/hr)	1:1 mixture w/w of Aroclor 1254 and wash solvent
Liquid feed to burner at combustion chamber of boiler	5	456 lb/hr (51 gal/hr)	Same as 4
Atomizing air to kiln burner and water nozzle	6	44 acfm	110 psig
Tempering water	7	716 lb/hr (86 gal/hr)	Water from any source--can be contaminated with PCB's.
Shredded capacitors and barrels to kiln	8	347 lb/hr	Shredded to 1½" size or smaller
Combustion air to kiln burner	9	281 acfm	110% of theoretical air for the burner at 10 in. H_2O
Infiltration at front seal	10	466 acfm	Combustion air (150% of theoretical air and 1800°F in kiln)
Infiltration at rear seal	11	255 acfm	Combustion air
Combustion gas from kiln	12	4726 acfm	200% of theoretical air and 1350°F
Ash to landfill	13	163 lb/hr	Steel and other inorganics
Combustion air to burner at the combustion chamber of boiler	14	1090 acfm	110% of theoretical air for the burner
Cold dilution air to mixing box at inlet to booster fan	15	2623 acfm	Cold (60°F) dilution air to mix with combustion gas from kiln
Combustion gases to combustion chamber of boiler	16	7343 acfm	To combustion chamber as overfire air in coal fired boiler--300°F

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Table 6-20

FLOW STREAMS -- DESIGN FLOW RATES AND PROPERTIES
(SYSTEM FOR BURNING SOLID/LIQUID PCBs INTO A CEMENT KILN)

Description	Stream No.	Rate	Characteristics
Liquid PCB's and wash solvent to pump station	1	3.3 Bbls/hr	1:1 mixture w/w Aroclor 1254 and wash solvents in 55-gallon barrels
Capacitors to shredder	2	770 lb/hr	Undrained capacitors
Empty barrels to shredder	3	166 lb/hr (3.3 Bbls/hr)	Empty 55-gallon barrels
Liquid feed to kiln burner	4	318 lb/hr (35 gal/hr)	1:1 mixture w/w of Aroclor 1254 and wash solvent
Liquid feed to burner at combustion chamber of kiln	5	1240 lb/hr (139 gal/hr)	Same as 4
Atomizing air to kiln burner and water nozzle	6	120 acfm	110 psig
Tempering water	7	1967 lb/hr (236 gal/hr)	Water from any source--can be contaminated with PCB's.
Shredded capacitors and barrels to kiln	8	944 lb/hr	Shredded to 1½" size or smaller
Combustion air to kiln burner	9	766 acfm	110% of theoretical air for the burner at 16 in H_2O
Infiltration at front seal	10	1276 acfm	Combustion air (150% of theoretical air and 1800°F in kiln)
Infiltration at rear seal	11	693 acfm	Combustion air
Combustion gas from kiln	12		200% of theoretical air and 1350°F
Ash to landfill	13	463 lb/hr	Steel and other inorganics
Combustion air to burner at the combustion chamber of the kiln	14	2964 acfm	110% of theoretical air for the burner
Cold dilution air to mixing box at inlet to booster fan	15	7132 acfm	Cold (60°F) dilution air to mix with combustion gas from kiln
Combustion gases to combustion chamber of the kiln	16	19,966 acfm	To fired end of kiln--500°F

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The capital costs of the solid/liquid PCB combustion systems are itemized in Table 6-21. The annual operating cost of the systems for boiler and cement kiln application are shown in Tables 6-22 and 6-23, respectively.

Summary of costs for PCB solids and/or liquids combustion in boilers and cement kilns. Table 6-24 presents a summary of capital, operating, and unit costs for PCB combustion in utility boilers and cement kilns based upon the conceptual systems discussed previously in this section.

PCB INCINERATOR PERMITTING AND APPROVAL PROCEDURES

Introduction

The requirements of the PCB regulations create additional costs and potential time delays above and beyond those normally encountered by any applicant for a hazardous waste disposal facility. The purpose of this section is to list the pertinent requirements of these regulations, and to discuss how they are being interpreted in practice.

The federal regulations (150) outline the procedures for obtaining approval to operate a PCB incinerator. The major steps required to obtain EPA approval are:

- Obtain state and local permits as required. Federal approval to operate a PCB incinerator will not supersede or replace these permitting requirements.
- Obtain an NPDES permit and prepare SPCC and ECC* plans. The approval to operate a PCB incinerator will not supersede or replace these requirements.
- Submit an initial report to the Regional Administrator.
- Notify local officials as required by the regulations.
- Obtain approval for a test burn and conduct the test.
- After final approval, maintain records and submit reports as required by the regulations.

*SPCC - Spill Prevention, Control, and Countermeasures.
ECC - Exposure and Contamination Control.

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Table 6-21

CAPITAL COST ESTIMATE FOR A SYSTEM TO BURN SOLID/LIQUID PCBs INTO A UTILITY BOILER OR A CEMENT KILN

	Installed Cost ($)	
	Utility Boiler (8.9×10^6 Btu/hr)	Cement Kiln (24.2×10^6 Btu/hr)
A--Receiving and storage	40,000	75,000
B--Barrel and capacitor shredding	117,700	117,700
C--Barrel pumping, liquid storage and feed pumps	40,300	73,500
D--Rotary kiln with ash removal system and burner	150,000	326,000
E--Combustion air blower	7,800	15,400
M--Instrumentation and controls	145,000	145,000
N--Laboratory	81,200	81,200
O--Offices, maintenance shop and change room	19,400	52,700
P--Groundwater, surface runoff and ambient air monitoring	30,000	30,000
R--Booster fan	6,900	9,900
S--Liquid burner	7,200	10,250
Permitting and test burn	55,000	55,000
Allowance for funds during construction (AFDC) (9 mo at 8 percent annual interest)	42,050	59,500
Total Capital Investment	$742,550	$1,051,150

MONS 028440

Table 6-22

ANNUAL OPERATING COST FOR A SYSTEM TO BURN
SOLID/LIQUID PCBs INTO A UTILITY BOILER

Item		Cost/Yr ($)	
Cost of Capital*			170,800
Maintenance (9 percent of capital investment*)		58,100	
Utilities		15,700	
Electric power [48 K 24)(310)] [0.025 $/Kw.hr]	= 8,900		
Fuel oil, No. 2 [19,4.0 gal] [0.35 $/gal]	= 6,800		
Solid Waste Disposal (163 lb/hr) (24) (310) (20 $/2,000 lb) (includes transport)		12,130	
Credit for heating value [(8.9)(24)(310)] [1$/mmBtu]		(66,200)	
Labor		200,900	
Plant supervisor (20 percent of labor)	= 23,600		
Lab technician (1)(8)(260)(7.00 $/hr)	= 14,600		
Chief operator (1/2)(24)(365)(8.00 $/hr)	= 33,000		
Operators (1)(24)(365)(7.00 $/hr)	= 61,300		
Receiving & storage (1/2)(8)(260)(7.00 $/hr)	= 7,300		
Supplies (20 percent of operating labor)	= 23,600		
Payroll related expenses (30 percent of payroll)	= 35,500		
Subtotal Operating Costs		220,630	
Levelized Operating Costs (using 10-yr Levelizing Factor of 1.335)			294,550
Total Levelized Annual Costs			$465,350

*Employs 10-yr levelized fixed charge rate of 23 percent per EPRI Technical Assessment Guide.

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Table 6-23

ANNUAL OPERATING COST FOR A SYSTEM TO BURN SOLID/LIQUID PCBs INTO A CEMENT KILN

Item		Cost/Yr ($)	
Cost of Capital*			241,750
Maintenance (9 percent of capital investment*)		84,300	
Utilities		43,000	
Electric power [130 kw(24)(310)] [0.025 $/kw·hr]	= 24,180		
Fuel oil, No. 2 [52,800 gal] [0.35 $/gal]	= 18,480		
Solid Waste Disposal (443 lb/hr)(24)(310)x (20 $/2,000 lb)		33,000	
Credit for heating value [24.2(24)(310)] [2.07/mmBtu]x [0.65†]		(242,300)	
Labor		379,920	
Plant supervisor	= 30,000		
Plant chemist	= 25,000		
Chief operator (1)(24)(365)(8.00 $/hr)	= 70,080		
Operators (2)(24)(365)(7.00 $/hr)	= 122,640		
Receiving & storage (1)(8)(260)(7.00 $/hr)	= 14,560		
Supplies (20 percent of operating labor)	= 46,456		
Payroll related expenses (30 percent of payroll)	= 71,184		
Subtotal Operating Costs		297,920	
Levelized Operating Costs (using 10-yr Levelizing Factor of 1.335)			397,700
Total Levelized Annual Costs			$639,450

*Employs 10-yr levelized fixed charge rate of 23 percent per EPRI Technical Assessment Guide.
†65 percent utilization of heating value.

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Table 6-24

SUMMARY OF INVESTMENT, COMBUSTION RATES, AND OPERATING COSTS FOR PCB COMBUSTION SYSTEMS

	Liquid/Solid		Liquid Only	
	Utility Boiler	Cement Kiln	Utility Boiler	Cement Kiln
Heat release, Btu/hr	8.9×10^6	24.2×10^6	8.9×10^6	24.2×10^6
Waste burned, lb/yr				
Capacitors	2.1×10^6	5.8×10^6		
Liquid PCBs	2.1×10^6	5.8×10^6	2.5×10^6	6.9×10^6
Wash solvents	2.1×10^6	5.8×10^6	2.5×10^6	6.9×10^6
Total	6.4×10^6	17.4×10^6	5.1×10^6	13.8×10^6
Capital Investment, $	742,550	1,051,150	432,850	531,200
Total Levelized Annual Costs	465,350	639,450	194,350	110,300
Cost per pound, $/lb	0.073	0.037	0.038	0.008

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Application Procedures

The application procedure and associated requirements are given under Annex I of the regulation, paragraph 761.40--Incineration, part d, item 1 as follows:

(d) Approval of incinerators. Prior to the incineration of PCBs, the owner or operator of an incinerator shall receive the written approval of the Agency Regional Administrator of the Region in which the incinerator is located. Such approval shall be obtained in the following manner:

(1) Initial report. The owner or operator shall submit to the Regional Administrator an initial report which contains:

(i) The location of the incinerator.

(ii) A detailed description of the incinerator including general site plans and design drawings of the incinerator.

(iii) Engineering reports or other information on the anticipated performance of the incinerator.

(iv) Sampling and monitoring equipment and facilities available.

(v) Waste volumes expected to be incinerated.

(vi) Any local, state, or federal permits or approvals.

(vii) Schedules and plans for complying with the approved requirements of this regulation.

The information required is similar to that of most permit applications, but it must specifically address all the requirements of the PCB disposal regulations as discussed at the beginning of this chapter.

The regulations allow the Regional Administrator to grant waivers under paragraph 761.40--Incineration, part d, item 5, as follows:

(5) Waivers. An owner or operator of the incinerator may submit evidence to the Regional Administrator that operation of the incinerator will not present an unreasonable risk of injury to health or the environment from PCBs, when one or more of the requirements of paragraphs (a) and/or (b) of this section are not met. On the basis of such evidence and any other available information, the Regional Administrator may in his discretion find that any such requirements are not necessary to protect against such risk, and may waive such requirements in any approval for that incinerator. Any such finding and waiver must be stated in writing and included as part of the approval.

If any controversy arises as a result of the public announcements, however, the administrator will not likely grant any waivers.

Each Regional Administrator has broad authority to expedite or delay approval of disposal facilities. State and local regulatory impediments, however, have been the predominant cause of delays in most cases to date.

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In each EPA region, a Site Approval Coordinator has been designated to handle all applications on the federal level. Regional Coordinators and available contacts are identified in Table 6-25.

Site Approval Coordinators are the primary government contacts for potential site operators. The site coordinators process all permit applications, and are responsible for ensuring operator compliance with all applicable regulations. Appendix D (PCB Disposal Facility Approval: Checklists) presents a summary of the guidelines which Site Coordinators will use to evaluate facility applications. The information contained in the checklists can be considered the minimum to be supplied for approval. As an alternative to conducting a full-scale investigation of each facility applying for PCB disposal approval, the Regional Administrator, through the site coordinator, can accept state certification as sufficient basis for federal certification. State certification is sufficient only when state standards are at least as restrictive as those promulgated on the federal level. Appendix F is a summary of the guidelines to be used by the Regional Site Coordinators when evaluating possible state certification of a PCB disposal facility.

The first round of PCB incinerator applications are still being processed, so the typical amount of time required to process an application is not yet known.

Test Burn

A PCB test burn will almost certainly be required following approval of the initial report. The pertinent regulations on the test burn are paragraph 761.40--Incineration, part d, item 2, as follows:

> (2) Trial burn. (i) Following receipt of the report described in subparagraph (1) of this paragraph, the Regional Administrator shall notify the person who submitted the report whether a trial burn of PCBs must be conducted. The Regional Administrator may require the person who submitted the report described in subparagraph (i) of this paragraph to submit such other information as the Regional Administrator finds to be reasonably necessary to determine the need for a trial burn. Such other information shall be restricted to the types of information required in (1) (i) through (1) (vii) above.
>
> (ii) If the Regional Administrator determines that a trial burn must be held, the person who submitted the report described in subparagraph (1) of this paragraph shall submit to the Regional Administrator a detailed plan for conducting and monitoring the trial burn. At a minimum, the plan must include:
>
> (a) Date trial burn is to be conducted.
> (b) Quantity and type of PCBs to be incinerated.
> (c) Parameters to be monitored and location of sampling points.
> (d) Sampling frequency and methods and schedules for sample analyses.

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Table 6-25

REGIONAL EPA, PCB SITE APPROVAL COORDINATORS AND FURTHER CONTACTS, REGIONAL EPA OFFICES

Regional EPA, PCB Site Approval Coordinators

Region	Name	Telephone Number
I	Dick Boynton	(617) 223-5775
II	Wayne Pierre	(212) 264-0505
III	Mike Pelenski	(215) 597-8116
IV	Jim Scarbrough	(404) 881-3016
V	Karl Klepitsch	(312) 353-2197
VI	Jim Sales	(214) 767-8941
VII	Morris Tucker	(816) 374-3307
VIII	Dr. Henry Schroeder	(303) 837-2221
IX	James Stahler	(415) 556-4606
X	Roger Fuentes	(206) 442-1260

Further Contacts, Regional EPA Offices

I	Bob Dangle	(617) 223-0585
II	Dr. Arthur Gibirtz	---
III	Bill Schremp	(215) 597-8116
IV	Ralph Jennings	(404) 881-3864
V	Jay Goldstein	(312) 353-2197
VI	---	---
VII	---	---
VIII	Ralph Larson	---
IX	---	---
X	James Everts	(206) 442-1090

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(e) Name, address, and qualifications of persons who will review analytical results and other pertinent data, and who will perform a technical evaluation of the effectiveness of the trial burn.

(iii) Following receipt of the plan described in subdivision (ii) of this subparagraph, the Regional Administrator will approve the plan, require additions or modifications to the plan, or disapprove the plan. If the plan is disapproved, the Regional Administrator will notify the person who submitted the plan of such disapproval together with the reasons why it was disapproved. That person may thereafter submit a new plan in accordance with subdivision (ii) of this subparagraph. If the plan is approved (with any additions or modifications which the Regional Administrator may prescribe), the Regional Administrator will notify the person who submitted the plan of such approval. Thereafter, the trial burn shall take place at a date and time to be agreed upon between the Regional Administrator and the person who submitted the plan.

(3) Other information. In addition to the information contained in the report and plan described in subparagraphs (1) and (2) of this paragraph, the Regional Administrator may require the owner or operator to submit such other information as the Regional Administrator finds to be reasonably necessary to determine whether an incinerator shall be approved.

Note--The Regional Administrator will have available for review and inspection an Agency manual containing information or sampling methods and analytical procedures for the parameters required in 761.40(a) (3), (4), (6), and (7) plus any other parameters he may determine to be appropriate. Owners or operators are encouraged to review this manual prior to submitting any report required in this Annex.

Paragraph 761.40--Incineration, part a, item 6, is also applicable to the test burn, and is shown as follows:

(6) Monitoring of stack emission products shall be conducted:

(i) When an incinerator is first used for the disposal of PCBs under the provisions of this regulation, and

(ii) When an incinerator is first used for the disposal of PCBs after the incinerator has been modified in a manner which may effect the characteristics of the stack emission products.

(iii) At a minimum, such monitoring shall be conducted for the following parameters: (a) O_2; (b) CO; (c) CO_2; (d) Oxides of Nitrogen (NO_x); (e) Hydrochloric Acid (HCL); (f) Total Chlorinated Organic Content (RCL); (g) PCB Chemical Substances; (h) Total Particulate Matter.

The items mentioned above refer to testing of the combustion exhaust gases. In addition, the scrubber water ash (if any) and ambient air will have to be sampled during the test and analyzed for PCBs.

Conducting a PCB compliance test burn is a major undertaking. One such test burn which has reached the final planning stages consists of a background burn without PCBs and then three successive days of testing with PCBs. The contract (with an outside firm) for test performance and written report preparation is for $55,000.

This does not include the costs incurred by the applicant while preparing for and conducting the test. It is expected to take a minimum of 1 mo to conduct the test and submit the report to the EPA.

Completion of a successful test burn alone does not guarantee issuance of a permit to operate. A period of public review and comment, which can be very lengthy, routinely follows submittal of the test burn report. There is also a possibility that more than one test burn may be required.

Figure 6-23 summarizes the entire site approval process, from the initial contact with EPA to the issuance of a permit. The latter stages of this protocol should be regarded as theoretical, since no facility has ever progressed past the trial burn stage.

Record-Keeping Requirements

One of the requirements for EPA approval of a PCB combustion facility is to keep a comprehensive record of operating conditions, amount of PCBs burned, and numerous other data. The requirements are given in paragraph 761.45--Records and Monitoring, parts b, c, and d, as follows:

> (b) Disposal and storage facilities. Beginning July 1, 1979, each owner or operator of a facility used for the storage or disposal of PCBs shall by July 1 of each year prepare and maintain a document which specifies the manner in which PCBs were handled at the facility during the previous calendar year. Such document shall be retained at each facility for at least 5 years after the facility is no longer used for the storage or disposal of PCBs, except that in the case of chemical waste landfills such documents shall be maintained at least 20 years after the chemical waste landfill is no longer used for the disposal of PCBs. Such documents shall be available at the facility for inspection by authorized representatives of the Environmental Protection Agency. If the facility ceases to be used for PCB storage or disposal, the owner or operator of such facility shall promptly notify the Agency Regional Administrator of the region in which the facility is located that the facility has ceased storage or disposal operations, and shall specify where the documents required to be maintained by this paragraph shall be located. The following information shall be included in each document:
>
> (1) The date when any PCBs are received by the facility during the previous calendar year for storage or disposal, and the identification of the person and facility from whom such PCBs were received.
>
> (2) The date when any PCBs are disposed of at the disposal facility or transferred to another disposal or storage facility, including the identification of the specific types of PCB chemical substances,

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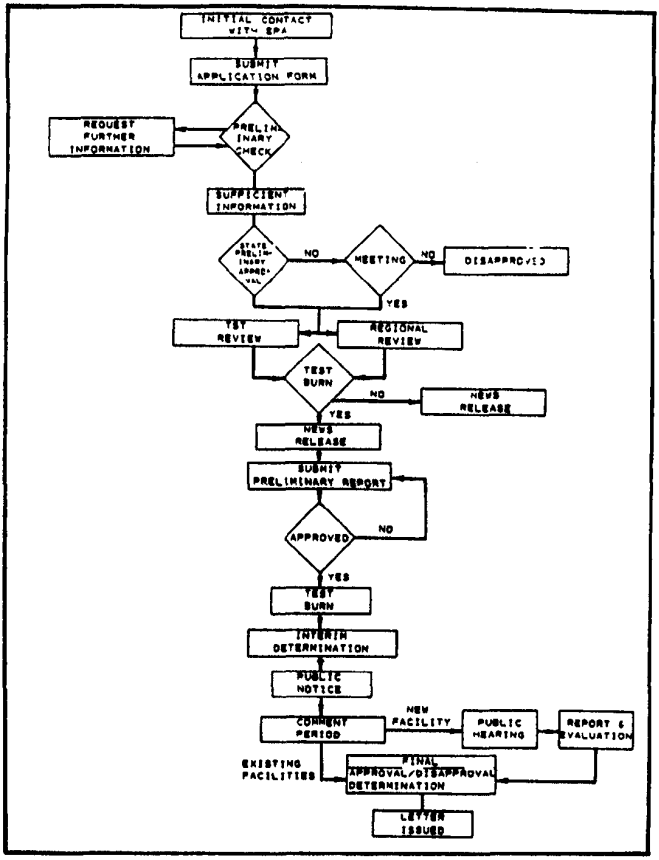

Figure 6-23. PCB Incinerator Approval Process

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PCB mixtures, or PCB articles in containers; PCB transformers; and PCB equipment or PCB articles not in containers which were stored or disposed of.

(3) Total weight in kilograms of any PCB containers and the total weight in kilograms of any PCB chemical substances or PCB mixtures contained in any PCB transformers, received during the calendar year, transferred to other storage or disposal facilities during the calendar year, and remaining on the disposal or storage facility site at the end of the calendar year, respectively, including, where applicable, the identification of PCB container contents such as liquids, capacitors, etc. When PCB containers or PCB chemical substances or PCB mixtures contained in a transformer are transferred to other storage or disposal facilities, the identification of the facility to which such PCBs were transferred shall be included.

(4) Total number of any PCB articles or PCB equipment, not in PCB containers, received during the calendar year, transferred to other storage or disposal facilities during the calendar year, and remaining on the facility site at the end of the calendar year, respectively, including the identification of the specific types of PCB articles and PCB equipment received, transferred, or remaining on the facility site. When PCB articles and PCB equipment are transferred to other storage or disposal facilities, the identification of the facility to which such PCB articles and PCB equipment were transferred must be included.

Note--Any requirements for weights in kilograms of PCBs may be calculated values if the internal volume of containers and transformers is known and included in the reports, together with any assumptions on the density of the PCB chemical substances or PCB mixtures contained in the containers or transformers.

(c) Incineration facilities. For each owner or operator of a PCB incinerator facility, the following information is required in addition to the information required in paragraph (b) of this section:

(1) When PCBs are being incinerated, the following continuous and short-interval data shall be collected and maintained for a period of 5 years from the date of collection:

(A) Rate and quantity of PCBs fed to the combustion system, as provided in Annex I-- 761.40(a) (3).

(B) Temperature of the combustion process, as provided in Annex I-- 761.40(a) (4).

(C) Stack emission products to include O_2, CO, and CO_2, as provided in Annex I-- 761.40(a) (7).

(2) When PCBs are being incinerated, data and records resulting from the monitoring of stack emissions as required in Annex I-- 761.40 (d) (2) shall be collected and maintained for 5 years.

(3) Total weight in kilograms of any solid residues generated by the incineration of PCBs during the calendar year, the total weight in kilograms of any solid residues disposed of by such facility in chemical waste landfills, and the total weight in kilograms of any solid residues remaining on the facility site shall be retained for 5 years.

(4) When PCBs are being incinerated, additional periodic data shall be collected and maintained as specified by the Regional Administrator pursuant to Annex I-- 761.40(d) (4).

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(5) A document shall be prepared on any suspension of the operation of any incinerator by the owner or operator thereof, as required in Annex I-- 761.40(a) (3). The document shall, at a minimum, include the date and time of the suspension and an explanation of the circumstances causing the suspension of operation. The document shall be sent to the appropriate Regional Administrator within 30 days of any such suspension.

(d) Retention of Special Records by Storage and Disposal Facilities. In addition to the information required to be maintained by paragraphs (b) and (c) of this section, each owner or operator of a PCB storage or disposal facility shall collect and maintain for the time period required in paragraph (c) of this section the following data:

(1) All documents, correspondence, and data provided to the owner or operator by any state or local government agency that pertain to the storage or disposal of PCBs at such facility.

(2) All documents, correspondence, and data provided by the owner or operator of such facility to any state or local government agency that pertain to the storage or disposal of PCBs at such facility.

(3) Any applications and related correspondence sent by the owner or operator of such facility to any local, state, or federal authorities in regard to wastewater discharge permits, solid waste permits, building permits, or other permits or authorizations, such as those required by Annex I-- 761.40(d) and Annex II- 61.41(c).

Conclusion

PCB disposal site permitting procedures are presently in an evolutionary mode. As more and more facility operators attempt to gain approval, the review process will be modified and reformulated to better meet the objective of the regulation.

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Section 7

TECHNOLOGY FOR LAND DISPOSAL OF PCB SOLIDS

BACKGROUND

There are several potential problems associated with land disposal of PCB solids. If improperly contained, the chemical could enter ground or surface water and become available for uptake by plant and animal life. Animals could also become exposed to PCBs directly at an improperly operated disposal site.

PCBs are among the most stable organic compounds known. The degradation of PCBs in the environment is extremely slow, particularly the higher chlorine isomers. Consequently, significant accumulation of PCBs has been found in soil near sites of PCB manufacture and use (132). Carey and Gowen (12) report that 63 percent of urban soils from 19 cities contain detectable levels of PCBs, primarily Aroclor 1254.

In a follow-up study of the distribution and fate of PCBs in soils and ground water after an accidental spill of transformer fluids, Moein, Smith, and Stewart (88) reported that chemical transformation and/or biodegradation did not effectively reduce Aroclor 1254 concentration in the contaminated soil and water. Similar results were reported by Itawa, Westlake, and Gunther (59). In a laboratory experiment, these researchers found after one year of treatment, 90 percent or more of Aroclor 1254 was recovered from four California soils, of which the organic matter, silt, and clay contents ranged from 1.4 to 19.5 percent, 25 to 40 percent, and 9 to 34 percent, respectively. PCBs may be lost from low organic sandy soil, primarily through volatilization.

In a comprehensive review on PCBs, Nisbet (96) reported that PCBs could last for at least 30 yr in anaerobic sediments.

The adsorption of PCBs by soil components increases as the number of chlorine atoms in the isomer increase. Hague and Schmedding (49) found that humic acid adsorbed 99 percent di-, tetra-, and hexachloro biphenyls, whereas for sand, the adsorption was very small for di- and tetrachloro isomers. Only the hexachloro isomer was adsorbed significantly on the sand. Illite clay and Woodburn soil (silt loam, 3.1 percent organic matter, 16.2 percent clay) were highly adsorptive for all three isomers with

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the hexachloro being adsorbed to a larger degree than di- and tetrachloro. The maximum desorption of PCBs from these adsorbents was less than 4 percent.

The solubility of PCBs in water is low, ranging from 0.025 mg/ to 0.2 mg/ , and decreases with increasing chlorine content (102, 54). PCB specific gravity ranges from 1.2 to 1.6 and also increases with increasing chlorine content (102, 54). These properties, coupled with the adsorption-desorption characteristics of PCBs, tend to reduce the potential of PCB migration into ground water. Leis, et al. (70), reported that PCB front-advance velocities were about two orders of magnitude slower than the ground water flow velocity. The observed rate of PCB movement into ground water is about one thousandth of the theoretical value calculated from Darcy's law.

PCB landfill site conditions must minimize off-site movement of PCBs. Consequently, EPA has instituted a special permit program to review and approve disposal sites for PCB solids. PCB solids are the only nonradioactive waste material so controlled by a federal agency. As a major user and disposer of PCB solids, the utility industry should:

- Understand the requirements for PCB solids disposal to land.
- Be familiar with the existing and proposed landfill sites for PCB solids disposal.
- Appreciate the steps necessary to initiate a new site for PCB solids disposal.

These, and other factors, as well as related economic considerations, are addressed in the following section.

CRITERIA FOR PCB DISPOSAL TO LANDFILL

Technical requirements for a PCB landfill are set forth in the EPA regulations of April 18, 1978 (150). These regulations and the types of PCB materials eligible for disposal on land are discussed in this section.

Technical Requirements for PCB Landfill

A landfill site used for the disposal of PCB materials must comply with the requirements listed below as specified by EPA in regulations issued April 18, 1978. However, when a site does not meet one or more of the requirements and evidence shows that their absence will not present an unreasonable risk of injury to health or to the environment from PCBs, EPA can grant a waiver.

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Soils. The landfill must be located in thick, relatively impermeable formations such as large-area clay pans. When this is not possible, the soil must have a high clay and silt content with the following characteristics:

- In-place soil thickness of at least 1.2 m (4 ft) or compacted soil liner thickness of 0.9 m (3 ft).
- Permeability of $\leq 10^{-7}$ cm/sec.
- Percent soil passing No. 200 sieve $\geq$30.
- Liquid limit $\geq$30.
- Plasticity index $\geq$15.

In addition, any membrane liners used must be at least 30 mil thickness.

Hydrology. The bottom of the landfill must be at least 15 m (50 ft) above the historical high ground water table. However, there is a proposed amendment that will reduce this requirement to 5 ft above the historical high watermark. There can be no hydraulic connection between the site and standing or flowing surface water. Flood plains, shore lands, and ground water recharge areas must be avoided.

Flood Protection. For landfills located below the 100-yr flood water elevation, the operator shall provide surface water diversion dikes around the perimeter of the landfill site with a minimum height equal to 60 cm (2 ft) above the 100-yr flood water elevation. If the site is above the 100-yr flood water elevation, the operator shall provide diversion structures capable of diverting all of the surface water runoff from a 24-hr, 25-yr storm.

Topography. The landfill must be located in an area of low to moderate relief that minimizes erosion and helps prevent landslides or slumping.

Monitoring Systems.

Water sampling:

- Ground and surface water from below and in the vicinity of the disposal site shall be sampled for baseline data purposes prior to receipt of PCB materials.
- Ground and surface waters shall be sampled at least once monthly when the landfill is being used for PCB disposal operations.
- Defined water sources shall be sampled indefinitely at a frequency of at least once every 6 mo after site closure.

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Ground water monitoring wells:

- If underlying soils are homogeneous, impermeable, and uniformly sloping in one direction, at least three ground water monitoring wells are required. These wells must be equally spaced on a line through the center of the disposal site and extending from the area of the lowest water table elevation.
- Monitoring wells shall be cased and the annular space cemented with portland cement to prevent percolation of surface water into the well bore. The well opening at the surface shall have a removable cap to provide access and to prevent entrance of rainfall or storm water runoff.

Water analyses:

- Water samples shall be analyzed for at least the following parameters: PCBs, pH, specific conductance, and total chlorinated hydrocarbons.

Leachate Collection. A leachate collection and monitoring system must be installed beneath the landfill, and the leachate must be monitored monthly for quality and quantity of leachate produced. Any leachate collected should be either treated to acceptable limits for discharge in accordance with a state or federal permit or disposed of by another state or federally approved method.

Chemical Waste Landfill Operations.

- PCBs must be handled in a manner to prevent damage to containers and must be segregated from wastes which are not chemically compatible with the PCB containers or the PCBs themselves.
- A site operations and disposal procedures plan must be submitted to EPA for approval.
- Records must be maintained for all PCB disposal operations and must include three-dimensional burial coordinates. The sources and dates of waste receipt should be recorded.

Supporting Facility.

- A 1.8-m (6-ft) fence must be provided around the perimeter of the site to prevent entry by unauthorized persons and animals.
- Access and on-site roads must be maintained in a safe condition.
- The site must be operated and maintained in a safe manner.

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PCB Materials Eligible for Disposal to Landfill

Table 7-1 indicates the types of PCB mixtures, articles, and containers eligible for landfilling before and after January 1, 1980. The paragraphs below define each category of PCB material.

PCB Mixtures. PCBs are defined as any mixture which contains 500 ppm (on a dry-weight basis) or greater of a PCB chemical substance.

PCB Articles. A PCB article is any manufactured item, other than a PCB container, whose surface(s) has been in direct contact with a PCB chemical substance. These articles include capacitors, transformers, electric motors, pumps, and pipes.

PCB Containers. PCB containers are packages, cans, bottles, bags, barrels, drums, tanks, or other devices used to contain a PCB chemical substance or PCB article. The surface(s) of a PCB container will have been in direct contact with a PCB chemical substance.

PROFILE OF EXISTING AND POTENTIAL PCB LANDFILLS

Promulgation of final EPA regulations for PCB disposal has discontinued PCB landfilling activities at many sites. In response to the new regulations, operators of several disposal sites applied to the appropriate EPA regional offices for approval to accept PCBs. Presently, seven land disposal sites have been approved for receipt of PCBs. Three additional sites are expected to be approved by late 1979.

In addition, regional EPA representatives indicate that many other sites are potentially capable of accepting PCBs, but have not filed a formal application with EPA. These potentially acceptable sites are primarily privately owned and operated, and have one or more of the following attributes:

- Meet California Class I (hazardous waste) landfill regulations or are permitted by other states to receive chemical and/or industrial wastes.
- Apparently meet EPA-specified technical requirements concerning soil, hydrological, and topographical characteristics, although the site is not presently permitted by the state for hazardous waste.

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Table 7-1

PCB CONTAMINATED MATERIALS ACCEPTABLE
FOR LAND DISPOSAL

Description of PCB Type	Eligible for Land Disposal After January 1, 1980
PCB Mixture Type	
• Non liquid PCB mixtures in the form of contaminated soil, rags or other solid debris	No
• Soil and solid debris contaminated with PCBs due to a spill or as a result of PCB placement in a disposal site prior to promulgation of final EPA regulations for PCB disposal (April 18, 1978)	Yes
• Dredged material and municipal sewage sludge that contain PCBs	Yes
PCB Articles	
• Those articles technically infeasible for incineration, such as drained and flushed transformers*	Yes
• Sealed capacitors	No
PCB Containers	
• Drained containers	Yes

* Written application to EPA is required for landfilling articles other than transformers.

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Existing Land Disposal Sites

The seven land disposal sites presently permitted by EPA to receive PCB materials are as follows:

- NEWCO Chemical Waste Systems, Inc., Niagara Falls, New York.
- SCA Chemical Waste Services, Inc., Model City, New York.
- Waste Management of Alabama, Inc., Sumter County, Alabama.
- Casmalia Disposal Company, Casmalia, California.
- Chem-Nuclear Systems, Inc., Arlington, Oregon.
- Wes-Con, Inc., Grand View, Idaho.
- Nuclear Engineering Company, Beatty, Nevada.

Complete descriptions of these sites are presented in Appendix I. Table 7-2 summarizes pertinent features of each facility.

Note that the sites are not well distributed. Utilities located far from these facilities must incur significant transportation costs to move PCB materials to acceptable land disposal sites.

Land Disposal Sites Awaiting PCB Permit Approval

Eight sites are being considered by EPA for approval of PCB disposal. These are as follows:

- SCA Services, Inc., Wilsonville, Illinois.
- A&F Materials Co., Hazel Dell, Illinois.
- Clermont Environmental Reclamation Co., Williamsburg, Ohio.
- Rollins Environmental Services, Inc., Baton Rouge, Louisiana.
- Kansas Industrial and Environmental Services, Inc., Wichita, Kansas
- Chem-Dyne, Inc., Wright City, Missouri.
- Warren County, North Carolina
- Scientific Laboratory, Los Alamos, New Mexico

The SCA Services' landfill in Wilsonville is currently under court order to close due to local citizen opposition to truck movement through the community.

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Table 7-2

OVERVIEW OF EXISTING LANDFILLS PERMITTED FOR DISPOSAL OF PCB MATERIALS

EPA Region	Facility Location	Facility Type	Operating Agency/ Person to Contact	Existing Available Capacity	Gate Charge $/t	Gate Charge $/m³	Gate Charge $/drum
II	Model City, NY	Secure landfill	SCA Chemical Waste Services, Inc. Mr. S. Odojewski (716) 754-8231	35,500 m^3	---	388	80
II	Niagara Falls, NY	Secure landfill	NEWCO Chemical Waste Systems, Inc. Mr. D. Cattieu (716) 278-1811	26,600 m^3	---	ND*	ND*
IV	Sumter Co., AL	Landfill	Waste Management of Alabama Mr. M. Gregory (205) 652-9340	34,000 m^3	---	ND*	ND*
IX	Casmalia, CA	Landfill	Casmalia Disposal Mr. K.H. Hunter, Jr. (805) 969-4703	2.2 ha	165	---	---
X	Arlington, OR	Landfill	Chem-Nuclear Systems, Inc. Mr. F. Dement (503) 454-2777	1,278 m^3	---	137	28.5
X	Grand View, ID	Missile silos	Wes-Con, Inc. Mr. G. Rinebold (208) 734-7711	3,209 m^3	130	---	---
IX	Beatty, NV	Landfill	Nuclear Engineering Co. Mr. Steve Carpenter (702) 553-2203	NA	ND*	ND*	ND*

*ND = not disclosed

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Descriptions of three of these sites are presented below. Operators of the five other potential sites declined to provide similar information; thus, the information was not available for publication.

Hazel Dell, Illinois, Site.

Site description. The A&F Material Company landfill site (AF site) is located in Hazel Dell (Cumberland County), Illinois. The company headquarters' address is 104 Pine Street, Hazel Dell, Illinois 62430 (telephone [217] 932-2388).

The AF site occupies 55 ha (135 ac), 49 ha (120 ac) of which are suitable for landfilling. Disposal operations began in 1976. A site life of 35 yr is expected. The site accepts liquid and solid chemical wastes except pesticides, cyanide, and waste containing high concentrations of arsenic and mercury. No PCBs have been received. Presently, less than 300 m^3 (10,600 ft^3) of waste materials are received daily.

Status of approval for PCB disposal. Company management has applied to EPA Region V for approval of PCB disposal and expects a final decision from the EPA Regional Administrator by late 1979.

Wichita, Kansas, Site.

Site description. The Wichita, Kansas, landfill site is located approximately 19 km (12 mi) northeast of Wichita. It is owned and operated by Kansas Industrial and Environmental Services. The company headquarters' address is P.O. Box 745, Wichita, Kansas 67201 (telephone [316] 744-1286).

The Wichita site currently occupies 32 ha (80 ac). Addition of another 32 ha (80 ac) is planned. A wide range of chemical wastes is accepted.

Some PCB materials have been deposited here. Prior to the April 18, 1978, promulgation of EPA final regulations for PCB materials, the site was permitted for PCB disposal by the Kansas State Department of Health and Environment. About 7 m^3 of the 0.5 million m^3 of total chemical wastes received to that date were PCBs.

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The company has proposed PCB containment instead of landfilling. A series of 3 m x 3 m x 15 m (10 ft x 10 ft x 50 ft) underground vaults would be constructed. Each vault would have 30-cm (12-in) thick steel-reinforced concrete floors and 20-cm (8-in) thick walls of the same construction material. No leachate collection system would be required for this disposal method. An area of 3720 m^2 (40,000 ft^2) at the site has been set aside for PCB containment.

The site is underlain by silty clay and Wellington shale. Soil permeability ranges from 3 x 15^{-8} to 2 x 15^{-9} cm/sec and its plasticity index varies from 20 to 25. There are no surface water bodies in the surrounding area. Ground water is 23 m (75 ft) deep in the western and 11 to 12 cm (35 to 40 ft) deep in the eastern portions of the site. Annual precipitation and evaporation are 98 cm (39 in) and 104 cm (41 in), respectively.

Status of approval for PCB disposal. The company has applied to EPA Region VII for approval of PCB disposal in the concrete vaults. A final decision from the EPA Regional Administrator is expected by late 1979. Public awareness of site operations has not spawned opposition to date. It is expected that little or no public opposition to PCB containment at this site will occur.

Wright City, Missouri, Site.

Site description. Bob's Home Service Landfill is located at Wright City, Missouri, approximately 48 km (30 mi) west of St. Louis. The site owner and operator is Chem-Dyne, Inc., located at Route Box 116 F-1, Wright City, Missouri 63390 (telephone [314] 745-3711).

Bob's Home Service Landfill occupies 61 ha (150 ac). Landfill activity is currently concentrated in a 5-ha (12-ac) area, and another 16 ha (40 ac) of land are being prepared for operation. The site opened in July 1977 and operates all year.

Approximately 18,200 kg (40,000 lb) of chemical wastes are received daily. PCB materials had been received until April 18, 1978. Company management expects to accept 54,500 kg/d (120,000 lb/day) of PCB-contaminated materials after the appropriate permits are granted. The gate charge for PCBs will vary from $50 to $60 per 55-gal drum, subject to change depending upon EPA permit conditions.

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The base of the landfill is a clay soil with very low permeability (10^{-10} cm/sec). The nearest surface water body is a recreational lake about 5 km (3 mi) from the site. Ground water is 61 m (200 ft) deep. Annual rainfall, snowfall, and evaporation are 90 cm (35 in), 44 cm (17 in), and 76 cm (30 in), respectively.

Status of approval for PCB disposal. Bob's Home Service has filed for approval of PCB disposal with EPA Region VII office. The application review process is still in its early stages. Residents in the local community are aware of the site's existence and its activity, but no major objection has been raised.

Potential PCB Landfill Sites

As noted earlier, EPA representatives are aware of several landfill companies that are either considering offering PCB disposal services or that could qualify for such a permit.

Table 7-3 presents relevant information on these sites. Note that these facilities either have not filed a formal application with the EPA office or have withdrawn their application. Company representatives cite one or more of the following reasons for their hesitance to submit an application at this time:

- Public acceptance is unknown. The PCB site application may focus public attention on other hazardous waste disposal activities and jeopardize a major part of their existing business.
- Preparation to meet EPA criteria is relatively costly in relation to the undefined PCB wastes volumes that would be received.
- Profit potential is uncertain because many PCB materials are acceptable for land disposal only until January 1, 1980.

CONCEPTUAL DESIGN AND ESTIMATED COST FOR A PCB LANDFILL

A conceptual landfill design is presented in this section. This design can be used as a planning tool for those who may consider implementation of a new landfill as a disposal alternative for PCB materials. However, the conceptual design does not provide all necessary information to completely design and manage a land disposal facility for PCB materials.

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Table 7-3

LANDFILL SITES POTENTIALLY ACCEPTABLE FOR PCB MATERIAL DISPOSAL

EPA Region	Location	Operator	Area	Waste Received	Site Conditions / Geology	Precipitation/Evap.	
II	Bridgeport, NJ	Richard Sernyak Rollins Environmental Services, Inc. (609) 467-3100	NA	NA	NA	NA	NA
V	Sheffield, Il 3 km (2 mi) south of Interstate 80, 24 km (15 mi) west of Interstate 180	Richard Orenderff Nuclear Engineering Co., Inc. P. O. Box 158 Sheffield, Il 61361 (815) 454-2624	16 ha (40 ac)	Industrial , hazardous. PCBs before 4-18-78 Opened 1977.	Clay[1]	86 cm (34 in)	102 cm (40 in)
VI	Robstown, Tx Southern Tx, 16 km (10 mi) from Gulf of Mexico	Cliff Chandler Texas Ecologists, Inc. Subsidiary of Nuclear Engineering Co., Inc. Robstown, Tx. (512) 387-3518	97 ha (240 ac)	Industrial,, hazardous PCBs before 4-18-78. Site life: 30 to 40 yr.	11 m clay stratum[2]	80 cm (34 in)	127 cm (50 in)
VI	Deer Park, Tx	Jack Lurcott Rollins Environmental Services Inc. (302) 658-8451	NA	NA	NA	117 cm (46 in)	190 cm (75 in)
VI	Baton Rouge, La	Jack Lurcott Rollins Environmental Services, Inc. (302) 658-8541	NA	NA	NA	150 cm (59 in)	165 cm (65 in)
VII	Andrew County, Mo 10 km (6 mi) north of St. Joseph, Mo.	Clay Bruntrock Wheeling Disposal Service Co., Inc. P. O. Box 104, Station A St. Joseph, Mo. 64503 (816) 279-2815	81 ha (200 ac)	Municipal, industrial, Chemicals, PCBs before 4-18-78 Opened 1970.[3]	7.6m clay (permeability 10-7 to 10-9 cm/sec) 11 m to gw.	137 cm (54 in)	140 cm (55 in)

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Table 7-3 (continued)

EPA Region	Location	Operation	Area	Waste Received	Site Conditions Soils/Hydrology	Percipitation/Evap.	
VII	Kansas City, Ks	Steve Montee Browning Ferris Industry (913) 2810343	NA	NA	NA	NA	NA
IX	Solano County, Ca Benicia, Ca, off Lake Herman Road	Tom Melchtry IT Environmental Corporation 4575 Pacheco Blvd Martinez, Ca 94553	114 ha (281 ac)	Liquid and solid industrial waste. Opened 1969 Site life: 50 yr.	No data available	76 cm (30 in)	NA
XI	West Covina, Ca 4.6 km (3 mi) north of Pomona Freeway	Leonard Tinman BKK Corporation 3031 E. First St. Wilmington, Ca 90748 (213) 775-3607	236 ha (583 ac)	Industrial waste PCBs before 4-18-78 remaining Site life: 30 yr	Class I (41 ha) Class II (195 ha)	37 cm (15 in)	152 in (60 in)
X	Bruneau, Id 32 k. (20 mi) south of the City of Bruneau. (known as the Bruneau "A" site)	Gene Rinehold West-Con, Inc P. O. Box 564 Twin Falls, Id 83301 (208) 734-7711	41 ha (100 ac)**	None yet plans: begin accepting in- dustrial waste by late 1978.††	Impermeable breccia, 760 m (2500 ft) to gw. snake River 32 km n. of site	25 cm (10 in)	157 cm (62 in)

Note: No formal permit applications have been submitted to EPA by owners of these sites and/or the application was withdrawn.
*=Except sodium and potassium substances.
†=No ground water (gw) or other hydrological information available.
/=Wheeling Disposal Service expresses no interest in applying for a PCB disposal permit.
**=This site is a former missile launch complex, consisting of below grade silos.
††=Wes-Con plans to request PCB disposal permit.
NA=Not Available

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There is no correct or "typical" land disposal facility design for PCB materials. However, the basic design features (e.g., disposal cell, leachate collection system, operational controls) are generally similar for most existing sites. The description below is of a hypothetical site and is presented for example purposes only. Pertinent design, construction, and operational features required for a PCB disposal site are included. Users of the conceptual design can identify differences between the hypothetical example site and corresponding characteristics of their actual site, and the technical and economic factors in the conceptual design can be adjusted to reflect site-specific conditions.

This conceptual site design is based on a synthesis of data obtained from various sources, including published literature, EPA regulations, interviews with EPA regulatory personnel, visits to six existing facilities, and related background information.

Basis for Design

The basic management objective for the conceptual design is assumed to be as follows:

- Disposal of PCB-contaminated materials to the land such that all wastes are contained. Potentially adverse environmental effects on local ground and surface waters are to be prevented.

Establishment of specific site selection and design criteria is necessary to assure that this management objective is met.

Site Design Criteria. A land disposal facility for PCBs must:

- Comply with state regulations for a chemical waste landfill facility and EPA regulations for PCB disposal.
- Be constructed such that environmental and aesthetic impact potentials are minimized.
- Be compatible with existing and proposed uses of nearby land.

Site Selection Criteria. Use of site well suited for hazardous waste land disposal is necessary for positive containment of PCB materials. The primary factors to consider in judging a site's suitability for PCB land disposal are as follows:

- Hydrogeology.
- Topography.

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- Local ecology.
- Land use.
- Climate.

Table 7-4 describes those attributes which must be considered in PCB disposal site selection. Ideally, evaporation should exceed precipitation; however, if a site must be located in a net precipitation area, design features can normally control excess moisture. The range of values for each site attribute considered to be acceptable and unacceptable as well as the ideal attributes for a PCB waste disposal site are indicated. Unacceptable conditions are those that would preclude the use of the site because of unavoidable environmental, social, and/or economic limitations. Acceptable conditions are those that will provide for a workable and environmentally safe site. Sites that are not naturally amenable for PCB disposal may be improved by proper design.

Note that site selection criteria such as those presented in Table 7-4 can be used to screen and rank alternative disposal sites. The degree to which each alternative site meets (or exceeds) the basic criteria can be designated numerically to provide a basis for ranking.

For the purposes of this conceptual example, it is assumed that a specific site has already been selected and that the ideal site selection criteria can be satisfied. In addition, the selected site has the following features:

- The site is situated in a relatively wet area, with an annual precipitation of 127 cm (50 in) and evaporation of 114 cm (45 in).
- Terrain at the site and in the surrounding area is relatively flat, with slopes ranging from 2 to 5 percent.
- On-site soils have a high clay content.

It is generally necessary to investigate subsurface conditions at a site to confirm that the hydrogeological features are indeed suitable for PCB disposal. Exploratory borings may be cased and used later for monitoring wells if the site is subsequently activated.

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Table 7-4

SITE SCREENING CRITERIA

Parameter	Minimum Acceptable Condition	Ideal
Soil	• Permeability of at most 1 x 10^{-5} cm/ sec. • At least 3.4 ft in situ. (<1.4 x 10 cm/sec overlayed) Class I or II agricultural soils.	• <1 x 10^{-7} cm/ sec .730% soil # 200 sieve o in situ >3.1m (10 ft), o liquid limit >30. • plasticity index >15.
Slope	• No deep gullies, slope of no more than 15%.	10%
Surface Water	• At least 92m (300 ft) from any pond or lake used for recreational or livestock purposes, or any surface water body officially classified under state law. • Outside special flood hazard areas or recognized wetlands. • Outside the limits of a 100-yr flood.	• >61m (>1000 ft) from any surface water body. • >61m (>200 ft) from intermitten streams. • Outside the limits of a 100-yr flood.
Bedrock	• At least 9.2 (30 ft) from highly fractured rock or carbonates, and 3.1 m (10 ft) from all other rock.	• >15.3m (>50 ft) deep.
Ground Water	• Closer than 3.1m (10 ft) to ground water, wells tapping shallow aquifers, closer than 305m (1000 ft) to any water supply well.	• >15.3m (>50 ft) deep bedrock wells or no wells within 610m (2000 ft) radius. Flow towards site. Corresponding criteria.
Committed Land	• At least 305m (1000 ft) from parks, cereteries, residential areas, historic sites, etc.	• >457m (1500 ft) away
Biologically Sensitive Areas	• No endangered plant or animal habitats, unique or regionally significant environments.	• No woodlands or locally significant features.

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Site Area and Volume Requirements. The volumes and types of PCB-contaminated materials to be disposed of on land must be estimated as a first step in determining site area and capacity requirements.

The hypothetical site is operated by a utility and receives all PCB-contaminated materials from other utilities and generators in the region. An estimated 93,800 m^3 (3.31 million ft^3) of PCB-contaminated materials would require land disposal at the hypothetical site.

The landfill space utilization efficiency is poor for PCB-contaminated wastes because the waste components vary in size and cannot be compacted. (Regulations prohibit crushing of PCB solids to minimize undue exposure of liquid PCB.) A site volume capacity significantly greater than the projected waste loading is therefore required.

Experience with PCB landfills suggests that fill efficiencies range from 40 to 77 percent. Figure 7-1 shows the expected site volume requirements as a function of waste volume for this range of fill efficiencies.

A 50 percent fill efficiency is assumed for the hypothetical site. Thus, approximately 200,000 m^3 (7.06 million ft^3) of site disposal capacity is required for the example site. Based on an assumed fill depth of 10 m (33 ft), approximately 2 ha (5 ac) of site surface area are required for disposal purposes. An additional 3 ha (7.4 ac) are assumed to be required for support functions, including office and storage buildings, on-site access, drainage facilities, and a 60-m (200-ft) buffer zone around the active portion of the site.

Site Planning and Design

After a site is selected, an engineering development plan is prepared. This plan generally consists of drawings, written specifications, and an accompanying report. Location and design of waste disposal cells, drainage facilities, access roads, leachate control facilities and other design considerations are included. Results of geophysical investigations, procedures to procure site permits, recommendations for equipment purchase, and a description of recommended operational procedures are also an integral part of site planning and design efforts. The design report may also include recommended procedures for implementing a public information and education program.

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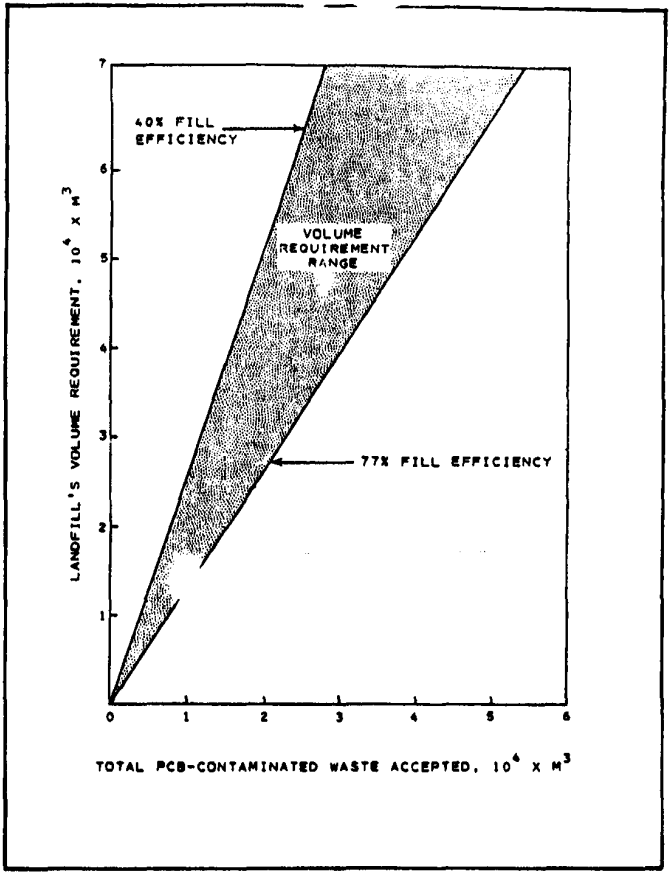

Figure 7-1. Volume Requirements for a PCB Landfill

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Figure 7-2 shows an artist's concept of the hypothetical site layout. For the final design several plan and cross-section drawings would be provided showing intended site features at various phases in the future. Details such as site preparation procedures, location of utilities and fences, and fill cell construction methods would be included. These and other site design considerations are discussed below.

Site Preparation. A disposal site is generally prepared by clearing shrubs, trees, and other obstacles that would hinder vehicle travel and landfilling operations. Obstructions such as boulders are moved to facilitate construction of buildings, roads, utilities, and drainage structures.

Clearing and grubbing. Trees and brush that hinder landfill equipment or trucks will be removed. Brush and tall grass in working areas can be rolled over or grubbed. When possible, natural stands of trees or brush will be left in nonworking areas to improve appearance and to control erosion and dust in yet-to-be-filled areas.

Access road. An all-weather access road will be provided from existing arteries to the site. This road will be designed to safely accommodate the anticipated volume of vehicular traffic. An access road usually has two lanes of sufficient width and strength to carry the expected delivery vehicle load (Figure 7-3). Access road grades will be a maximum 6 percent to 8 percent. Their intersection with the existing public road will be designed to reflect traffic volumes and safety requirements.

It is assumed that the on-site access road will be approximately 1.6 km (1 mi) and will terminate at the delivery control facility. Temporary unpaved roads will be utilized for transporting wastes from this point to the unloading area. Temporary roads will be constructed of on-site soil with a topping of suitable material (e.g., gravel, crushed aggregate, cinders, broken concrete, or demolition wastes). Lime, portland cement, or asphalt may be used as binders to maintain stability of the roads and to control dust. Asphalt is to be used at the example site.

Buildings. A shelter to maintain and house equipment used at the site will be provided. Part of this structure can serve as an office (alternatively, a trailer can be used for office space). Appropriate sanitary facilities, first-aid station and emergency shower facilities are required and will be provided for site employees and users.

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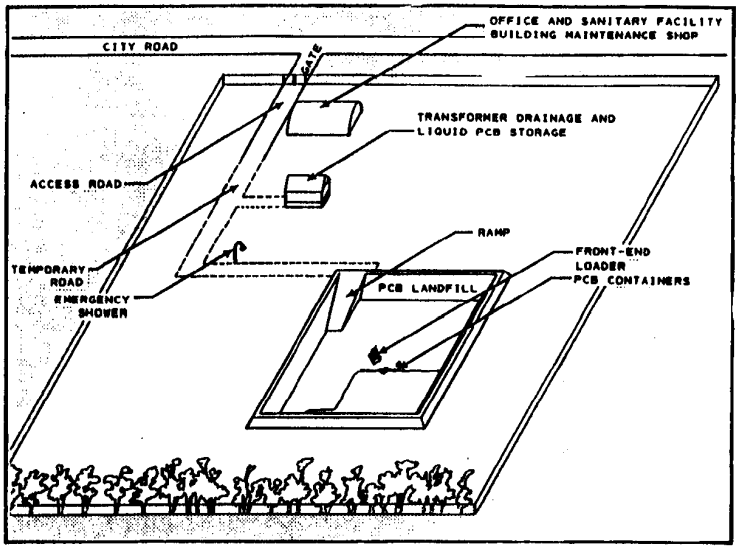

Figure 7-2. Artist Concept of PCB Landfill

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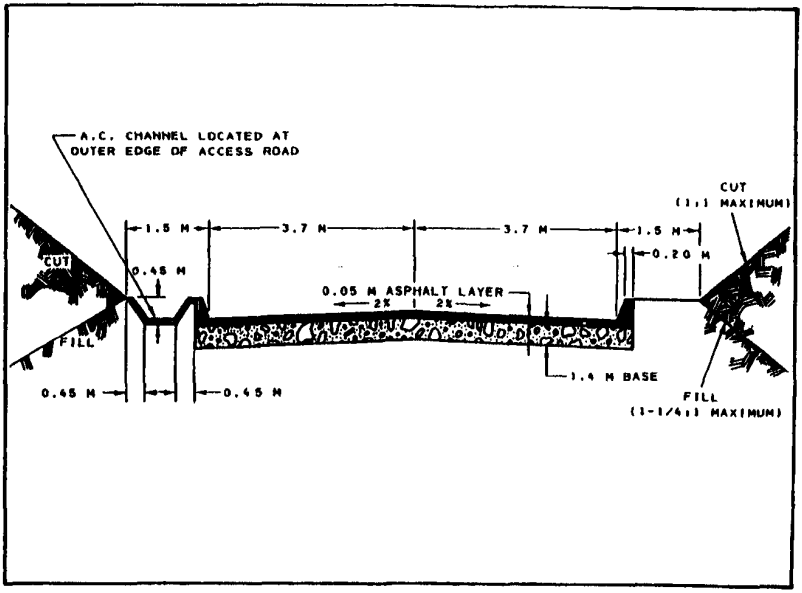

Figure 7-3. Landfill Access Road

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EPA requires that transformers must trained and flushed prior to landfill disposal. For the purpose of this cc ptual design, it is assumed that this activity will take place at the disposal site. It is also possible to establish a transformer drainage facility at a utility or at a separate transfer location near several utilities. However, a separate permit must be obtained for such a facility. A building is included for transformer draining and flushing and for rinsate storage. The building will be enclosed to prevent precipitation from contacting the stored PCB rinsate. The floor is to be constructed with a continuous smooth surface and be of impervious materials to minimize penetration of PCB chemical substances or mixtures. A continuous 15-cm (6-in) curbing will encircle the building for containment of any spills.

Hypothetical building floor space requirements for the example site are as follows:

- Office - 54 m^2 (600 ft^2).
- Equipment storage/maintenance - 140 m^2 (1560 ft^2).
- PCB draining/storage - 54 m^2 (600 ft^2).

Utilities. A PCB landfill site should be provided with power, water, and telephone. Power is required for maintenance of on-site operating equipment and for lighting. An electric generator (7-½ kW) will be installed rather than extend power lines to the site. Water in sufficient quantities and under adequate pressure is needed in the event of fire, for equipment maintenance, and for dust control. Potable water should be made available for site personnel. A 38,000-liter (10,000-gal) elevated storage tank will be provided at the site. Water to fill the tank must be periodically hauled to the site and pumped into the tanks. A two-way radio will be provided for communications in place of installing telephone lines to the site. Communications are particularly important at a PCB landfill to call in emergency services in the event of an accident or a fire.

Fencing. Fences are used to prevent trespassing by unauthorized persons. A 1.8-m (6-ft) high chain link fence topped with three strands of barbed wire projecting at a 45° angle will be installed around the 4-ha (10-ac) site periphery. An 8-m (26-ft) gate will be provided a he entrance and be closed and locked when the site is unattended or otherwise closed to users. Signs will be posted, warning that hazardous chemicals are present and unauthorized entry is prohibited.

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Drainage facilities. Drainage facilities are required to divert all off-site surface water runoff around the site. Also, drainage structures are needed to rapidly divert on-site runoff away from disposal operations. Drainage structure requirements depend on off-site and on-site topographic characteristics, the size of the site, and other factors.

Drainage structures are typically constructed of half-round corrugated metal pipe (CMP) channels, earth berms and channels, and asphalt concrete (AC) lined channels. The terrain of the example site and of the surrounding area suggests that a 76-cm (30-in) half round CMP channel around the periphery of the site would be adequate to divert off-site surface drainage. Earth berms and channels will be used to control on-site surface waters.

Equipment. The following equipment will be used at the example disposal site:

- 1 forklift.
- 1 front-end loader.
- 1 track dozer.
- 1 water truck.
- 1 pickup truck.

A scraper would be required if cover soil must be hauled long distances (over 100 m or 330 ft) or when one dozer alone cannot efficiently excavate trenches and spread cover soil. It is assumed that conditions at the example site do not warrant a scraper.

Landfill construction. Construction of a PCB landfill would typically involve the following steps: cell excavation, installation of a membrane or admix liner and internal leachate collection system, and placement of drainage facilities and ground water monitoring wells.

Cell excavation. Excavation at the hypothetical site must be such that the disposal cell floors are greater than 15.3 m (50 ft) from maximum ground water elevations, the distance stipulated by EPA regulations. As noted, it has been assumed that the site meets the ideal conditions.

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For illustrative purposes, it is further assumed that maximum ground water elevation is 18.3 m (60 ft) below surface grades at the hypothetical site. Thus, cell excavation can be only 3 m (10 ft) below grade. Additional cell capacity to yield a full depth of 10 m (33 ft) must be provided above grade by constructing berms of compacted soil around the excavation. Figure 7-4 depicts the disposal cell construction.

Disposal cell plan dimensions will be 60 m x 90 m (200 x 300 ft) with side slopes at 2:1 horizontal to vertical. The cell's perimeter berm will also serve to divert surface runoff away from the disposal area to adjacent collection ditches.

Note that deeper ex. ,tions would be possible if ground water were appreciably lower or absent or if ground water were under strong piezometric pressure.

Liner design and installation. It is assumed that most soils at the site meet the 10^{-7} cm per sec permeability requirement. However, some deposits of more permeable soils were found. Thus, EPA has stipulated use of a man-made liner at the example site to further ensure ground water protection. A 30-mil hypalon membrane liner is to be placed so that it completely covers the bottom and sidewalls of the cell. The liner integrity will be protected from mechanical damages by a 60-cm (2-ft) thick compact clay soil layer.

Leachate collection system. Leachate production is probable at this site because precipitation exceeds evaporation. Thus, a system to collect leachate that accumulates above the liner will be provided. The system is composed of 40 m (130 ft) of 15-cm (6-in) perforated vitrified clay pipe situated along the low end of the cell within the PCB landfill. The cell bottom will be graded at 1 to 2 percent slope toward the collection line. Access to the collection line is provided by two 25-m (82-ft) leachate standpipes installed against the sidewall of the fill. This sloped standpipe design would facilitate movement of fill machinery and minimize the possibility of mechanical damage to the pipes.

For arid areas where precipitation is low and much less than evaporation, a leachate collection system may be unnecessary, provided that surface drainage facilities are maintained.

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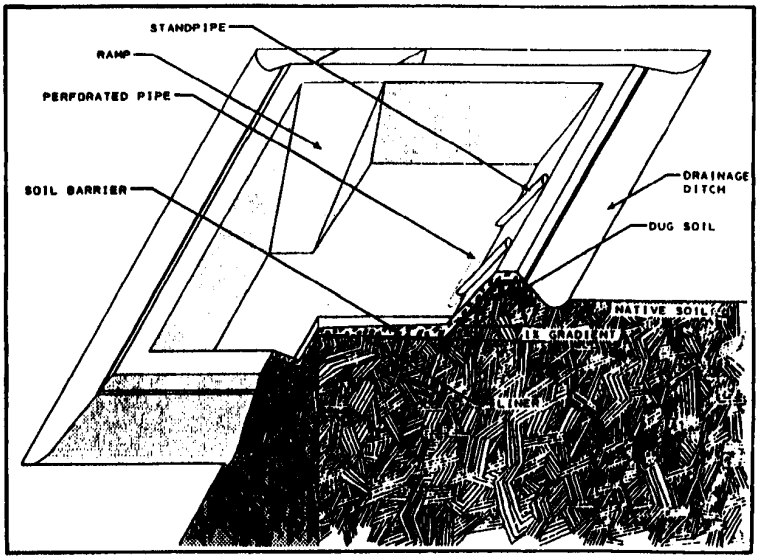

Figure 7-4. PCB Disposal Cell Construction

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Estimated Cost of PCB Landfill Development

The conceptual design provides a basis for estimating capital and operating costs for implementing a new PCB landfill. This estimate is presented below. In addition, costs are presented for sites of half and twice the capacity of the basic conceptual design.

Capital Cost for Conceptual Design. Table 7-5 summarizes the capital costs associated with development of a PCB landfill. Major capital cost elements are land, site preparation and construction, site planning and design, and equipment.

Operation and Maintenance Costs for the Conceptual Design. Operation and maintenance costs for the example site are estimated to be $38,400 annually, as shown in Table 7-6. Operation and maintenance costs include those costs associated with daily disposal of incoming waste and other actions required in maintaining a clean, environmentally safe, aesthetically pleasing, and efficient operation. The principal operating cost elements are personnel, equipment operating expenses (e.g., gas and oil, and repair), cover soil excavation and haul costs, general site maintenance (e.g., repair of drainage facilities), and administration and overhead. Costs to monitor ground water wells are also included.

Note that costs to transport PCB wastes from points of generation to the disposal site are not included here. Transportation costs are reflected in the discussion of PCB disposal system selection (Chapter VIII).

Estimated Cost for Sites of Other Capacities. Table 1-10 shows the estimated costs for implementing PCB disposal sites that receive twice and one-half the PCB wastes of the example site, respectively. Figure 7-5 depicts this information graphically.

Note that the unit costs for operating a relatively small site are significantly greater than for the larger sites. Such economies of scale are common for land disposal facilities. Basic equipment items and personnel must be assigned to any size of site, but utilization is not as efficient at smaller sites.

PCB LANDFILL APPROVAL PROCEDURES

A specific procedure has been established by EPA to expedite the review of permit applications. Each EPA Regional office is empowered to review applications from prospective site owners and operators within the Region. Permits for PCB land disposal facilities are granted or derived by the Regional Administrator based on

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Table 7-5

CAPITAL COST ESTIMATES FOR THE EXAMPLE SITE

Item	Life Span (yr)	Unit Cost	Quantity	Cost*	Levelizing Factor	Levelized Annual Cost
1. Land Procurement/ha	40	10,000	5	50,000	.18	9,000
2. Planning and Design	40	75,000	1	75,000	.18	13,500
3. Clearing and Grubbing/ha	40	2,000	2.5	5,000	.18	900
4. Access Roads/m						
A. Permanent	20	65.50	1,615	105,800	.19	20,102
B. Temporary	10	19.80	200	3,920	.23	902
5. Drainage Structures						
A. 30-in 1/2 round CMP/m	20	75	600	45,000	.19	8,550
B. Earth walls/m	40	2.20	240	530	.18	95
C. Debris basin/ea	40	3,000	1	3,000	.18	540
6. Fencing/m	20	50	800	40,000	.19	7,600
7. Buildings/m^2						
A. Office	40	444	54	24,000	.18	4,320
B. Maintenance/storage	40	289	140	40,500	.18	7,290
C. PCB Storage	40	289	54	15,600	.18	2,808
8. Utilities						
A. Electric Generator	10	4,000	1	4,000	.23	920
B. Communications Equipment	10	500	1	500	.23	115
C. Water Tank (10,000 gal)	10	10,000	1	10,000	.23	2,300
9. Equipment						
A. Forklift	8	20,000	1	20,000	.26	5,200
B. Front End Loader	8	70,000	1	70,000	.26	18,200
C. Track Dozer	8	100,000	1	100,000	.26	26,000
D. Pickup Truck	8	10,000	1	10,000	.26	2,600
E. Water Truck	8	20,000	1	20,000	.26	5,200
10. Initial Cell Examination/m^3	40	1	54,000	54,000	.18	9,720
11. Hypalon Liner with Clay Layer/m^2	40	22.50	5,400	121,500	.18	21,870
12. Leachate Collection System	40	20	90	1,800	.18	324
13. Ground Water Monitoring	40	600	3	1,800	.18	324
Totals				$821,950		$168,380

*Where applicable, costs include all factors such as installation, engineering, contractor's profit and contingencies, etc.
Levelized annual fixed charge rates are per EPRI Technical Assessment Guide.

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Table 7-6

OPERATING COST ESTIMATES FOR THE EXAMPLE SITE

Item	Unit Costs	Quantity	Cost*	Levelizing Factor†	Levelized Annual Cost
1. [illegible]onnel (including fringes)					
A. Superintendent	20,000	10%	2,000	2.095	4,190
B. Secretary	10,000	10%	1,000	2.095	2,095
C. Equipment Operator	17,000	1	17,000	2.095	35,615
2. Equipment Operation and Maintenance/Yr	9,000	1	9,000	[illegible]	18,855
3. Administrative/Yr	4,000	1	4,000	2.095	8,380
4. Monitoring/Yr	5,400	1	5,400	2.095	11,313
TOTAL			$38,400		$80,448

*All costs are for the first year of operation and include fringe benefits and administrative overheads, as indicated.
†Levelizing factor was computed per EPRI Technical Assessment Guide with 6 percent apparent escalation and 10 percent discount rate for a 40-yr facility life.

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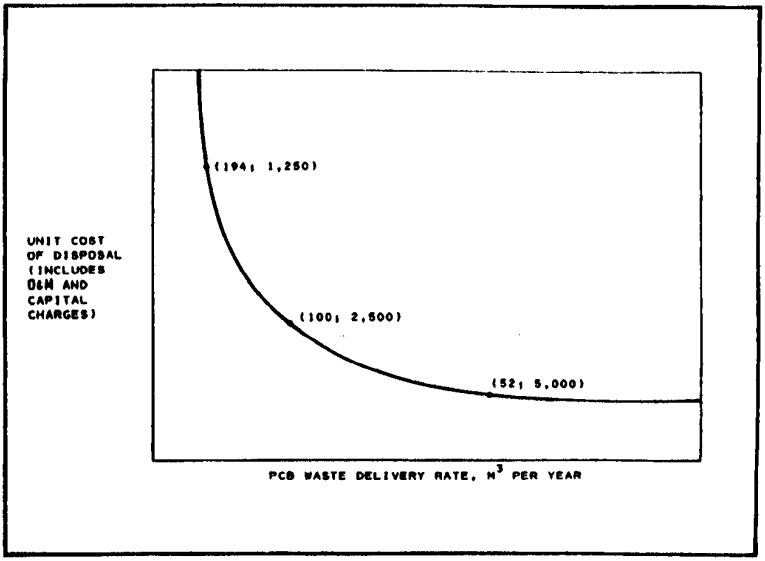

Figure 7-5. Unit Cost of PCB Land Disposal Facilities

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Ground Water Monitoring. A ground water monitoring program is a necessary part of any PCB disposal site design. To select ground water monitoring points, the designer must evaluate the following:

- The current and projected use of water resources of the area.
- The direction of ground water movement and any fluctuations that may occur throughout the year.
- The interrelationship of the underlying aquifer with other aquifers and surface waters.

For the hypothetical site, three sampling wells will be installed near the fill itself. One well will be upstream of the site, one at mid-site, and one downstream from the site in a line in the direction of ground water movement. Wells bored during the geophysical investigations will have established ground water flow direction.

Each sampling well will be cased and the annular space between the monitored zone (zone of saturation) and the surface backfilled with portland cement to effectively prevent percolation of surface water into the well bore. The well opening at the surface will have a lockable, removable cap to control access and to prevent entrance of extraneous water.

PCB Disposal Procedure

Containerized PCB-contaminated waste and uncontained sealed capacitors will be deposited in the cell intact. Transformers will first be drained and flushed in the PCB storage building prior to disposal. The transformer is drained of all free-flowing liquid, filled with solvent (e.g., kerosene, xylene, toluene), allowed to stand for at least 18 hr, and then drained thoroughly. The liquid and solvent mixtures are stored for later shipment to an incineration facility.

The drained transformers are trucked to the landfill and unloaded from the hauling truck by a forklift. They are then deposited in the disposal cell and stacked by a front-end loader as required. The deposited wastes are covered with native soil to minimize infiltration of rainfall. Wastes are covered daily in the wet season and several times per week during other times of the year.

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the merits of the plans and site conditions. Figure 7-6 describes the basic review and approval process for the permitting action.

Under ideal conditions, an EPA permit could be processed and granted within 17 wk after submittal of the permit application (along with any supporting environmental assessments or impact reports that may be required by local entities). However, delays may be encountered if additional data are requested by EPA during the review process.

The procedures addressed here are for obtaining a permit from EPA for operation of a PCB landfill. In many states it may be necessary to first or concurrently obtain a permit from state and/or local agencies prior to issuance of an EPA permit.

Application Procedure

The basic steps toward receiving a permit for a PCB solids disposal site are similar to those outlined in Chapter VI for PCB incinerator approval:

- Obtain all required local and state permits. EPA approval to operate a PCB landfill does not supersede or replace these permitting requirements.
- Obtain NPDES permit and prepare spill prevention, containment, and countermeasure (SPCC) plan. The approval to operate a PCB landfill will not supersede or replace these requirements.
- Submit an initial report to the Regional Administrator.
- Notify local officials as required by the regulations.
- After final approval, maintain records and submit reports as required by the regulations.

There is no application fee for this permit process.

A disposal site proponent first contacts the EPA Regional PCB Site Approval Coordinator (see Table 6-25). The following items are to be addressed in the initial discussion:

- Facility address and location.
- Expected types and sources of PCB solids.
- Management techniques proposed.
- State permits or approvals received or pending.

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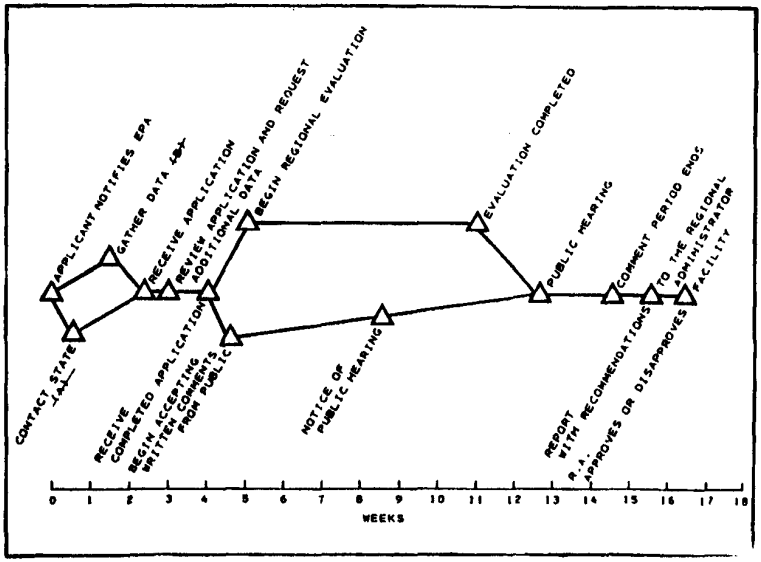

Figure 7-6. EPA Schedule for PCB Landfill Approval Procedure

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A technical report is the major part of the application. The Regional Coordinator will review report preparation plans and content with the proponent to assist in production of a document that meets EPA needs.

The EPA Regional Coordinator and staff review the technical report and identify any data gaps. If additional information is deemed necessary, the Regional Coordinator will seek it from the following:

- The applicant.
- State or federal agencies.
- By site visits.

Concurrent with EPA staff evaluation, an opportunity for public review and comment is provided as a necessary condition for approval. EPA informs the public of a 30-day comment period by notifying the Regional Intergovernmental and Congressional Assistants, and by posting notice at post offices or other public places in the municipality nearest the proposed site. The applicant's technical report is made available to the public at both the EPA regional offices and at a location near the disposal facility, usually a public library. Confidential information will not be disclosed, however. During the comment period, written comments from all concerned individuals and groups will be accepted by the EPA Regional Staff.

In addition to the public comment period, EPA may provide a public hearing if there is sufficient public interest or particularly if the approval is likely to be controversial or result in litigation.

EPA will decide on the permit application after all data are reviewed and the public comments are received. The decision is based primarily on whether or not the facility location and design meet the EPA regulator criteria for PCB solids disposal. Other factors such as public concerns will also be considered.

Where the proposed facility does not meet all EPA regulatory requirements, EPA can decide if less stringent requirements would result in a lesser degree of environmental protection. In some cases, mitigating design site features may be acceptable to EPA. The Regional Administrator may waive specific requirements in such instances.

Note that the EPA Regional Administrator is not authorized to withhold approval of a PCB land disposal site on the sole basis that the site does not have state and/or

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local approval or that it does not meet more stringent state or local standards. However, site proponents cannot implement their facility with an EPA permit without state or local approval.

Application Contents

In general, the application should provide, but need not be limited to, the following information:

1. Location of the fill with respect to the following:

   --Industrial sites (both manufacturing and commercial).

   --Residential areas.

   --Navigable waterways such as rivers and lakes.

   --The nearest city, town, or village.

2. A detailed description of the proposed landfill, including site plans and design drawings. At a minimum, the description should include the following:

   --Discussion of site geology.

   --Discussion of site hydrology, including the maximum/minimum ground water levels.

   --Identification of local ground water aquifers used or potentially usable for water supply.

   --Areal extent of the proposed landfill and volume capacity projected.

   --Approximate size and dimensions of the cells or trenches that will contain PCBs.

   --Discussion of the planned monitoring system location and construction methods, including a map to indicate well placement.

   --Description of type of leachate collection and treatment system proposed (if applicable).

   --Description of the type of liner to be installed (if applicable).

   --Discussion of the proposed security measures, i.e., type of fencing, patrolling.

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3. An engineering report describing how the landfill complies with the requirements for PCB solids disposal to land. The report should include data on the following:

   --In-place soil thickness or proposed thickness of compacted soil liner.

   --Soil permeability.

   --Percent soil passing No. 200 sieve.

   --Liquid limit of soils.

   --Plasticity index of soils.

   --Artificial liner thickness (if applicable)

   --Distance from bottom of landfill to the maximum ground water level.

   --Relative location of landfill to the 100-yr flood water elevation.

   --Surface runoff control, erosion control.

4. Sampling and monitoring equipment and facilities available:

   --Description of on-site laboratory facilities (if any).

   --Quantity of ground and surface water in and around the disposal area prior to disposal operations (baseline data).

   --Description and frequency of sampling, and analytical procedures to be followed for assessing PCB wastes. (At a minimum, the following parameters shall be analyzed: PCBs, pH, specific conductance, and chlorinated hydrocarbons.)

5. Expected volumes of PCBs solids.

6. General description of waste materials other than PCBs that are expected to be disposed of in a landfill.

7. Landfill operation plan, which should include the following:

   --Procedures for controlling surface water runoff.

   --Methods for handling PCB solid waste (i.e., drummed waste, capacitors) and for placing PCBs in the landfill.

   --Procedures for covering PCB solids and type of final soil cover proposed.

   --Planned landfill operating schedule.

8. Local, state, or federal permits or approvals required.

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9. Schedule or plans for complying :h the approval requirements of these regulations.

10. A detailed description of on-site PCB storage facilities planned to include the following information:

--Location of the PCB storage building relative to the landfill.

--Descriptions of the storage area, including design drawings of the structure, i.e., type of building, type of flooring, containment capacity.

--Manner in which wastes are labeled and stored.

--Method of transporting the PCBs from the storage area to the landfill.

--Frequency and method of inspecting the PCB storage area for leaks and spills.

--Estimated average quantity of each type of PCB solid waste to be stored.

--Cleanup procedures in the event of a spill or leak in the storage area.

--Decontamination procedures to be used in the storage area.

--Description of the planned record keeping and reporting procedure.

Permit Approval

Upon formal EPA approval, a letter is provided to the site operator that indicates the following:

- Any waivers and rationale.
- Any special conditions placed on the approval.
- A statement that revocation of approval is possible for any violation of the standards.
- The permit period.
- A statement that approval will be reevaluated upon expiration of the permit period.
- Agreement to allow site access by EPA personnel sampling and inspection.

Permits for existing PCB solids disposal sites are issued for no longer than 3 yr.

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Section 8

SELECTION OF A PCB DISPOSAL SYSTEM

The selection of a PCB disposal system which best meets the needs of an electric utility company is a complex problem. The selection process must go beyond conventional economic analysis to address the social, legal, environmental, and institutional issues and risks associated with hazardous waste management. The information presented previously provides the necessary tools for decision-making in PCB disposal. This chapter provides some general guidelines to aid both the utility industry as a whole and the individual utilities in incorporating the above issues into the analysis.

DEVELOPMENT OF EVALUATION CRITERIA

Each utility or group of utilities has a limited range of available PCB disposal alternatives. According to law, PCBs and contaminated flushing solvents of a concentration greater than 500 ppm must be destroyed in an approved high-temperature incinerator, and solids contaminated by PCBs of a concentration greater than 500 ppm must be decontaminated and disposed of in an approved landfill. PCB liquids originating from PCB-contaminated (50-500 ppm) transformers may be disposed of in one of the following three methods: high-temperature incineration, efficiency boiler, and chemical landfill if the liquid is nonignitable. PCB solids having been contaminated by 50 to 500 ppm PCBs need not be decontaminated before disposal in an approved chemical landfill. The associated design criteria are satisfied by many existing combustion facilities and landfills. No incinerators and only six landfills, however, have been formally approved to accept PCBs; existing and proposed PCB disposal sites were described previously in Chapters VI and VII.

In view of the apparent lack of necessary PCB disposal capacity, utilities are faced with a choice between waiting for more commercial capacity to be approved, and constructing and operating their own facilities expressly for the purpose of in-house PCB disposal. In the former case, utilities could provide added impetus for new commercial capacity construction through financial assistance or PCB waste flow guarantees. In the latter case, economies of scale favor large cooperative regional facilities, particularly in regions with no existing or planned commercial capacity.

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The selection of a PCB disposal system from various combinations of the above alternatives should be based primarily upon two evaluation criteria:

- The reliability of, and the risks associated with, each alternative.
- The total cost of PCB management to the utility over the next 40 yr of PCB waste generation.

The selection process is further complicated by the impending need to also dispose of other low-volume wastes defined as hazardous under RCRA, Section 3001.

ASSESSING PCB DISPOSAL SYSTEM RELIABILITY

It was estimated in Chapter V that annual PCB waste generation will be in the millions of pounds over the next 40 yr. Decisions made in the near future regarding long-term PCB disposal must take into account the associated reliability of the disposal system throughout this 40-yr disposal period.

The term "reliability," as it is used here, refers to the continuing ability of the disposal system to accept a specified flow of PCB waste. PCB disposal system reliability is a function of three major variables:

- The operational performance of the disposal system itself, e.g., operating and maintenance history, design life.
- The threat of competition for waste disposal capacity, by both PCBs and other chemical (hazardous) wastes.
- The potential for facility shutdown due to nontechnical factors, e.g., public opposition, poor financial management, or noncompliance with environmental regulations.

Disposal System Performance

The selection of a PCB disposal facility for long-term PCB waste management planning should be limited to proven PCB combustion technologies and landfill designs. Incinerator designs such as the rotary kiln (for PCB solids) and liquid injection incinerators (for PCB liquids) have a proven record of performance with many types of solid and liquid waste (including PCBs), and will meet the EPA design criteria for PCB destruction. Certain utility boiler configurations and most cement kilns are theoretically capable of destroying PCBs; field tests are currently planned under EPRI RP 1263-2 to further substantiate the limited, but promising, data base on boiler and cement kiln destruction of PCBs.

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The use of cement kilns has been adopted by the Canadian government (Environmental Protection Service) as the primary means of PCB waste disposal. The Canadians have adopted a national plan calling for construction of disposal facilities with adequate capacity to handle the total expected PCB disposal demand. The federal plan proposes a cooperative effort with the provincial governments to establish criteria for plant siting; to develop standards for the necessary equipment, instrumentation, and operating conditions; and to initiate negotiation leading to the designation of a number of regional disposal facilities.

In the absence of a similar effort in the United States to promote PCB disposal capacity addition, utilities will be forced to take the initiative if adequate disposal capacity is to be established. This could include acquiring controlling interests in existing cement companies, or alternatively establishing new cement production facilities for the dual purpose of burning waste PCBs and producing cement. An added benefit would be the use of fly ash in cement production.

Disposal Capacity/Demand Considerations

In view of the apparent difficulties being encountered in siting new hazardous waste disposal facilities, competition for disposal capacity may become the most important factor in long-range PCB disposal planning. Table 8-1 displays a comparison between projected PCB disposal capacity and estimated PCB waste generation during the period 1980 and 1990. The table clearly shows that approved and potential PCB landfill capacity combined would exceed demand in six of ten EPA regions, as well as nationwide. Similarly, the table indicates that the demand for PCB liquid incineration facilities would not only be satisfied but surpassed if only the two currently pending sites were approved.

The figures for incineration demand versus capacity are deceiving, however. These data assume that 100 percent of existing capacity at the Rollins and ENSCO facilities would be dedicated to PCBs. In reality, both companies currently operate successful chemical waste incineration operations, with most of the incineration capacity being dedicated to other types of liquid and solid wastes. Discussions with both companies reveal that 10 to 20 percent of existing liquid combustion capacity could be dedicated to PCB-contaminated materials and capacitors. Nevertheless, considering that PCB liquids command a higher gate fee than other liquid wastes for a similar operating cost, the capacity dedicated to PCB liquids could increase substantially once a greater demand is apparent.

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Table 8-1

COMPARISON OF REGIONAL PCB DISPOSAL CAPACITY WITH PROJECTED DEMAND

	PCB Disposal Capacity*				Average Annual PCB Waste Generation Rate, 1980-1990					Number of Years to Fill Landfill Sites with PCB Solids	
	Total 10^3 [m^3] Solids (Landfill)		Solids and Liquids 10^6 lb/yr (Incineration)		To Incineration†		To Landfill†	Capacity as a Percent of Demand PCB Incineration			
EPA Region	Approved	Potential	Potential	Proposed	Liquids (10^6 lb)	Solids (10^6 lb)	Solids (10^3 [m^3])	Potential	Proposed	Approved	Potential
I	62	0	0	0	.228	2.613	2.147	0	0	29	0
II	0	0	66	0	.532	6.097	5.009	>100	0	0	0
III	0	0	0	0	.632	7.236	5.945	0	0	0	0
IV	34	0	0	50	1.223	14.00	11.50	0	>100	3.0	0
V	0	4,400	0	50	1.229	14.07	11.56	0	>100	0	>50
VI	0	8,600	147	0	.778	7.973	6.549	>100	0	0	>50
VII	0	16,000	0	0	.298	3.015	2.476	0	0	0	>50
VIII	0	0	0	50	.150	1.541	1.266	0	>100	0	0
IX	200	8,400	0	50	.670	6.968	5.724	8	>100	35	>50
X	54	700	0	0	.380	3.886	3.192	0	0	17	>50
Totals	350	38,100	213	200	6.104	67.40	55.369	241[F]	272[F]	6.3[]	>50[]

*Total disposal site capacity - 100 percent of capacity may not be dedicated solely to utility PCB disposal.
Approved: Sites which have obtained PCB disposal permits.
Potential: Existing sites pending approval or considered capable of meeting EPA design criteria for PCB disposal.
Proposed: PCB disposal sites which are being planned but do not yet exist.
Totals represent capacity/demand relationship if all regions utilize all sites.

†Assumes all liquids go to incinerator or boiler for disposal. There is no way to determine how much PCB-contaminated liquid will go to landfills, although some landfills have to date expressed a reluctance to accept any liquids. Similarly, there is no way to estimate how many utilities will attempt to obtain permits to burn PCB-contaminated liquids in their boilers.

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It is therefore apparent that PCBs will compete with other chemical wastes for incineration capacity. An important decision-making tool for utilities would be an estimate of how much PCB material these facilities can accept, and how that capacity relates to total utility industry demand. Assuming that utilities with a closer proximity to these sites have an economic advantage (due to lower transportation costs), Figures 8-1, 8-2, and 8-3 were developed to demonstrate the geographic influence of approved and potential PCB incineration sites. The concentric circles shown in each figure represent the percent of facility capacity dedicated to PCB solids or liquids; the area within the circles is that required to generate sufficient PCB materials to satisfy the dedicated capacity.

For example, Figure 8-1 shows that area of the United States which could be most economically serviced by the two pending PCB incinerators, should those facilities dedicate two percent and four percent of their liquids disposal capacity to PCBs. At 10 percent capacity dedication (not shown), the entire United States generation of PCB mixtures and flushing solvents could be disposed of at these two facilities. The transportation cost associated with the latter alternative, however, could be high.

Figures 8-2 and 8-3 display the same type of demand/capacity relationship for solids disposal. In Figure 8-2, the two pending facilities could accept only an estimated 70 percent of all PCB solids, leaving only certain north central and northeastern states without reasonable access to disposal facilities.

The same approach was employed for estimating PCB landfill capacity as a function of percent dedication of approved PCB landfill sites, as shown in Figure 8-4. Instead of showing annual capacity versus generation, the shaded areas represent those parts of the United States which could be serviced entirely by the indicated landfill over the 40-yr PCB generation period. The figure shows that more than half of the United States could be served by existing landfills for 40 yr. (The Casmalia, California, site has a larger capacity than all other PCB sites combined; it is assumed that only a portion of that capacity will be dedicated to PCBs.)

These figures together comprise a market analysis of PCB waste disposal, based on current landfill and incineration capacity. Employing cost/capacity data for new facilities (from Chapters VI and VII), coupled with the locations and capacities of proposed disposal facilities, recommendations for additional regional PCB disposal capacity were developed. These recommendations are presented in Table 8-2.

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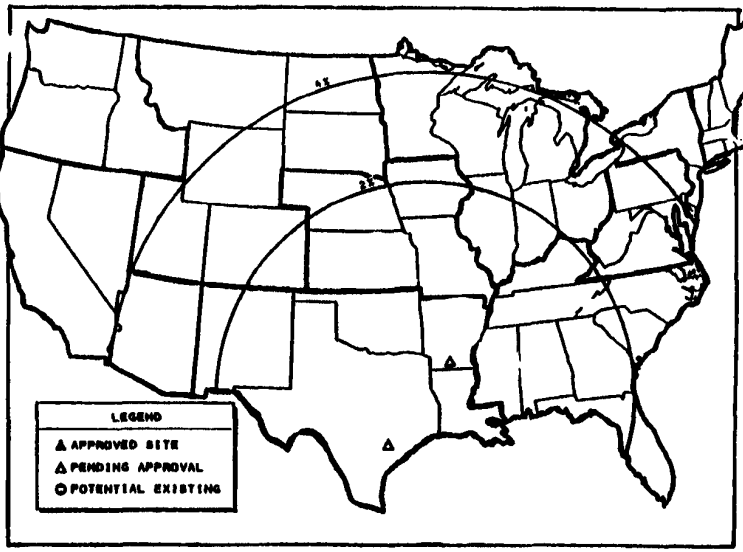

Figure 8-1. Estimated geographic influence of PCB liquids incineration capacity (1980-1996, based on 1980 capacity projections).

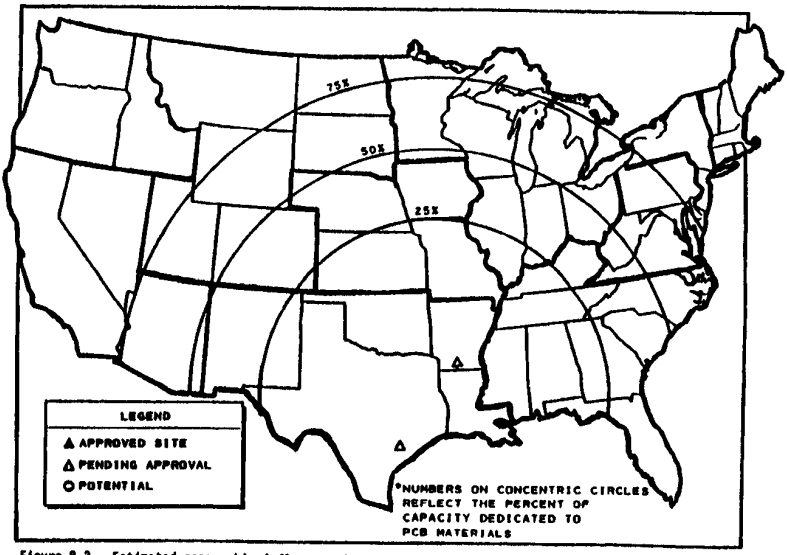

Figure 8-2. Estimated geographic influence of PCB solids incineration capacity (based on 1980 capacity projections).

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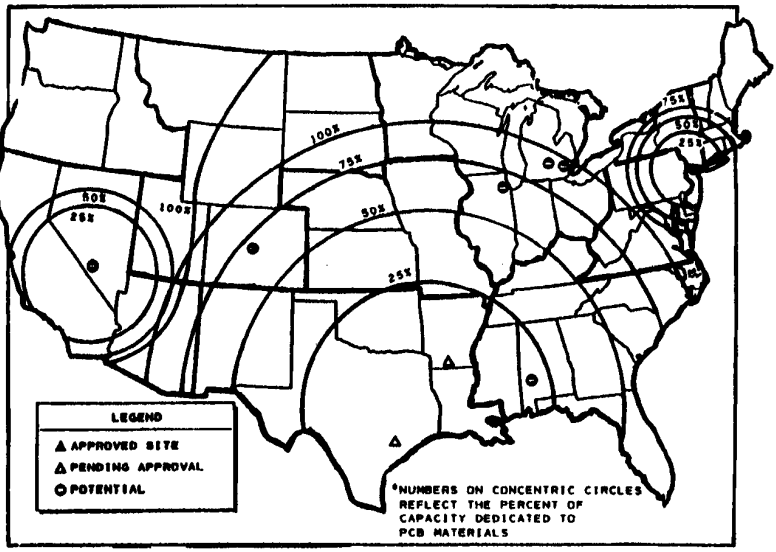

Figure 8-3. Estimated geographic influence of PCB solids incineration capacity (based on 1985 capacity projections).

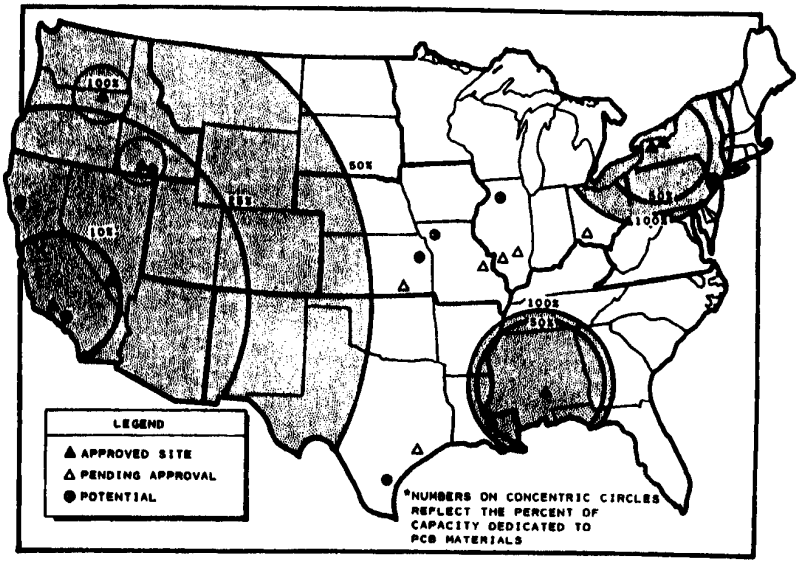

Figure 8-4. Estimated geographic influence of approved PCB landfills: lifetime landfill capacity versus total demand.

Table 8-2

RECOMMENDED REGIONAL ACTIVITIES TO ENSURE LONG-TERM PCB DISPOSAL CAPACITY, 1980

EPA Region	Incineration: PCB Mixtures and Solids — % of Demand Unfulfilled[a]	Incineration: PCB Mixtures and Solids — Recommendations[b]	Landfilling — % of Demand Unfulfilled[c]	Landfilling — Recommendations[b]
I	100	• Await new installation (1982), or develop 7×10^8 lb/hr integrated solid/liquid facility	90	Establish new site (2,400 m^3)
II	97	• Same as Region I	10	Await new capacity; use existing sites
III	15	• Use existing facility, or develop 10^9 lb/yr integrated facility	40	Use existing sites, establish new site (2,600 m^3)
IV	0	• Use existing capacity with one or more PCB-equipped boilers (east)	40	Establish new sites (6,000 m^3 total)
V	0	• Use existing capacity (south); develop PCB-equipped boilers or kilns (north)	95	Await new capacity; establish new sites (north, 4,000 m^3 total)
VI	0	• Use existing capacity	95	Await new capacity; establish new site (west, 2,900 m^3)
VII	0	• Use existing capacity	100	Await new sites
VIII	40	• Use existing capacity, with remote boiler or kiln modifications	80	Establish new site (north, 1,000 m^3 total), use existing capacity
IX	75	• Integrated solids/liquids facility, 8×10^8 lb/yr capacity	0	Use existing capacity
X	100	• Develop one or more integrated facility, 5×10^8 lb/yr total)	80	Await new capacity; establish new site northwest, 1,000 m^3. Use existing capacity.

[a] At 6 percent capacity commitment.
[b] Data presented in this report showed most large-scale facilities to be cost-competitive with commercial rates; new facilities are therefore recommended where the combined waste stream justifies the investment.
[c] At 25 percent capacity commitment for Canada site.

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Other Nontechnical Considerations

Selection of a reliable PCB disposal system requires that certain nontechnical factors be addressed. The public acceptance of a facility plays a key role in facility longevity and must be assessed. The environmental impacts of a facility, whether it is new or established, must be minimal in order to avoid later closure due to noncompliance with regulations. Legal ramifications of facility siting must also be addressed, as well as the legal requirements which accompany ownership and operation of a hazardous waste disposal facility.

Table 8-3 lists some of the impacts of selected nontechnical factors on PCB disposal facility operation. The impacts of these factors center around three subject areas:

- The cost of each factor's impact to the user or owner.
- The responsibility for controlling the impacts.
- The benefits realized as a result of ownership versus use only.

The costs of operating a hazardous waste disposal facility, whether regulatory in nature or simply the costs of capital and routine operation, are ultimately passed on to the user. The high costs of rectifying problems associated with spills and other mishaps are one of the risks associated with chemical waste management operations, and serve as a major drawback to facility ownership and operation. The liabilities of ownership can be balanced by the benefits, particularly that of reliability of disposal capacity.

Regardless of whether the facility is commercial or utility owned, it is in the best interest of the utilities using the site to ensure its reliability. The utility which commits itself to a long-term PCB disposal agreement should provide its support in matters of public opposition and legality of operation. These considerations should be factored into any comparative cost analysis. Similarly, the costs of obtaining permits, environmental impact reports, and legal aid should be liberally budgeted to ensure continuous operation of the facility.

COST ANALYSIS OF PCB WASTE MANAGEMENT ALTERNATIVES

The second principal evaluation criterion is cost. A cost comparison between alternative commercial sites is based simply on gate fees and transportation costs, assuming system reliabilities have been satisfactorily addressed. Comparing commercial disposal costs with those of a new utility-owned PCB disposal facility is more

Table 8-3

SUMMARY OF NON-TECHNICAL FACTORS AND THEIR IMPACT ON PCB DISPOSAL DECISION-MAKING

Alternative Disposal Systems	Social and Political Factors/Impacts	Environmental Factors/Impacts	Legal Factors/Impacts
Utility - Owned Boiler or Integrated Incinerator System	• Reduced public awareness of PCB operation and disposal • Public and political opposition may be difficult, costly, and time - consuming to overcome • Utility controls all aspects of PCB management	• Reduces the probability of shipping accidents • No liquid scrubber effluent in boiler application • Responsible for maintaining air and water quality control systems, monitoring performance and disposing of residue	• Interstate transport may be avoided • Utility is responsible for permitting SPCC and EIA requirements, and responsible for all record keeping • Utility stands alone in any liability litigation • Possible PUC conflict
Commercial Cement Kiln	• Must compete with non-utility PCBs for disposal • Need to guarantee waste flow • Need to assist cement company in combatting public opposition so as to ensure disposal system availability	• Most environmentally acceptable • No liquid scrubber effluent • Utility is not responsible for environmental controls • Widespread distribution of facilities could reduce transportation, thereby reducing spill potential	• Approval for PCB disposal may impact cement producing operations • Possible interstate transport restrictions
Commercial Incinerator Facility	• Excessive transportation costs in some cases • Must compete with non-utility PCBs for disposal • Suitability subject to public opposition	• Utility is not responsible for residue disposal, nor for environmental controls and monitoring • Increased potential for spills during transport due to long distances to sites	• Limited utility liability • Possible interstate transport restrictions
Utility-Owned Landfill	• Depreciation of land value • Public fear of environmental contamination breeds opposition, which may be difficult to overcome • Utility controls all aspects of PCB management	• Locating acceptable site may be difficult • Persistance of PCBs in the environment may require long-term monitoring of site after closure • Reduction in transport, and hence spill potential	• Permit is difficult to obtain • Utility is liable for any environmental impacts • Requires extensive monitoring to satisfy regulatory agencies • Utility responsible for all record-keeping • Possible PUC conflict
Commercial Landfill	• Must provide support against public opposition to ensure disposal system availability • Must compete with non-utility PCBs for disposal	• Utility is not responsible for site monitoring • Possible long-distance transport hence greater spill potential	• Limited utility liability • Possible interstate transport restrictions

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complicated and involves capital operating costs, dependability of waste supply, costs of legal support during site planning and permitting, costs of delays in site approval, and transportation costs (if the utility-owned facility serves more than one utility).

This section presents a framework for the comparative cost analysis of PCB disposal alternatives. The procedure outlined here is only intended for preliminary analysis, and should be followed by a more detailed feasibility study if the utility-owned PCB disposal options appear to be attractive.

General Procedure for Evaluating PCB Disposal Alternatives

In order for an individual utility to determine the most cost-effective means of PCB waste management, the utility should follow an evaluation procedure similar to that shown in Figure 8-5. The first step in this procedure is to establish decision-making priorities before beginning the evaluation. The relative importance of such factors as investment expenditures, annual costs, reliability of alternatives, interim storage requirements and limitations, and allowable risks needs to be determined during this step.

During the second step, projected annual PCB disposal requirements are identified (including regional, local, and utility-specific requirements). Contractual agreements with commercial PCB disposal operators should be reviewed as to their adequacy, long-term reliability, and long-term price stability. Current utility financing needs and resources should also be examined. Other capital additions may take precedence over investment in disposal operations, and the additional capital required may have an unfavorable influence on debt/equity ratios or otherwise impair the utility's financial status.

The third step shown in Figure 8-5 requires that a set of PCB disposal options be identified and developed for preliminary screening. In addition to determining gate fees and PCB transport costs to commercial disposal sites, the individual utility may wish to consider the PCB disposal requirements of other local utilities. Preliminary cost estimates can then be prepared, and economies of scale can be quantified. Technology assessment and risk identification should be performed at this stage of the analysis.

The fourth step in the decision-making process is to determine alternative system conformance to the previously identified utility priorities and capabilities.

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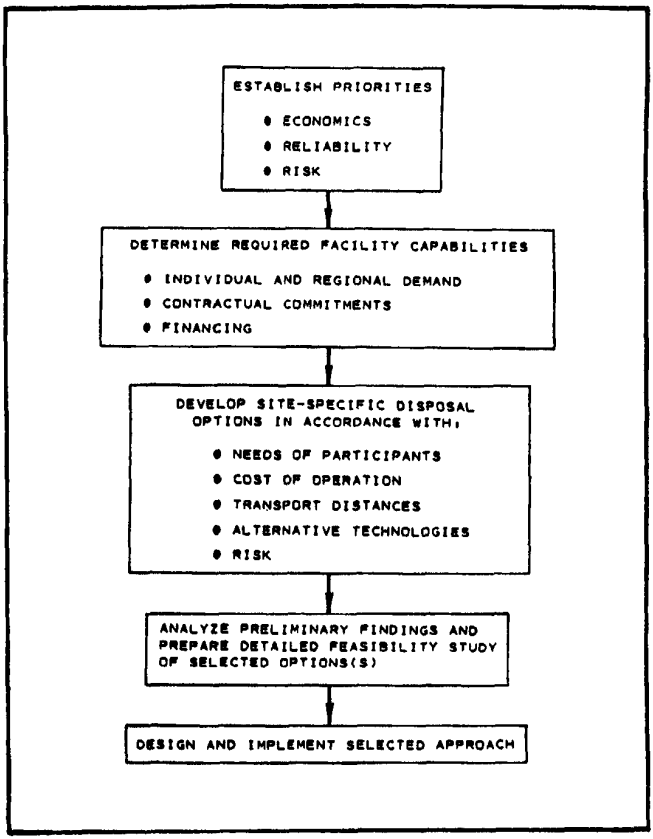

Figure 8-5. Procedure for evaluating utility-specific PCB disposal alternatives.

Should any of the alternatives appear to be more attractive than use of commercial facilities, a more detailed feasibility study is in order.

The final step in the procedure is to implement the selected PCB disposal practice, based upon the results of the feasibility study. Execution of the first four steps should require no more than 9 mo to complete.

Conceptual Description of the Decision Process

The diversity of local conditions makes it impossible to describe in greater detail the actual process which a utility must go through in each step. It is possible, however, to conceptually describe the cost considerations that a utility must face in choosing between commercial and utility-owned PCB disposal.

Figure 8-6 is a conceptual depiction of these cost considerations. In the figure, point A represents the average cost for an individual utility to provide its own PCB disposal. Because of the small-scale of operation, but high economy of scale, average cost A is much higher than gate fee B charged at a commercial disposal operation. The commercial operation is assumed to be C miles distant from the utility in question. After the necessary transport costs (D-B) are added to gate fee B, it is still cheaper for this utility to use the commercial site (and pay a total of D) than to operate its own disposal site (and pay A).

However, the utility may join with other utilities in the region to develop their own PCB disposal operation. This option would take advantage of certain economies of scale, though it requires that PCBs be transported to some central location convenient to the participating utilities. The analysis then evolves into a trade-off between lower unit disposal costs and higher average transport costs, as the number of participating utilities, and hence the scale of operation, increases.

Figure 8-6 portrays this graphically by displaying average unit costs for three different scales of utility PCB disposal operations. The line representing transportation to a commercial disposal site (D to B) is simply a reversed version of the other graphs, presented in this fashion to show the comparative economies of the two alternatives. Note that transport distance from left to right for commercial disposal, while increasing for the utility-owned disposal options. Looking at just the small-scale operation, the average unit cost E at the disposal site does not include transportation.

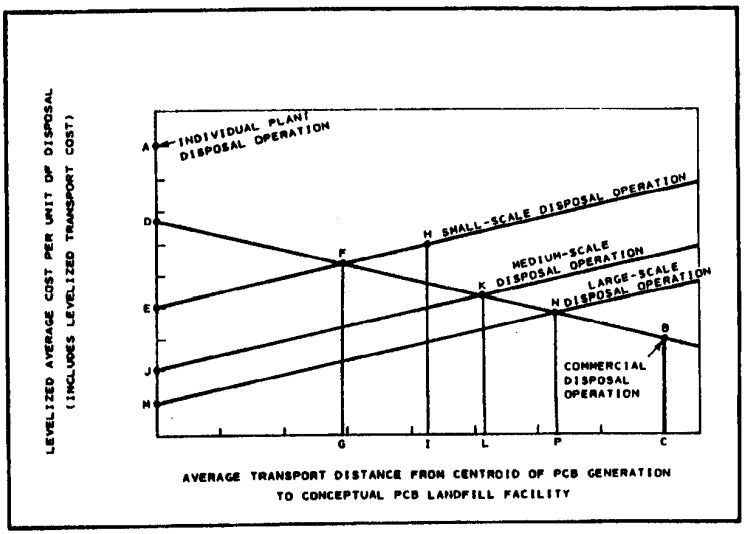

Figure 8-6. Graphical depiction of the PCB disposal decision process: commercial disposal versus utility-owned system.

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Transportation costs are depicted as the slope of the small-scale average cost curve. As the figure shows, the average PCB disposal cost per ton increases linearly with distance from the small-scale disposal facility. At point F, the average unit cost to all the cooperative participants just equals the average unit cost (including transport) to use the commercial site. It follows that point G represents the maximum average distance that utilities could afford to transport PCBs to their own facility before commercial disposal becomes more economical. Point G could also be interpreted as a maximum radius for the small-scale facility service area, and would thus limit the region from which utilities could afford to participate in the utility-operated disposal site.

If an adequate number of participating utilities can be found, and if the average transport distance (I) exceeds this maximum radius, then the average unit cost to the participating utilities (H) will exceed what some of the participants would have to pay to use commercial disposal. Conversely, if adequate PCB waste generation exists within radius G, the unit disposal cost to each participating utility in a cooperative venture will be less than for commercial PCB disposal.

The comparison of commercial PCB disposal versus medium and large utility-operated facilities follows much the same reasoning. The slopes of their respective cost curves in Figure 8-6 are identical to that for the small-scale system due to constant unit transportation costs. But because their unit disposal costs ("tipping fees") are lower, their maximum service economical area radii are larger. Points L and P represent the respective transport limits for the medium- and large-scale utility-operated PCB disposal facilities.

Further Discussion of PCB Disposal Costs

The previous discussion demonstrates some of the complexities of selecting a utility PCB disposal system, and provides a graphic method of analysis. The comparative analysis of disposal costs must be based on comparable cost estimation procedures. PCB disposal cost estimates developed in Chapters VI and VII include estimates for all factors contributing to the initial capital investment and annual operating costs. The cost estimates were then placed into a levelized format which reflects a 6 percent inflation rate, a 10 percent discount rate, and the respective useful lives of the disposal facilities.

A summary of the estimated unit cost and their associated scales of operation is shown in Table 8-4. In order to provide a useful data base for the method of comparative analysis discussed previously, this cost data was expanded to reflect other reasonable scales of operation. Figures 8-7 and 8-8 display the unit cost/capacity relationships for PCB landfills and PCB combustion facilities, respectively.

To illustrate how this information can be used, assume that, as part of its PCB management program, an individual utility wishes to determine the most cost-effective means of decontaminated PCB solids disposal to landfill. Assuming the utility's transportation costs to be \$0.15/ton-mi or \$0.215/m^3-mi, the levelized transport cost over a 40-yr period is computed as follows:

$$2.095\ (\$0.215/m^3\text{-mi}) = \$0.450/m^3\text{-mi}$$

where 2.095 is the appropriate levelizing factor. The levelized gate fee at a commercial PCB disposal site 400 mi from the utility is assumed to be \$150/m^3.

This information, coupled with unit disposal cost information from Figure 8-7, can be used to develop an actual cost analysis diagram as shown in Figure 8-9. In this figure, the cost to the utility for operating its own individual landfill is \$450/m^3. It is, therefore, less expensive to transport flushed PCB transformer shells to the commercial site at a cost of \$330/m^3. However, if the individual utility could locate sufficient annual PCB disposal demand (i.e., 1250 m^3/yr) within a 145-mi radius, then a utility-owned small-scale PCB landfill operation could be price-competitive with the average costs of using a commercial system.

For this particular example, Figure 8-9 also shows the price-competitive maximum transport distance for medium (2500 m^3/yr) and large (5000 m^3/yr) scale PCB landfill operations. These maximum service area radii are shown to be 255 mi and 310 mi, respectively. As in the case of the small-scale of operation, the annual PCB disposal rates for these larger operations must equal or exceed the projected waste flows if average disposal costs are to equal those shown.

The optimal scale of utility-controlled disposal cannot be determined in this example because the assumptions do not include an actual profile of regional PCB generation. It is important, nonetheless, to recognize from this example that the competitive radius increases with the scale of contemplated PCB disposal operation.

Table 8-4

SUMMARY OF COST ESTIMATES FOR PCB COMBUSTION SYSTEMS AND SYSTEM MODIFICATIONS

Integrated PCB Solids/Liquids Incinerator

Size of Incinerator, $\frac{Btu}{hr}$	72.5×10^6	11×10^6
Waste Burned, lb/yr		
Solvents	17.4×10^6	2.64×10^6
Liquid PCBs	17.4×10^6	2.64×10^6
Wash Solvents	17.4×10^6	2.64×10^6
Total	52.1×10^6	7.92×10^6
Capital Investment, $	$3,520,350	$1,607,800
Total Levelized Annual Costs, $	$3,065,700	$1,066,400
Cost per Pound, $/lb	0.059	0.135

PCB Combustion Systems for Boiler and Cement Kiln Application

	Liquid/Solid		Liquid Only	
	Utility Boiler	Cement Kiln	Utility Boiler	Cement Kiln
Heat release, Btu/hr	8.9×10^6	24.2×10^6	8.9×10^6	24.2×10^6
Waste Burned, lb/yr				
Capacitors	2.1×10^6	5.8×10^6		
Liquid PCBs	2.1×10^6	5.8×10^6	2.5×10^6	6.9×10^6
Wash Solvents	2.1×10^6	5.8×10^6	2.5×10^6	6.9×10^6
Total	6.4×10^6	17.4×10^6	5.1×10^6	13.8×10^6
Capital Investment, $	$742,550	$1,051,150	$432,850	$531,200
Total Levelized Annual Costs, $	$465,350	$639,450	$194,350	$110,300
Cost per Pound, $/lb	0.073	0.037	0.038	0.008

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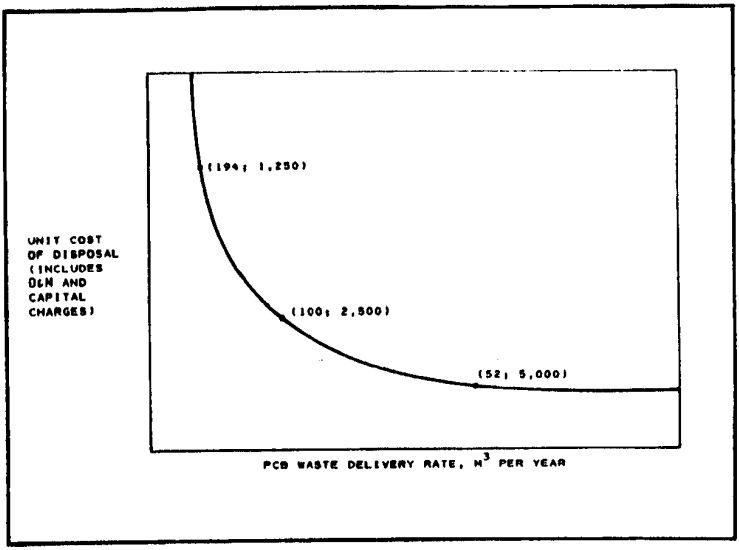

Figure 8-7. Unit Cost of PCB Land Disposal Facilities

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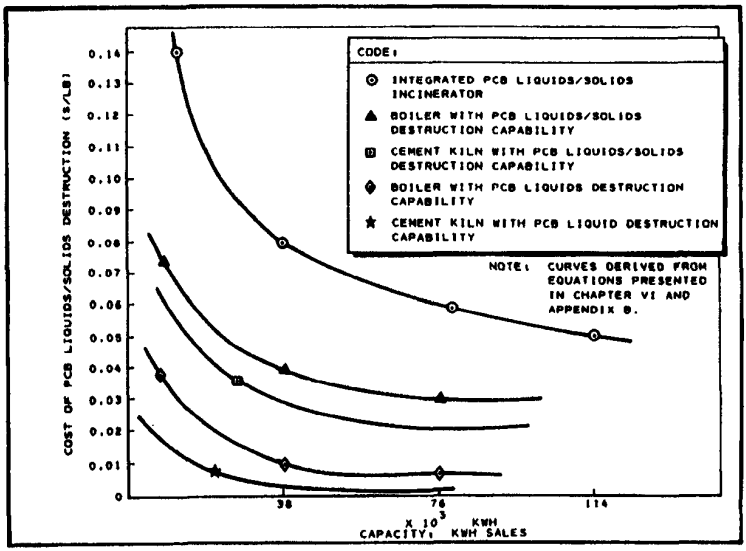

Figure 8-8. Disposal Cost Versus Capacity, 5 Utility Disposal Options

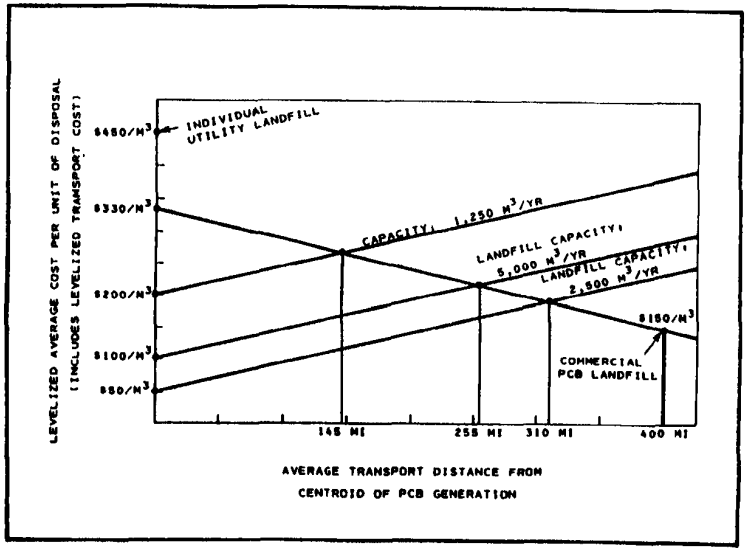

Figure 8-9. Example Application of PCB Disposal Decision Diagram

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It is equally important to recognize that differences in unit costs between commercial and utility-owned PCB disposal systems are not by themselves an adequate basis for selecting among disposal alternatives. Levelized transportation costs must also be included, and can be very important in determining if a particular utility-owned PCB disposal operation can attract sufficient waste to fulfill its intended design capacity, and thus meet its anticipated unit costs of operation.

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APPENDIX A

CRITERIA FOR ALLOWABLE BURNING RATES OF PCBS IN ELECTRIC UTILITY BOILERS

1. Based on Scrubbing Requirements:

To keep chlorine content of total feed below 0.5 percent and, presumably, avoid the requirement for scrubbing, the PCB feed rate must be less than

$$\frac{0.5}{0.53} = 1.0 \text{ percent by weight of the total fuel feed rate to the boiler.}$$

Based on Boiler Tube Corrosion:

Chlorides are known to increase corrosion rates on boiler tubes, but relatively large changes in chloride levels are required to cause significant changes in corrosion or "wastage" rates. Waste heat boilers are in use on incinerators firing up to 50 percent chlorine fuels, but the operating conditions are not typical of utility boiler practice. Common practice is as follows:

- Limit combustion temperatures to 1204°C (2200°F).
- Use a fire tube boiler - no radiation section.
- Use low boiler pressures, 250 psig and less, preferably.

Burning 100 percent municipal solid waste (typically 0.4 weight percent chlorine) causes significant increases in corrosion rates of high-temperature boilers, but up to 15 percent of boiler heat input can be supplied by RDF (refuse derived fuel) without noticeable effects. A heating value of 15 percent, as supplied by RDF, implies about 37.3 percent of weight input is from solid waste based on 13,800 Btu/lb coal and 4800 Btu/lb for original solid waste. This corresponds to a PCB feed rate of

$$\frac{0.4\ (0.373)}{0.53} = 0.3 \text{ percent by weight of the total feed rate of the boiler.}$$

Assume that doubling the chloride content of the fuel would not significantly affect corrosion rates in boilers whose tubes are not sensitive to chloride attack. Some coals contain as much as 0.1

*Assume that the typical PCB waste stream contains 53 weight percent chlorine.

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weight percent chlorine (1000 ppm). In this case, 0.1 additional weight percent could safely be added or

$$\frac{0.1}{0.53} = 0.2 \text{ percent by weight of PCBs.}$$

Fuel oils contain very low chloride levels. The same incremental approach would recommend very low feed rates of PCBs in oil-fired boilers.

3. Based on Maximum Downwind Concentration of HCL:

Maximum allowable ambient concentrations of HCL are not yet established, but may be comparable to SO_2 (the TLVs of SO_2 and HCl are identical at 5 ppm).

Chlorine levels comparable to the sulfur content of low sulfur coals (say less than 0.8 percent) would probably meet this ambient limit, assuming plume dispersion is already adequate.

4. Conclusions:

Based on the preceding discussion, a maximum of 0.3 percent by weight of pure PCBs would be acceptable in the fuel for older, smaller, lower temperature boilers. For example, a 100 megawatt (MW) unit requiring 16,000 Btu/kwh (21 percent effficiency) would give

$$\text{PCB feed rate} = \frac{100{,}000\ (16{,}000)(0.003)}{13{,}800} = 348 \text{ lb/hr}$$

A maximum of 0.1 weight percent of pure PCBs would be prudent on a newer, larger, higher temperature boiler. For example, a 500 MW unit requiring 10,000 Btu/kwh (34 percent efficiency) would give

$$\text{PCB feed rate} = \frac{500{,}000\ (10{,}000)(0.001)}{13{,}800}$$

The design feed rate for a typical boiler should therefore be about 350 lb/hr of pure PCBs.

APPENDIX B

RELATIONSHIP OF OXYGEN CONCENTRATION, COMBUSTION TEMPERATURE, AND NECESSARY RESIDENCE TIME

Generalization of Required Residence Times in Accordance with Federal Regulations

The following general expression relates residence time to oxygen concentration and combustion chamber temperature:

$$t_r \geq (\exp (A/T))/(BO)$$

where

t_r = required residence time(s)

A,B = constants

O = oxygen concentration (percent by volume in exhaust)

T = furnace exit temperature (°K)

Federal regulations specify a temperature of 1200°C (2200°F) for 2 sec with an exhaust O_2 concentration of 3 percent; or alternately, 1600°C (2912°F) for 1.5 sec with 2 percent oxygen. Inserting these values into the above equation:

$2 = (\exp (A/1473.15)/(3B)$;

$1.5 = (\exp (A/1873.15)/(2B)$

Solving these equations simultaneously yields:

A = 4780.25

B = 4.2784

Because of the statutory nature of the above requirements, the equation is assumed to be valid only in the following intervals:

$1.5 \leq t_r \leq 2$

$2 \leq O \leq 3$

$1200 \leq T \leq 1600$

A plot of required residence time versus furnace exit temperature is shown in Figure B-1.

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APPENDIX C

INCINERATOR INSPECTION REPORT*
TECHNOLOGY ASSESSMENT

1. Gather background information:
   - Name.
   - Location.
   - Business.
   - Size.
   - Experience.
2. Characterize waste:
   - Types.
   - Sources.
   - Amounts.
   - Heating value.
   - Percent water.
   - Percent solids.
   - pH
   - Viscosity.
   - Flammability.
   - Toxicity.
   - Hazardous components and concentrations (S, N, halogens, heavy metals, As, etc.).
3. Observe facility appearance - general condition:
   - Odors.
   - Spills.

*EPA publication.

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- Corrosion.
- Vegetation.
- Animal life.
- Neighborhood.
- Geography.

4. Inspect incinerator:
   - Type.
   - Manufacturer.
   - Overall dimensions.
   - Feed capacity.
   - Feed system.
   - Interior configuration.
   - Ash removal mechanism.
   - Flame appearance.
   - Condition of refractory.
   - General equipment condition.
5. Note instrument readings:
   - Temperatures.
   - Feed rates (air, waste, fuel).
   - Emission monitors (CO_2, CO, O_2, HCs).
   - Others.
6. Inspect emission controls:
   - Types.
   - Scrubbing solution.
   - Pressure drop.
   - Effluent disposal.
7. Observe materials handling:
   - Continuous.
   - Transfer mechanisms.
   - Storage.

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8. Check safety equipment:
   - Automatic shutdown.
   - Fire extinguisher.
   - Alarms.
   - Personnel safety equipment (respirators, goggles, gloves, etc.).
   - Accidents.
   - Economics.
   - Permit status.
   - OSHA inspection.
9. Interview state and local regulatory authorities' performance history.
10. Additional observations/comments.
11. Persons contacted:

Name	Title	Phone Number

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APPENDIX D

PCB DISPOSAL FACILITY APPROVAL: CHECKLISTS*

In evaluating requests for the approval of PCB disposal facilities, the Regional PCB Site Approval Coordinator will need to make several decisions throughout the site approval process. Attached are several checklists which can be used to assist the Regional Coordinator in making these determinations:

1. Initial Contact by Facility Owner/Operator who Desires Approval.

   The Agency's first contact is likely to be by phone or letter from the facility owner/operator who desires approval. Regardless of who receives these contacts within the Region, they should all be funneled through the appointed Regional PCB Site Approval Coordinator. In this initial interview with the facility owner/operator, the Regional Coordinator may find it useful to use the attached "Initial Interview Checklist" to obtain some basic information which will (1) indicate whether the facility requires EPA approval and (2) assist the Regional PCB Site Approval Coordinator to prioritize the requests that are received.

*EPA publication.

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INITIAL INTERVIEW CHECKLIST

A. Name, address, and phone number of company (include both headquarters and disposal site).

B. Individual making initial contact and phone number.

C. Principal contact within company and phone number.

D. PCBs currently handled:

1. Types of PCBs currently handled, i.e., liquids, sludges, capacitors (whole or shredded), transformers, contaminated soils, etc.

2. Source of PCBs currently handled, i.e., utilities, capacitor or transformer manufacturers, railroads, industry, etc.

3. Estimated concentration and quantity for each type of PCB currently handled (total and rate). (Note: PCB mixture means any mixture, except municipal sewage treatment sludge, which contains 0.05 percent (500 ppm) on a dry weight basis or greater of a PCB chemical substance.)

4. Management techniques for each type of PCB waste currently handled, i.e., landfill, incineration, landspreading, storage, treatment, etc.

5. Approximately how long has the company been handling PCBs?

E. Approval sought:

1. Types of PCBs which will be handled, i.e., liquids, sludge, capacitors (whole or shredded), transformers, contaminated soils, etc.

2. Source of PCBs which will be handled, i.e., utilities, capacitor or transformer manufacturers, railroads, industry, etc.

3. Estimated concentration and quantity for each type of PCB which will be handled (total and rate).

4. Management techniques for each type of PCB waste which will be handled, i.e., landfill, incineration, landspreading, storage, treatment, etc.

5. Are PCBs currently being stored on site; if yes, how are they being stored and how much of each type of PCB is being stored?

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F. Have any state or local permits or approvals been received for the facility? For PCBs specifically? If yes, which state or local agency(s) issued the approval (principal contact from state or local agency(s) and phone number).

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2. Determination as to Whether Sufficient Information Exists in Technical Report.

After receiving the facility's application (technical report) to dispose of PCBs, and assuming that an EPA evaluation is to be conducted (state certification is not available or is not accepted by the Regional Administrator), the Regional PCB Site Approval Coordinator will need to conduct a cursory review of the report and determine whether sufficient information exists from the technical report and other sources with which to proceed. The attached "Technical Report Review Checklist" should be used by the Regional PCB Site Approval Coordinator to assist him in making this determination.

TECHNICAL REPORT REVIEW CHECKLIST

A. The technical report that is submitted on incinerators should, at a minimum, contain the following information:

1. The technical report should describe the location of the incineration facility with respect to:

   a. Industrial sites (both manufacturing and commercial).

   b. Residential areas.

   c. Navigable streams, i.e., rivers, lakes, etc.

   d. The nearest city, town, or village.

2. The technical report should contain a detailed description of the incinerator, including general site plans and design drawings. The description should include at a minimum:

   a. General description, i.e., rotary kiln, liquid injection, etc., of the incinerator (indicate manufacturer).

   b. Capacity of the incinerator (include the dimensions of the combustion chamber).

   c. Type of feed mechanism into the combustion chamber.

   d. Type of auxiliary fuel used, if any, and method of feeding the auxiliary fuel into the combustion chamber.

   e. Stack height.

   f. Type of air pollution control (APC) equipment, i.e., high-energy venturi scrubber, electrostatic precipitator, afterburner, etc.

   g. Capacity of the APC equipment.

   h. Type of instrumentation on the APC equipment.

   i. Type of residues, i.e., bottom ash, scrubber effluent, dust, generated from incinerator and disposal techniques, i.e., sanitary landfill, etc.

3. The technical report should contain any engineering report, test results, or other information on the performance (anticipated or measured) of the incinerator when PCBs are destroyed. The report should include at a minimum:

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a. Operating temperature of combustion chamber.

b. Operating temperature of afterburner (if appropriate).

c. Dwell time of incinerator (at temperature).

d. Combustion efficiency.

e. Mass emission rate (for incineration of nonliquid PCBs).

f. Quality of stack gases.

g. Quality of residues, including scrubber effluent.

4. The technical report should contain a description of the sampling and monitoring equipment used when PCBs are destroyed and facilities are available. The report should include at a minimum:

a. Description of laboratory facilities on site (if any).

b. Description and frequency of sampling and analytical procedures performed for PCB wastes (description and drawing of sampling train should be included).

c. Description of sampling station at the stack, i.e., portholes, platform, instrumentation.

d. Description of the monitoring equipment on the incinerator for the following:

- Temperature.
- Flow rate of combustion air.
- Flow rate of PCBs being fed into the combustion chamber.
- Stack gases, i.e., O_2, CO, CO_2, NO_x, HCl, total chlorinated organic content, PCB chemical substance, total particulate matter, etc.
- Water pressure on wet scrubber.

e. Description of the automatic shutoff system for the following:

- Failure of the monitoring operations for combustion products and incineration operations.
- Failure of the PCB rate and quantity measuring and recording equipment.
- When the combustion temperature, dwell time, and/or excess oxygen fall below specified criteria.
- Flameout.

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- Loss of water pressure in scrubber.
- Failure of feed mechanism into combustion chamber.

5. The technical report should contain the estimated quantity for each type, i.e., liquids, sludges, capacitors (whole or shredded), transformers, contaminated soil, etc., of PCB to be incinerated.

6. The technical report should include any state, local, or federal permits or approvals.

7. The technical report should include a description of the storage area.

8. The technical report should include a description of the record keeping and reporting procedures.

9. The technical report should include a list of schedules and plans for complying with the approved requirements, i.e., compliance schedule.

(For any requirements of the regulation which the facility owner/operator requests a waiver, a detailed discussion shall be included which describes the requirement(s) the facility owner/operator wants waived and the reason for requesting the waiver.)

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APPENDIX E

DESCRIPTION OF POTENTIAL
PCB INCINERATION FACILITIES

Rollins Environmental Services
Deer Park, Texas

PART I - General Information

A.	Facility name:	Rollins Environmental Services Deer Park Plant
B.	Owner:	RLC Corporation
C.	Plant manager:	Donald C. Matter (Operations) Edgar Henry (Sales)
D.	Address:	P.O. Box 609 Deer Park, Texas 77536
E.	Phone number:	(713) 479-6001
F.	Respondent:	Edgar Henry, Donald Matter, Clark Hickman
G.	Date:	October 17, 1978
H.	Comments:	Contact Edgar Henry relative to contracting for PCB disposal

PART II - Receiving/Storage

A.	Service area:	200-300 mi immediate - continental United States, other
B.	Receiving modes:	Truck, rail, barge
C.	Storage capacity:	
	1. Liquids	450 55-gal drums
	2. Solids	56 yd^3 bins; 2800 ft^2, other
D.	Comments:	Subsidiary Matlack Trucking handles shipping outside 200-300 mi radius

PART III - Preprocessing Capability

A.	Liquid blending:	Comprehensive
B.	Solids shredding:	35-gal fibre packs - 12 per hr

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Comments:	Shredding capacity not yet installed

PART IV - Incineration Equipment

A. Capacity:	
1. Liquids	5-5.5 x 10^6 [lb/mo]
2. Solids	1-1.3 x 10^6 [lb/mo]
B. Feed rate:	
1. Liquids	6600 lb/hr
2. Solids	1440 lb/hr
C. Comments:	Solids are shredded PCB capacitors

PART V - Regulatory Status

5A - Federal

A. Test application:	Submitted - one test completed
B. Certification:	Pending
C. Comments:	Second test burn to be scheduled in 1979

5B - State

A. Comments:	Texas Air and Water Commission working in conjunction with federal EPA

PART VI - Miscellaneous

A. Legal status:	Not permitted to burn PCBs Not receiving PCB materials at this time
B. Other wastes handled:	Many
C. Decontamination procedures:	Landfill available for transformer cases
D. Future plans:	Will attempt to certify New Jersey facility if Deer Park tests are positive
E. Comments:	Disposal costs to be determined at a later date

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Energy Systems Company (ENSCO)
El Dorado, Arkansas

PART I - General Information

A.	Facility name:	ENSCO - El Dorado Plant
B.	Owner:	Energy Systems Company, Inc.
C.	Plant manager:	Charles Robertson - Melvin Bell
D.	Address:	P.O. Box 1975 El Dorado, Arkansas 71730
E.	Phone number:	(501) 863-7173
F.	Respondent:	Charles Robertson/George Combs
G.	Date:	November 9, 1978
H.	Comments:	Contact Charles Robertson relative to contracting for PCB disposal

PART II - Receiving/Storage

A.	Service area:	Continental United States
B.	Receiving Modes:	Truck/rail
C.	Storage capacity:	
	1. Liquids	4200 ft^2
	2. Solids	16,800 ft^2

PART III - Preprocessing Capability

A.	Liquid blending:	Comprehensive
B.	Solids shredding:	>2500 [lb/hr]

PART IV - Incineration Equipment

A.	Capacity:	
	1. Liquids	3.66×10^6 [lb/mo]
	2. Solids	1.83×10^6 [lb/mo]
B.	Feed rate:	
	1. Liquids	5000 [lb/hr]
	2. Solids	2500 [lb/hr]
C.	Comments:	Solids represent shredded capacitors

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PART V - Regulatory Status

5A - Federal

A.	Test application:	Submitted
B.	Certification:	Pending
C.	Comments:	Test burn not yet completed. Scheduled for July 1979

5B - State

A.	Comments:	Cleared for test burn and operation by Arkansas Department of Pollution Control and Ecology - March 24, 1978

5C - Local

A.	Other:	County ordinance prohibits waste PCB combustion
B.	Comments:	ENSCO has challenged county ordinance in court and received a favorable ruling

PART VI - Miscellaneous

A.	Legal status:	Not now permitted to burn PCBs. Not receiving PCB materials at this time
B.	Other wastes handled:	Wide range of chemical toxic and hazardous wastes
C.	Decontamination procedures:	Will accept contaminated materials for decontamination or disposal

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APPENDIX F

PCB DISPOSAL FACILITY APPROVAL: STATE CERTIFICATION

In evaluating a facility for the disposal of polychlorinated biphenyls (PCBs), the Regional Administrator and his staff may choose one of two alternatives in conducting the site approval process. The first alternative is to perform the site evaluation in-house, using Regional personnel with support from the Headquarters/ Laboratory Technical Support Team, if necessary. The second alternative is to accept state certification of the facility, thus obviating the need for any EPA investigation. This guidance document addresses the latter option and discusses the state's role with regard to certification and approval of facilities for the disposal of PCBs.

In conducting the initial interview with the facility owner/operator desiring approval and/or in reviewing the applicant's technical report, the Regional PCB Site Approval Coordinator should review and evaluate the technical data and information provided by the applicant. If the facility claims to have a state permit which covers PCB disposal, the Regional PCB Site Approval Coordinator should contact the issuing state agency to determine whether the state is willing to certify in writing that the facility meets the U.S. EPA technical criteria, which are cited in Annex I and/or II of the Federal EPA PCB Marking and Disposal Regulation, or to submit information to the Regional Administrator which indicates that operation of the disposal site will not present an unreasonable risk of injury to health or the environment from PCBs should one or more of the criteria described in Subparts 761.40(a) and (b) and 761.41(b) not be met. (The Regional PCB Site Approval Coordinator should forward a completed copy of the applicant's technical report to the state as soon as possible for their review and consideration.) It is suggested that the Regional PCB Site Approval Coordinator contact the state as soon as possible to discuss the state's role with regard to site evaluation and certification for PCB disposal facilities. In addition, a copy of the PCB Marking and Disposal Regulation should be sent to each state as soon as the regulation is signed by the Administrator.

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It should be noted that, unlike other federal legislation, e.g., Federal Water Pollution Control Act (FWPCA), Resource Conservation and Recovery Act (RCRA), etc., the Toxic Substances Control Act does not authorize the Administrator to delegate his authority outside the Agency (e.g., to state or political subdivisions) to carry out any parts of the Act or any requirements prescribed in any subsequent regulations unless the Administrator is unable or is not likely to take action against a chemical substance or mixture under this Act for its prevention or elimination. Therefore, any facility owner/operator who requests permission to dispose of PCBs must seek this approval from the appropriate federal EPA Regional Administrator. Facilities which currently hold a state permit to dispose of PCBs would still require approval from the federal EPA to dispose of PCBs. However, nothing in the Toxic Substances Control Act will affect the authority of any state or political subdivision of a state to establish or continue in effect regulation of any chemical substance, mixture, or article containing a chemical substance or mixture unless the state's authority provides a lesser degree of protection than afforded by the Toxic Substances Control Act or any subsequent regulations. (See Section 18(a) (2) (b) of the Toxic Substances Control Act for more details.) For example, if the state or political subdivision provides the same or a higher degree of protection for PCBs than the requirements under the PCB Marking and Disposal Regulation, the state's standards will remain in effect and not be preempted by the federal standards. In any event, federal approval will be required. (It is intended that the PCB Marking and Disposal Regulation will be amended to allow states to permit all hazardous waste disposal facilities once the RCRA implementation process is instituted.)

If the state is willing to certify that the facility meets the specified U.S. EPA technical criteria or submits a certification which indicates that operation of the facility will not present an unreasonable risk of injury to health or the environment from PCBs when one or more of the criteria described in the regulation is not met, then the Director of the issuing state agency should notify the Regional Administrator by letter certifying the facility and recommending approval of the facility for the disposal of PCBs. A certification letter from the state to the Regional Administrator should include the following:

- The identification and location of the facility.
- A statement which indicates whether or not the facility meets all the criteria specified in Subparts 761.40(a) and (b) and 761.41(b) of the regulation.
- Any waivers on the criteria recommended by the state and why the waiver should be granted.

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- Any conditions which are placed on the state permit.
- A statement which indicates when the permit was issued and when the permit will expire.
- A statement which indicates the last date that the facility was inspected.
- A recommendation as to whether the facility should be granted approval by the Regional Administrator.
- A copy of the state permit.

The Regional Administrator and his staff will then decide whether certification from that particular state obviates the need for any further EPA investigation. In all such decisions, the opinion of the Regional Solid Waste staff should weigh heavily because they have monitored and assisted the development of the state programs and intimately know the quality of these programs. When an incineration facility is involved, the Regional PCB Site Approval Coordinator should confirm that the facility has conducted a trial burn or has monitoring data for incinerating PCBs prior to accepting the state's certification and recommendation to approve the site. A copy of all such monitoring data should be secured from the state.

If the Regional Administrator decides to accept the state's certification and recommendation to approve the facility, then upon receipt of the technical report (a completed copy of the application should be sent to the state for its review and consideration) and after providing the public an opportunity to comment on the applicant's request to dispose of PCBs, the Regional Administrator may issue a letter of approval to the facility for the disposal of PCBs. (The Regional PCB Site Approval Coordinator must confirm that the owner/operator had notified each state and political subdivision at least 30 days prior to when a required disposal may occur before the Regional Administrator may grant approval to the site.) A letter of approval to the facility should indicate the following:

- Any waivers and why the waivers were granted.
- Any conditions which are placed on the approval.
- A statement to the effect that revocation of approval is possible for violation of the standards.
- A statement to the effect that approval will be reevaluated as part of the RCRA permit process.
- Agreement to allow access for purposes of sampling and inspection.

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If the Regional Administrator does not accept the state's certification and recommendation to approve the facility for the disposal of PCBs, the Regional Office will need to perform an evaluation of the facility before any approval is granted.

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APPENDIX G

DESCRIPTION AND COST ESTIMATE
FOR PROCESS MODULES

The fully integrated liquid-solid PCB incinerator discussed in Chapter VI can be described in terms of "modules," each of which performs a specific function. These modules are identified by letters in Figure 6-17. The capital cost of the overall facility is obtained by adding the installed cost of the individual modules. This approach allows considerable flexibility in design through deletion or addition of certain modules.

The discussion of each module uses the data for the large (72.5×10^6 Btu/hr) facility. However, costs are given for both the large and the small (11×10^6 Btu/hr) facility.

All costs are updated to January 1979 using the appropriate CE Plant Cost Indices. Cost estimates are obtained from vendors' quotes and the literature. The excellent book by Guthrie (46) is used as a source of economic data, such as exponents for economy of scale and ratios of installed cost to purchased equipment cost. The modules are based on commercially available state-of-the-art designs.

MODULE A - RECEIVING AND STORAGE

This module will provide unloading facilities for 1680 55-gal size barrels of liquid PCBs and contaminated wash solvents, and 392,000 lb of capacitors per week. Unloading operations are scheduled only for a 5-day, 40-hr week, so 336 barrels (about 4 truckloads) and 78,400 lb of containerized capacitors (approximately 3 truckloads) must be unloaded and stored per work day. The facility will provide about a 10-day storage capacity, i.e., 2400 barrels and 560,000 lb of capacitors. Material-handling equipment, such as forklifts, is included in the cost of this module.

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Itemized Costs

Covered receiving dock (35 ft x 75 ft) with lighting and fire prevention	$ 34,900
Warehouse (75 ft x 120 ft) with lighting, fire prevention, and 6-in curbing	144,000
Forklifts (2 - 2500 lb, LPG)	30,000
	$208,900

The smaller incinerator will need only one forklift. The receiving dock and warehouse areas vary in proportion with the capacity of the unit, as do their costs. The total cost for the smaller unit is $42,200.

MODULE B - BARREL AND CAPACITOR SHREDDING AND FEED SYSTEM

MB Associates (see Appendix H and Chapter VI) have designed a sophisticated system for loading, shredding, and feeding solids to a rotary kiln. The following description is taken from their report (137):

Loader

The loader design consists of several ground level nestable loading hoppers that can be filled at remote areas with debris and solids to be processed through the shredder. These ground-level loading hoppers are transportable by either forklift or boom-type overhead carriers with hooks. The bins are loaded onto the extended forks of the loading mechanism and are mechanically/hydraulically lifted up to the edge of the shredder hopper, where the ground-level hopper is rotated and dumped into the main hopper. The ground-level hopper is returned to a vertical position where it, in conjunction with a fabric dust cover, acts as a seal for preventing excessive dusting. The fabric section acts as a potential explosion relief should some type of explosive material inadvertently enter the shredder hopper. The enclosed area above the shredder hopper is vented to the primary kiln so that the shredder hopper is effectively under negative pressure for improved dust control.

Shredder

The shredder is basically a shear-type counter rotating shaft unit with 1-in teeth capable of processing a wide range of materials. The shredder's capability for debris processing includes 55-gal containers, radial tires, wood pallets, batteries, brittle and soft metals such as lead or aluminum, 4-in x 4-in fence posts, small logs, shrubs, sand, gravel, dirt, paper, and other items of trash. The system will

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automatically reverse for jam clearing and does not require manual clearing unless the item causing a jam is of nonshreddable nature (e.g., steel gears, shafts, large rocks, and so forth). The potential for drawing through long shredded pieces, such as wire, metal strapping or slender sticks, is recognized. In order to compensate for this problem, three transaxial plate bars are installed to prevent excessively long, slender objects from being generated.

Ram Feed Subsystem

A ram feeder loads all solid wastes into the rotary kiln. The ram feeder is hydraulically operated with a 3 1/4-in diameter x 121-in stroke cylinder. It has the capacity of ramming up to 2 cu ft in 30 sec, as well as partial volumes over longer periods. The rate of ram feed is determined by the characteristics of the material being destroyed and can easily be field controlled for both volume and speed.

The ram cylinder rod is protected from the shredder by a sliding steel-cover plate, which is attached to and moves with the ram face. The plate seals off the ram trough from the shredder intermediate hopper and prevents shredded debris from piling up behind the advancing ram. During shredding, the ram is positioned such that the trough is closed to the shredder. The ram face provides an additional barrier to the kiln atmosphere, in addition to the two swing gates which are operated independently but sequentially as the ram advances and retracts. The ram cover plate limits the amount of material volume that the shredder can process to that volume between the cover plate and the rotating jaws, thereby, in effect, reducing potential trough overfill and ram jamming. This controlled volume represents 75 percent of the volume in the fully opened ram trough. The leading edge of the ram has a shearing edge to further reduce potential ram jamming.

The solids volume feed control is effected by controlling the ram pullback position so that the kiln can be charged frequently with partial loads and thereby reduce combustion transients or localized starved air conditions to the kiln. Swing-up gates have been incorporated in the trough bottom to isolate the shredder from the kiln atmosphere. Each swing gate functions sequentially as the ram advances and retracts. Swing gates were chosen in order to avoid slots and slide grooves which can easily be fouled with sand, dirt, oil, or debris. Additionally, the elimination of slots and grooves reduces ambient air leaks into the kiln and eliminates potential hazardous material leaks to the ground. Gate position switches control and limit ram movement in order to prevent the possibilities of uncontrolled air entering the kiln. The gate closest to the kiln is an insulated, sandwich

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construction faced with Inconel 671. The ram trough section in the kiln atmosphere will also be made of Inconel 671 for corrosion and heat considerations.

The unit can shred and feed 240 ft^3/hr. There is no cost saving for smaller incinerators because (1) the components must still be sized to handle the same size objects and (2) instantaneous peak loads are typically of the same magnitude. The cost estimate for the small incinerator shred and feed system is $117,700 (Appendix H). The larger size incinerator requires additional automatic material-handling equipment (conveyors, hoists, etc.) which is not justified with the smaller unit. The cost estimate for this unit has been adjusted to $147,700 to provide for these facilities.

MODULE C - BARREL PUMPING, LIQUID STORAGE, AND FEED PUMPS

The barrels are pumped with an air-powered stainless steel diaphragm pump. These pumps are self-priming and also pump air, so the drums can be completely drained. The bulk liquid is stored in a stainless steel tank with a capacity of 21,000 gal (1-3/4 days' production). The feed pump is a stainless steel centrifugal pump. It is oversized so that a recycle stream can be returned to the storage tank to mix it continuously.

A separate fuel oil system must be provided for warming the plant up to operating temperatures and to maintain temperatures when PCB feed is interrupted.

The estimated cost for this module is given below:

Item	Installed Cost
Pumps (diaphragm barrel pump, centrifugal feed pump, with spares)	$ 29,000
Scraped "Y" strainers	4,000
Storage tank	61,000
Fuel oil feed system	48,000
	$142,000

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The cost of this module will scale up exponentially (0.6 power) with capacity. The estimated cost for the small incinerator is, therefore, computed as follows:

$$\$142,000 \left(\frac{11}{72.5}\right)^{.06} = \$45,800$$

MODULE D - ROTARY KILN WITH ASH REMOVAL SYSTEM AND BURNER

The volume of the kiln is 966 ft^3, with a heat release rate of 25,000 $Btu/ft^3/hr$. A length to diameter ratio of 2:1 to 4:1 is considered reasonable, so internal dimensions of 7 ft I.D. by 25 ft long were selected as satisfactory. The portable unit, designed by MB Associates (137), uses a kiln with a volume of 236 ft^3 and dimensions of 4.33 ft I.D. by 16 ft long. The cost estimate for the kiln, drive, burners, ash removal, etc., is $176,300. The cost of kilns increases as the 0.78 power of the kiln volume; thus, the estimated cost for the 7-ft by 25-ft kiln would be:

$$\$176,300 \left(\frac{966}{236}\right)^{0.78} = \$529,000$$

This is the cost for the large incineration system. The MB Associates' kiln is a reasonable size for the small incineration system, and the associated cost is used directly in this report.

MODULE E - COMBUSTION AIR BLOWER

The total combustion air required is 17,070 scfm. However, due to leakage at the kiln seals, only 11,170 scfm must be provided by the blower. The blower should also be oversized about 25 percent (to 14,000 scfm) to allow for temporary operation at higher excess air than the design value. The design pressure to the burners is 16 in of water. The purchase cost of the fan is $8,400; the installed fan cost is $32,500, including associated ductwork, controls, electrical, etc.

The cost of blowers increases with the 0.68 power of flow rate. The cost for the small incineration system is computed as follows:

$$\$32,500 \left(\frac{11}{72.5}\right)^{0.68} = \$9,000$$

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MODULE F - ATOMIZING AIR COMPRESSOR

The air compressor is a standard, air-cooled, screw-type package unit. It delivers 360 scfm at 110 psig with a 75-hp motor. A recent price quote is available:

Equipment cost	$12,150
Installation, at 31 percent	3,770
Total installed cost	$15,920

The capacity exponent for the air compressor is about 0.28; thus, the compressor cost for the smaller system is as follows:

$$\$15,920 \left(\frac{11}{72.5}\right)^{0.28} = \$9,390$$

MODULE G - AFTERBURNER CHAMBER WITH BURNER AND ACCESSORIES

The preferred configuration of the afterburner is a vertical cylinder with a 3:1 length to diameter ratio and a conical bottom. The gases should have a strong rotary or vortex motion in order to provide rapid mixing of the gases from the rotary kiln with those from the burners in the afterburner. The vertically up-fired Peabody Vortex-type incinerator (105) meets these requirements.

The flow rate of flue gases is 105,000 acfm at 2200°F, with 40 percent excess air and 1 lb of water per pound of combustibles. However, if different combustion parameters are used, this volume can be higher. For example, at 2200°F, 72 percent excess air and 0.5 lb water per pound combustibles, the exhaust flow increases to 120,000 acfm. A residence time of 2.5 sec at design conditions will allow some flexibility in operation while maintaining a minimum 2-sec residence time. The associated internal dimensions of the afterburner are 12 ft in diamter by 36 ft long.

The cost of the afterburner and interconnecting ductwork based on recent quotes is as follows:

Incinerator, refractory, burners	$ 72,000
Interconnecting ductwork and refractory	15,000
Total base equipment cost	87,000
Installation at 136 percent of base equipment cost	118,300
Total installed cost	$205,300

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The cost of the smaller unit, based on a capacity exponent of 0.6, is as follows:

$$\$205,300 \left(\frac{11}{72.5}\right)^{0.79} = \$146,500$$

MODULE H - SCRUBBING SYSTEM WITH PUMPS, FAN, AND ALL ACCESSORIES

The 72.5×10^6 Btu/hr incinerator produces 48,000 acfm of flue gas which are saturated with water at 185°F. No reduction in flue gas volume is assumed by using large volumes of cool water to condense water vapor and reduce the dew point of the gases. This is normally an economically attractive option because it reduces the size of the induced draft fans and also improves the scrubbing efficiency. The scrubbing system consists of a venturi, two absorption trays, and a demister, with a total pressure drop of 60 in of water for the entire system. The design is conservative in terms of both flow rate and pressure drop.

Materials of construction must be adequate for highly corrosive conditions where both low pH and chlorides are present. Acid brick, rubber-lined steel, high alloys (such as Hastelloy C-276), fiberglass-reinforced polyester, and vinylester plastics are suitable materials of construction.

The literature revealed two different scrubber cost estimates for this same capacity. Ackerman, et al. (3), developed a cost estimate for a system similar to that used at the Rollins plant in Deer Park, Texas (see Chapter VI). After updating costs to January 1979 and adjusting for relative capacities, a total installed cost of $621,000 for the scrubber system without stack was obtained. Also, using cost data given by Perry (108), and by correcting for inflation and materials of construction, a cost of $678,000 was obtained. The average value of $650,000 was used in the analysis.

The cost of a high-energy venturi scrubbing system scales with a 0.79 capacity exponent. Thus, the scrubbing system for the smaller system will cost approximately:

$$\$650,000 \left(\frac{11}{72.5}\right)^{0.79} = \$146,500$$

MODULE I - LIME STORAGE AND SLAKING

This package unit includes a 3000 ft^3 storage bin, bin activator, lime slaker (2500 lb/hr), slurry storage tank, slurry, pump, dust controls, wiring, lighting, and

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motor controls. Vendors' quotes on this unit (May 1978) ranged from $100,000 to $120,000. The estimated cost, as of January 1979, is as follows:

Equipment cost	$116,000
Installation @ 30 percent of equipment cost	34,800
Total installed cost	$150,800

This system has a storage capacity of 180,000 lb or a 5 1/2-day supply (4 truckloads of bulk lime) for the large incineration system.

There are limitations on the size reduction that is possible with the smaller unit. The storage volume must be at least 1 1/2 truckloads or 60,000 lb. The 2500 lb/hr slaker is the smallest size available, and many other components have fixed costs. A 60,000 lb storage system costs about $112,000 installed.

MODULE J - SETTLING AND SLUDGE LAGOON

A lined lagoon is needed to clarify scrubber water and to accumulate sludge and calcium chloride brine for disposal. A 45-m by 45-m lagoon is adequate for the large unit. The liner is chlorinated polyethylene reinforced with polyester fibers. Estimated costs are as follows:

Liner @ $5.92/$m^2$ (49 m x 49 x liner)	$14,000
Dirt work and liner installation @ $5.25/$m^2$	12,800
Total cost	$26,800

A 0.10-hec lagoon is adequate for the smaller unit; its cost is an estimated $13,400, based on recent quotes for a similar system.

MODULE K - STACK

The stack is sized for a flow of 48,000 acfm of combustion gases saturated with water at 185°F. The most economical materials of construction for stacks handling high-corrosive gases are fiberglass-reinforced polyester and vinylester plastic. The cost for a 1.8-m by 30.5-m stack with test platform and ladder for the large incinerator unit is as follows:

Bare stack*	$18,200
Platform and ladder*	10,600
Total equipment	28,800

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Installation @ 50 percent of equipment cost	$14,400
Total installed cost	$43,200

A 1-m x 23-m stack is adequate for the small unit. Its cost is:

Bare stack*	$ 9,100
Platform and ladder*	9,300
Total equipment	18,400
Installation @ 50 percent of equipment cost	9,200
Total installed cost	$27,600

*These costs are based on vendors' quotes obtained in May 1978 and are adjusted for inflation to January 1979.

MODULE L - INJECTION WELL

The injection well will dispose of 736 gal/hr of 30 percent calcium chloride brine (specific gravity - 1.28). The depth of the well and the injection pressure required will be dependent upon local geological conditions. This cost estimate is for a median depth of 1700 m and average formation pressures and permeability. The injection rates are relatively low, so little reduction in cost can be expected for the small incinerator injection system.

The following cost estimate, therefore, is used for both the large and the small incinerators:

Site preparation	$ 5,500
Drilling rig service	90,500
Cementing (materials and service)	12,000
Testing, perforating, stimulation services	50,700
Tubular goods	45,750
Consultant fees (including permit application)	15,000
Well equipment	7,000
Contingency	16,500
Subtotal - Deep Well	$242,950

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TRANSFER STATION

Storage tank (84,000 gal capacity)	$ 12,000
Pumps, motors, filters, electrical controls, etc.	15,200
Contract labor	3,500
Contingency	3,000
Subtotal - Transfer Station	$ 33,700
Total cost	$276,650

MODULE M - INSTRUMENTATION AND CONTROLS

A sophisticated control system is needed both because of the relative complexity of a combined liquid-solid incinerator and because of the monitoring and automatic shutdown requirements of the PCB disposal regulations. MB Associates has designed an appropriate control and monitoring system for PCB incinerators (137), which is recommended for this application.

The control system is a rugged industrial-grade programmable controller utilizing relay ladder logic. This system is therefore capable of being programmed by personnel familiar with standard electrical diagrams. A visual display provides the operator with critical operating data, adjustments being made by the controller at a given moment, and alarms that are both visual and audible. The audible alarms are dual level so that operating personnel can distinguish between critical conditions requiring rapid attention and emergency demands for shutdown procedural action.

The controller scans all pertinent operating conditions several times a second, compares these data to standard operating data in the memory bank, indicates the control adjustment required, and provides a visual display of the adjustment in-process. Extreme or abnormal conditions trigger a buzzer alarm signifying rapid operator attention. Dangerous and very critical system failures result in both an emergency horn and flashing lights.

The cost estimate for this system is $123,400 (see Appendix H). The addition of carbon monoxide and carbon dioxide stack gas monitors, and of the interlocks to stop the feed of PCBs as required by the regulations, is estimated to raise the total cost to about $145,000. This cost is independent of the size of the incinerator.

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MODULE N - LABORATORY

Because of the strict regulations imposed on the operation of a PCB incinerator, an on-site laboratory is needed. This laboratory should be able to measure PCBs at low concentrations in the scrubber water or ash, surface runoff, ground water samples, etc. It should be able to determine the PCB content, heating value, chlorine, and ash content of the feed streams. The estimated cost of the laboratory, instruments, and supplies is given below:

Basic laboratory area and services, (20 ft x 30 ft = 600 ft^2) @ \$50/ft^2	\$30,000
Additional cost for equipment (hoods, benches, etc.) @ \$31/ft^2	18,600
Gas chromatograph: dual columns, dual detectors (electron capture and flame ionization)	15,000
Bomb calorimeter and accessories	2,000
Assorted glassware, reagents for titrations, distillation and concentration equipment for PCB analyses	2,500
Gas chromatograph accessories: installation (copper tubing, fittings, gas cylinders, regulators)	1,000
Gas chromatography supplies: columns, column packing materials, syringes	2,000
pH meter with specific ion capabilities	1,500
Analytical balance	3,000
Refrigerator/freezer (sample and reagent storage)	600
Drying oven, centrifuge, vortex mixer, hotplate stirrer, constant temperature water bath, and various other peripheral items of equipment	5,000
Total cost	\$81,200

MODULE O - OFFICE, MAINTENANCE SHOP, CHANGE ROOM

The large plant requires offices for six people, change and break room for 28 people, and adequate maintenance shop space. The estimated cost for these facilities is itemized below:

Office building - 900 ft^2 @ \$46/ft^2	\$ 41,400
Office equipment @ \$12/ft^2	10,800

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Change and break room - 900 ft^2 $46/$ft^2$	$ 41,400
Equipment @ $12/$ft^2$	10,800
Maintenance shop - 1200 ft^2 @ $26.50/$ft^2$	31,800
Shop equipment @ $18/$ft^2$	21,600
Total for buildings	$157,800

The small incinerator requires office space for three people, and change and break room space for nine people. The estimated cost for these facilities is itemized below:

Office building - 450 ft^2 @ $46/$ft^2$	$20,700
Office equipment @ $12/$ft^2$	5,400
Change and break room - 300 ft^2 @ $46/$ft^2$	13,800
Equipment $12/$ft^2$	3,600
Maintenance shop - 400 ft^2 @ $26.50/$ft^2$	10,600
Shop equipment @ $18/$ft^2$	7,200
Total for Buildings	$61,300

MODULE P - GROUND WATER, SURFACE RUNOFF, AND AMBIENT AIR MONITORING

The proposed regulations for hazardous disposal facilities require a minimum of four ground water monitoring wells. Surface runoff will be collected in a single lagoon where it can be tested and either discharged or incinerated.

At least one upwind and one downwind ambient air monitoring station will likely be required as well, although not specified in existing regulations. The ambient air monitors must be capable of sampling both particulate and organic vapors (PCBs in particular). The estimated costs are as follows:

6 ground water monitoring wells	$15,000
2 portable ambient air monitoring stations	10,000
0.6 hec-m clay-lined lagoon	25,000
Total cost	$50,000

MONS 028557

Estimated costs for the small incinerator are as follows:

4 ground water monitoring wells	$10,000
2 portable ambient air monitoring stations	10,000
0.12 hec-m clay-lined lagoon	10,000
Total cost	$30,000

MODULE Q - LAND

Two philosophies of site selection and acquisition are considered for locating the PCB incinerator:

1. Purchase of 6 hec in an industrialized area at approximately $50,000/hec.

2. Purchase of 60 hec in a rural area at approximately $5,000/hec.

The cost of land in either case would be $300,000.

For the case of the small incinerator, a 1.5-hec industrial site or a 15-hec rural site would be required, with an associated price of $75,000.

MONS 028558

APPENDIX H

COST ESTIMATE FOR PORTABLE PCB
INCINERATOR - MB ASSOCIATES

Capacity:		
	Dry sand or dirt:	Up to 9000 lb/hr
	Water or sludges:	Up to 1400 lb/hr
	Oil (18,000 Btu/lb):	Up to 725 lb/hr

Total estimated cost: $1,137,800.

Detailed cost breakdown:

Control Subsystem	
• Programmable controller	
• Display console	
• Dual-level alarm	
• Gas stream monitoring	
• Control values	$123,400
Feed Subsystem	
• Solids loader	
• Solids shredder	
• Solids ram feeder	
• Sludge and liquid feed systems	$117,700
Incinerator Subsystem	
• Kiln and drive	
• Economizer chains	
• Burners and blowers	
• Ash removal	
• Protective cowling	$176,300

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Afterburner Subsystem

- Primary afterburner
- Burners and blowers
- Inlet swirl plate
- Outlet molar flow nozzle
- Protective cowling $125,600

Exhaust Gas Treatment Subsystem

- Venturi quench
- Particle scrubber
- Absorption scrubber
- Induced draft blower
- Blower drive
- Sound attenuation
- Stack $312,800

Equipment Interconnects

- Inconel ducting
- Water plumbing
- Electric power system
- Fuel plumbing
- Control wiring $70,200

Auxiliary System

- Hydraulic
- Diesel alternator
- Air compressor
- Emergency water $82,800

Trailers

- Basic trailers
- Material handling cranes
- Steps, rails, and platforms
- Equipment storage rack $130,000

MONS 028560

APPENDIX I

DESCRIPTION OF LAND DISPOSAL SITES
PERMITTED FOR RECEIPT
OF PCB MATERIALS

Niagara Falls, New York	I- 2
Model City, New York	I- 7
Sumter County, Alabama	I-12
Arlington, Oregon	I-17
Casmalia, California	I-23
Grand View, Idaho	I-26

MONS 028561

NIAGARA FALLS, NEW YORK

OVERVIEW

The Niagara Falls, New York, site is located in the industrial sector of the city of Niagara Falls, New York. Relatively wet climate and near surface ground water (<15 m) have necessitated construction of special water quality protection facilities for this secure landfill.

Region II has approved the area of this site known as secure landfill No. 2 for receipt of PCB-contaminated materials. The permit is valid for a period of three years, commencing August 18, 1978. Twenty-five units within subcell I of secure landfill No. 2, occupying a volume of 26,600 m^3 (937,500 ft^3) have been designated for PCB-contaminated materials. Site operations are interrupted temporarily during heavy rains or snowstorms. There is no public objection to the PCB landfill activity. The monitoring program at secure landfill No. 2 includes monthly sampling ground water monitoring wells, surface water sampling points, and accumulated leachate. A total of 44 water sampling points is used for the monitoring purpose.

HISTORY OF PCB LANDFILL ACTIVITY

The Niagara Falls landfill site is operated by NEWCO Chemical Waste Systems, Inc. (NEWCO). Site operations began in 1976, and PCBs were received through 1978. On January 30, 1978, NEWCO applied to the New York State Department of Environmental Conservation (DEC) to construct secure landfill No. 2 for disposal of hazardous waste. A construction permit was granted by DEC on May 9, 1978, and one month later (June 8, 1978) NEWCO received the operation permit.

NEWCO also applied to EPA Region II on April 24, 1978, for approval of secure landfill No. 2 as a PCB material disposal site. EPA approval of a three-year permit was formally granted on August 18, 1978, following a one-month public comment period (from May 29, 1978, to June 28, 1978) and a review of submitted documents.

MONS 028562

SITE DESCRIPTION

Location

NEWCO's Niagara Falls site is located at 56 Pine Avenue, Niagara Falls, New York, and is about 32 km (20 mi) northwest of Buffalo International Airport (Figure 1).

Operating Agency

The site is owned and operated by NEWCO. The company's headquarters is located at 4626 Royal Avenue, Niagara Falls, New York 14303, telephone (716) 278-1811.

Site Area

The disposal site was constructed on the outskirts of the city of Niagara Falls and is surrounded by industrial factories and plants. It is fenced and covers approximately 266 ha (658 ac). Only authorized personnel are permitted to enter the site. There are four separate sections inside the fenced area: (1) an office, maintenance shop, and laboratory to the northwest; (2) an acid-base neutralization pond and an aqueous pretreatment system to the east; (3) a municipal solid waste sanitary landfill to the southeast; and (4) an area designated as secure landfill to the southwest of the site (Figure 2).

The secure landfill areas have three cells: Secure Landfill (SL) No. 1, which has been filled; SL No. 2 is in operation; and SL No. 3 is being prepared. SL No. 2 was built 20 percent below and 80 percent above ground. It is 7.6 m (25 ft) deep and is divided into three subcells by clay berms. Subcell I is designated for general chemical and halogenated organic wastes; Subcell II is for pseudo-metals; and Subcell III is for heavy metals. Each subcell is, in turn, divided into grids of 15 m x 9 m (50 ft x 30 ft) to ensure that incompatible wastes are segregated. In SL_3 No. 2, Subcell I, 25 units with a total volume of 26,600 m^3 (937,500 ft^3 or 25 ft x 50 ft x 30 ft x 25) are designated for PCB-contaminated materials.

Secure Landfill Construction

In constructing SL No. 2, the land was excavated to a depth of 1.5 m (5 ft). Part of the excavated soil was used to construct compacted soil berms on the edge of the cell to provide an additional height of 6.1 m (20 ft). As a result, the total depth of the cell is 7.6 m (25 ft). The cell is lined with 30 mil B. F. Goodrich Flexseal 30 HP membrane liner which is sandwiched between 90-cm (3-ft) thick recompacted clay

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underneath and 60-cm (2-ft) thick recompacted clay on top. After liner placement, clay berms were built to divide the cell into subcells.

Provisions for containing and collecting any leachate are also installed. Two concrete standpipes for leachate collection are located in each subcell, and each pair of standpipes is hydraulically connected with perforated vitrified clay pipes overlayed with stone. Each subcell floor is sloped towards the leachate standpipes at a 2 percent gradient.

Environmental Factors

Soil. The base of SL No. 2 consists of 6 m [illegible] ft) of compacted clay with a moisture content of greater than 30 percent [illegible] a plasticity index exceeding 15. The clay obtains a permeability of about 10 [illegible] cm/sec (160). Permeability of recompacted clays is even lower (10^{-9} cm/sec).

Hydrology. Local topography is generally flat. The site is less than 15 m (50 ft) above the ground water and is about 3.2 km (2 mi) north of the Niagara River. Ground water contains a very high concentration of chloride and is considered not potable (109). There is no hydraulic connection between this river and the site (160). The landfill perimeter is bermed to an elevation of 6 m (20 ft) above the datum and, consequently, is capable of diverting all off-site, upstream surface water runoff from a 24-hr, 25-yr storm.

Climate. Climatic data from Buffalo, which is approximately 32 km (20 mi) southeast of NEWCO's secure landfill site, are presented in Table 1 (17). The monthly average temperature at the site is approximately the same as that of Buffalo. However, normal precipitation is about one fourth that registered at Buffalo.

PCB-CONTAMINATED WASTE HANDLING

Disposal Procedures

Prior to delivery of PCB-contaminated materials to the site, the waste characteristics are documented by NEWCO's customers and verified by chemical analysis at the site. The waste specification is then recorded, using a six-digit code which specifies the following:

- Designated location for the wast [illegible] SL No. 2.
- Characteristics of the waste.
- Cover material required.

MONS 028564

The coded waste is then containerized in barrels or cardboard boxes and hauled to the site. NEWCO provides hauling service to its customers if they so desire or receives the delivered waste materials in customer vehicles.

The PCB-contaminated materials received consist of sealed capacitors, drained transformers, PCB-contaminated earth, rags, etc. These materials are unloaded to a designated unit in Subcell I by front-end loader and/or forklift, and are covered with 45-cm (1.5-ft) thick soil-lime mixture. The lime material is available at the site as a by-product of a former acetylene production process. The amount of lime stockpiled at the site is estimated at up to 50 million m^3. The lime additive helps keep pH high to minimize potential for heavy metal movement from the disposal area.

For PCB-contaminated wastewater treatment sludges, the sludge must be thoroughly dewatered before shipment. As a handling procedure, the percentage of free liquid is checked by NEWCO's on-site laboratory prior to disposal. The sludge must have less than 15 percent by volume of free liquid.

Quantity Received and Gate Charge

NEWCO's Niagara Falls site is relatively busy. On the average, 10 to 15 truckloads of chemical waste material per day (200-300 t/d, or 200-300 m^3/d) are received. Less than 10 percent of the shipment contains PCBs. NEWCO expects to accept a larger quantity of PCBs in the near future from new customers. Some large utility industries are negotiating for service contracts.

The site operates five working days per week year-round. Off-hour delivery schedules, however, can be arranged.

The gate charge for PCBs is negotiated with each customer. No information on charges was disclosed for publication.

Monitoring Program

Thirty-two ground water monitoring wells are in place at the site. These wells are cased, and the annular space between the monitored zone (zone of saturation) and the surface is backfilled with portland cement to prevent percolation of surface water into the well bore. The well opening at the surface has a removable cap to provide access and to prevent the entrance of rainfall or storm water runoff.

MONS 028565

During the operational life of the site, each monitoring well and six surface sampling points are investigated monthly. Samples are analyzed for the following parameters: PCBs, pH, total chlorinated organics, and specific conductance. After closure of the SL No. 2 cells, the sampling frequency will be reduced to every six months indefinitely.

Leachate from SL No. 2 is monitored monthly. Leachate is pumped out via a portable pump or vacuum truck when leachate level in the standpipe exceeds 46 cm (18 in). Based on analysis, leachate will be collected and treated on-site accordingly, prior to discharging to nearby streams. A water treatment facility is provided on-site by NEWCO.

Equipment and Personnel Summary

For the NEWCO PCB disposal activity, the following equipment is used:

- One small track dozer.
- One front-end loader.
- One to two forklift(s) equipped with drum grabber.
- One pickup truck.

Three to five persons are assigned to the SL No. 2 (including a supervisor), depending upon the work load.

OPERATIONAL PROBLEMS

Inclement weather causes slippery soil conditions for mobile equipment. In addition, during extreme heavy rain or snowstorms, site activity may be temporarily interrupted. However, NEWCO has on-site snow removal capability to keep the site open under adverse conditions.

PUBLIC ACCEPTANCE

The NEWCO Niagara Falls site is surrounded by factories and industrial plants. The landfilling operation appears to be of little concern to the public because air pollution and other impacts from surrounding industrial operations are more obvious. During the summer of 1978, CBS and NBC television networks were inivited to visit the site while covering a report on the Love Canal incident (water contamination due to improper chemical waste disposal in the 1950s). Such media coverage on NEWCO's activities has resulted in a positive impact for the site operation.

MONS 028566

MODEL CITY, NEW YORK

OVERVIEW

The Model City, New York, site is about 55 km (34 mi) north of Buffalo International Airport. The PCB secure landfill portion of this site involves features to protect surface waters and near surface ground water (<15 m) from contamination.

EPA approval for disposal of PCB-contaminated materials has been granted to secure landfill No. 7 at the site for a period of three years, commencing October 2, 1978. Total volume of the available fill is about 177,500 m^3 (6,250,000 ft^3) and one fifth is designated for PCBs. The site monitoring program includes monthly sampling of five ground water monitoring wells, eight surface water sampling points, and accumulated leachate. Gate charge is \$388/m^3 (\$11/ft^3) or about \$80 per each 55-gal drum of PCB-contaminated waste.

Local environmental groups have expressed concern with the site's chemical waste disposal operations.

HISTORY OF PCB LANDFILL ACTIVITY

The Model City, New York, secure landfill is owned and operated by SCA Chemical Waste Services, Inc. (SCA). The site covers 348 ha (860 ac), one quarter of which was purchased in 1972 and the remainder in 1974. The site housed TNT production facilities during World War II. After the war, some radioactive wastes were buried here. Prior to conversion to a secure landfill, the site was decontaminated (by removal of radioactive waste) to reduce radioactivity levels to below 50μ Ci.

All chemical wastes, except radioactive and explosive substances, are accepted at this site. Before promulgation of final EPA regulation for PCB, approximately 10 percent by volume of total waste accepted were PCB materials. On April 24, 1978, SCA filed application with EPA Region II for approval of secure landfill No. 7 for PCB disposal. The EPA approval was formally granted on October 2, 1978, for a three-year period following one month of public comments (from June 2 to July 2, 1978) and review of submitted documents. In addition, the New York Department of

MONS 028567

Environmental Conservation granted SCA state permit to construct a secure landfill at this site.

SITE DESCRIPTION

Location

SCA's Model City secure landfill is located on Balmer Road, Model City, New York, and is about 24 km (15 mi) north of the NEWCO's Niagara Falls site (Figure 3). A local map showing directions to the SCA site from the Buffalo area is shown in Figure 4.

Operating Agenc

The site is own and operated by SCA, which provides collection, treatment, recovery and disposal of solid and chemical wastes. Its stock is traded on the New York Stock Exchange under the symbol SCA. Its executive offices are located at 60 State Street, Boston, Massachusetts 02109, telephone (617) 367-8300.

SCA has other major waste processing and disposal facilities in New Jersey, New York; Illinois; and South Carolina.

Site Area

The Model City, New York, secure landfill has an area of approximately 348 ha (860 ac). It is fenced and posted to warn of hazardous chemical storage and dissuade unauthorized entry. There are three separate sections inside the fenced area: (1) a laboratory and offices area; (2) a storage building; and (3) the secure landfill area.

Secure landfill No. 7 has a volume capacity of 177,500 m^3 (6.25 million ft^3 or 500 ft x 500 ft x 25 ft) and consists of five subcells. Each subcell is designated for a special type of waste, as follows:

Subcell No.	Waste Type or Constituents
1	Heavy metal
2	Pseudo-metals
3	Organics
4	Halogenated organics (including PCBs)
5	Sludge

MONS 028568

Figure 5 shows the general configuration of this area.

Secure Landfill Construction

The land was first excavated to a depth of 5.2 m (17 ft). Part of the excavated soil was used to construct a compacted earthen berm on the perimeter of the pit to a height of 2.7 m (9 ft). Thus, the effective pit depth before liner and clay barrier installation is 7.9 m (26 ft). These construction features are designed to create a higher upward piezometric pressure underneath the pit, preventing downward movement of any leachate that may be generated. Unused soil was stockpiled and will be used as cover material.

The pit was next lined with 50-mil hypalon membrane liner (Figure 6). The membrane is protected from mechanical damages by a 90-cm (3-ft) thick compacted clay layer. After liner placement, clay berms were built to divide the fill into subcells (Figure 5). Two vitrified clay collection pipes were laid on the sidewall of each subcell. These pipes are hydraulically connected with a sump to provide for leachate collection.

Leachate Factors

Soil. The base of SCA's secure landfill No. 7 consists of 9-m (30-ft) clay with permeability of less than 10^{-7} cm/sec, plasticity index of greater than 15, and liquid limit of greater than 30 (161).

Hydrology. Ground water is at less than 15 m (50 ft) beneath the fill and is nonpotable. Piezometric pressure beneath the fill tends to oppose downward movement of liquids or leachate from the waste containment areas. The closest surface water bodies are two small creeks, called Twelve Mile Creek and Six Mile Creek, which are on or immediately adjacent to the site. These streams flow intermittently. There is no hydraulic connection between these water bodies and the fill. There is no surface water on the site, other than lagooned wastewater that is part of the disposal operation.

The landfill perimeter is bermed to an elevation of 3 m (9 ft) above the datum. These berms are capable of diverting all of the surface water runoff from a 24-hr, 25-yr storm.

Topography. The site is relatively flat. Little or no evidence of erosion is apparent.

MONS 028569

Climate. The climatic data of Buffalo, located 55 km (34 mi) south of the site, are presented in Table 1 in the previous section (Niagara Falls, New York). Generally, the area is relatively wet with 145 cm per yr (57 in per yr) rainfall and 69 cm per yr (27 in per yr) evaporation.

PCB-CONTAMINATED WASTE HANDLING

Disposal Procedure/Quantity Received

SCA individually negotiates the details of PCB waste delivery and disposal with each customer. The generator provides SCA with a description of its waste characteristics which SCA can verify in its laboratory prior to disposal.

At the disposal site, PCB-contaminated materials are unloaded to subcell No. 4 by use of a front-end loader and/or a forklift. The waste is covered with clay on an "as required" basis. PCB-contaminated sludge is not containerized but spread on the fill floor and covered with clay.

Landfill No. 7 was originally projected to be filled in 3 yr, but will probably be filled within about one year because PCB-contaminated soils from a highway spill are being deposited here. The gate charge is $388 per m^3 ($11 per ft^3) or $80 per 55-gal drum. Identity of the company's present customers are considered proprietary information.

The site operates year-round on a 5-day per week schedule. However, special arrangements can be made for waste materials to be delivered on weekends.

Monitoring Program

Five ground water monitoring wells and eight surface water sampling points are sampled monthly and monitored for the following parameters: PCBs, pH, specific conductance, and chlorinated organics. After site closure, the sampling frequency will be reduced to every 6 mo for an indefinite period.

Any leachate that collects in the collection sump in each subcell is also monitored monthly. Leachate is pumed out via a vacuum truck when the leachate level in the standpipe exceeds 30 cm (1 ft). The leachate is then neutralized, settled, filtered, and treated by flow through a carbon bed. When its PCBs, other chlorinated organics, and salt content meet the state and federal regulatory standards, the treated effluent is discharged to nearby streams.

MONS 028570

Equipment and Personnel Summary

For the PCB disposal activity at the site, SCA utilizes front-end loaders and forklifts. The number of each type of machinery and personnel working at the site varies, depending upon the work load.

PUBLIC ACCEPTANCE

Local environmental groups and some candidates for political office have expressed concern about the SCA site. One court case challenging the site location was recently settled in favor of SCA because operations adhere to all state and federal regulations.

Presently, SCA has no formal public relations programs. The company, however, does offer site visits to those citizens who want to know more about its chemical waste handling activities.

MONS 028571

SUMTER COUNTY, ALABAMA

OVERVIEW

The Sumter County, Alabama, site is located in Emelle, on State Road 17, Mile Marker 163. The site is underlain by 152 m (500 ft) of dense gray to blue limey clay and chalk, with an average permeability of 4×10^{-8} cm/sec and a plasticity index of 10.8.

EPA approval for disposal of PCB-contaminated materials was granted to the site on June 28, 1978. Trench No. 5, which has a total volume of 34,000 m^3 (1.2 million ft^3), has been designated for PCB-contaminated material disposal. On the average, 25 m^3 waste (e.g., capacitors, drained transformers, etc.) and forty 55-gal drums containing PCB-contaminated materials are received daily. Gate charges are not published; they are negotiable depending on waste type and volume.

The site monitoring program includes monthly sampling at three monitoring wells downstream from the PCB trench; quarterly sampling at nine other wells on the site, and semiannual sampling of nine state wells. Leachate from Trench No. 5 is monitored via two standpipes hydraulically connected to a sump inside the trench. No major public objections or operational problems have been encountered.

HISTORY OF PCB LANDFILL ACTIVITY

The Sumter County, Alabama, landfill is owned and operated by Waste Management of Alabama, Inc. It was opened in May 1977 and accepts all types of hazardous wastes, except radioactive and pathogenic wastes. Municipal refuse are excluded as well. Prior to promulgation of final EPA regulations for PCBs, approximately 0.5 percent by volume of the total accepted waste was PCB. On March 10, 1978, Waste Management of Alabama filed application with EPA Region IV for approval of the site as a PCB disposal site.

EPA Region IV formally granted a permit for PCB waste disposal on June 28, 1978, following the requisite 30-day public review period (no public comments were submitted). The Alabama Division of Solid Waste and Vector Control recommended that EPA approve the site for PCB disposal.

MONS 028572

SITE DESCRIPTION

Location

The Sumter County, Alabama, site is located in Emelle, on State Road 17, Mile Marker 163, and is about 17 km (10 mi) northwest of Livingston, Alabama (Figure 7).

Operating Agency/Site Manager

The site is owned and operated by Waste Management of Alabama, also known as Resource Industries of Alabama, a division of chemical Waste Management, Inc. The company addresses are as follows:

Resource Industries of Alabama
P.O. Box 1200
Livingston, Alabama 35470
Telephone: (205) 652-9529

Chemical Waste Management, Inc.
900 Jorie Boulevard
Oak Brook, Illinois 60521
Telephone: (312) 654-8800

Site manager is Mr. Mark Gregory, telephone (205) 652-9529.

Site Area

The site covers approximately 365 ha (900 ac), all suitable for landfilling. About 41 ha (100 ac) are partially enclosed with a 1.8-m (6-ft) chain-link fence. Presently, three trenches (Trench Nos. 4, 5, and 6) are in operation (Figure 8). Trench No. 5, which has a total volume of 34,000 m^3 (1.2 million ft^3 or 100 ft x 200 ft x 60 ft), is designated for PCB-contaminated material.

In addition to the landfill trenches, there is one large evaporation pond on site. Other facilities are a new office and laboratory building and a maintenance shop.

Environmental Factors

Soil. The main geologic units found at and around the landfill site are the Demopolis and Ripley formations of the Selma Group (162). The outcrop of Demopolis at the site consists of dense gray to blue limey clay (containing up to 82 percent

MONS 028573

agricultural grade lime) and chalk, which are approximately 152 m (500 ft) thick. Seashells present on site indicate the area was formerly under seawater. Average soil permeability is 4×10^{-8} cm/sec, and the plasticity index is 10.8.

Topography and Hydrology. The site can be described as gently rolling, with low relief in a northward direction. The average site evaluation is approximately 45 m (148 ft) above sea level. The PCB-designated disposal trench is located on the crown of a ridge at an approximate elevation of 61 m (200 ft). This is well above the 100-yr floodwater elevation (38 m or 125 ft). The ground water table generally is at 46 m (150 ft) or deeper, although occasionally perched water seams are noted at the 3 m (9 ft) level (162). The closest surface waters are a small creek 1.6 km (1 mi) north of the site and Tombigbee River, 11 km (7 mi) to the northeast.

Climate. Climatic data of Whitfield, approximately 48 km (30 mi) southeast of the site, are presented in Table 2. The monthly average temperature for the entire year is 19°C (66°F), ranging from a low of 10°C (51°F) in December to a high of 27°C (81°F) in July. Annual precipitation is 133 cm (52 in) and evaporation 127 cm (50 in).

PCB-CONTAMINATED WASTE HANDLING

Disposal Procedures

Containerized PCB-contaminated materials, e.g., drained transformers, sealed small capacitors, drums, etc., are unloaded from the delivery truck by a forklift and delivered to the trench by a front-end loader (Figures 9 and 10). Wastes are covered daily with native soil. PCB-contaminated sludge is not containerized but spread on the fill floor and may be left uncovered for several days (Figure 11). After loss of excess moisture by evaporation, the sludge is covered, also with native soil.

Quantity Received

The site is relatively active. An average of 26 truckloads of chemical waste are delivered each day. This is equivalent to 85 m^3 (3000 ft^3) or 400 drums of waste. Before the final EPA's PCB regulations were issued, about 0.5 percent of the total waste received was PCBs. This rate has increased to more than 10 percent since July 1978 (to 25 m^3 waste and 40 drums daily). The company's major customers were not disclosed nor were the specific gate charges for PCBs. Indications are that disposal rates here are comparable to those elsewhere. Rates are negotiable.

MONS 028574

The site operates five working days per week year-round. Special arrangements can be made for waste materials to be delivered on weekends.

Monitoring Program

There are nine wells located nearby off-site (called state wells) and nine wells at the site. Water samples from the state and site wells are taken every six and three mo, respectively. In addition, water is also sampled from three downstream wells installed 5 m (15 ft) below the bottom of the PCB trench (Figure 8).

For leachate collection, a 10-cm (4-in) graded gravel blanket is provided in the PCB trench bottom. This blanket allows liquids to drain easily to a sump. Leachate monitoring is conducted monthly via two standpipes (ID = 15 cm) hydraulically connected to the sump (Figures 8 and 10).

Equipment and Personnel Summary

The site has the following equipment for trench construction, waste hauling, and disposal:

- 1 forklift.
- 2 front-end loaders.
- 3 bulldozers.
- 4 scrappers.
- 6 tractors.
- 3 vans.

Twenty-five persons are employed at this site. Assignments to the PCB disposal operations vary with waste loadings. Waste Management of Alabama also provides hauling service upon request. The company has a fleet of 12 trucks for this purpose.

PUBLIC ACCEPTANCE

The local community is small and agriculturally oriented. There has been no public opposition to disposal operations.

The apparent public acceptance is likely the result of an effective public information/education program initiated by Waste Management, Inc. For example, Waste Management personnel offer site tours, visits for community groups and

MONS 028575

individuals, and otherwise assist the public in understanding the disposal operations. In addition, ground-up agricultural grade lime (mined from the site during trench excavations) is provided to the local farmers at no cost.

MONS 028576

ARLINGTON POLLUTION CONTROL CENTER, OREGON

OVERVIEW

Arlington Pollution Control Center (APCC) is located southwest of Arlington, Oregon. The site is underlain by 61 m (2000 ft) of soil with permeabilities ranging from 4×10^{-4} to 5×10^{-7} cm/sec (1.6×10^{-4} to 2.0×10^{-7} in/sec). Between the soil and the ground water is a layer of impermeable basalt which confines the ground water under pressure. Evaporation at the site is 160 cm (63 in) as compared to the total annual precipitation of 25 cm (10 in). EPA Region X has approved disposal of PCB-contaminated materials at the APCC for a period of 1.5 years (from June 30, 1978, to January 1, 1980).

The northerly part of Trench No. 5, which has a total volume capacity of 1278 m^3 (45,000 ft^3), has been designated for PCB-contaminated material disposal. On the average, one truckload of the waste (approximately 15,890 kg or 35,000 lb) is received each week. The monitoring program at Trench No. 5 includes monthly sampling of two existing ground water wells and monthly checking of the presence of liquid at three test wells. No major public objection and/or operational problems have been encountered. The gate charge is $137 per m^3 ($3.90 per ft^3) or $28.5 per 55-gal drum.

HISTORY OF PCB LANDFILL ACTIVITY

The Arlington landfill site, called the Pollution Control Center, is operated by Chem-Nuclear Systems, Inc. It was opened in August 1976 and, as of August 1978, has accepted approximately 32,200 m^3 (1.13 million ft^3) of wastes. Less than 10 percent of the total wastes is PCB materials. On March 10, 1978, Chem-Nuclear Systems, Inc., applied to EPA Region X for approval of Trench No. 5 as a PCB disposal site. Public notice of the application was published on May 1, 1978. Response to the public notice consisted of one letter stating opposition to the disposal of radioactive materials at the site. No comments were received regarding PCB disposal.

EPA Region X formally granted an approval for PCB waste disposal for Trench No. 5 on June 30, 1978, following a review of applicant information (including the document,

MONS 028577

"Geological and Subsurface Investigations, Arlington Disposal Site, Gilliam County, Oregon") and observation of the site. The permit is valid through January 1, 1980.

SITE DESCRIPTION

Location

APCC is located in Section 25 and 26, Township 2 North, Range 20 East, W. M., Gilliam County, Oregon. This is about 20 km (12 mi) southwest of the city of Arlington, Oregon (Figure 12).

Operating Agency/Site Manager

The site is owned and operated by Chem-Nuclear Systems, Inc., which has offices in four states. The regional addresses of the company are as follows:

- Corporate and Western Operations' Office
  P.O. Box 1866
  Bellevue, Washington 98009
  (206) 827-0711

- Southeast/Southwest Operations' Office
  P.O. Box 726
  Barnwell, South Carolina 29812
  (803) 259-3588

- Northeast/Midwest Operations' Office
  3625 Eggert Road
  Orchard Park, New York 14127
  (716) 662-2562

- Compliance Assistance and Technical Services:
  Cosmopolitan Center North
  6135 Barfield Road
  Atlanta, Georgia 30328
  (404) 392-4507

The Arlington site manager is Mr. Frank G. Dement, telephone (503) 454-2777.

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Site Area

The site is located in a hilly area and covers approximately 130 ha (320 ac). Figure 13 shows the site entrance. Six ha (15 ac), fenced with 2-m (7-ft) fencing, plus three top strands of barbed wire, are used to enclose the hazardous waste disposal area. Three trenches are presently in operation. The northerly part of one of these trenches, Trench No. 5, has a total volume of 12,780 m^3 (450,000 ft^3, or 150 ft x 100 ft x 30 ft). Trench No. 5 is used for the deposit of PCB-contaminated materials. Trench No. 5 was prepared by first evenly spreading a 30-cm (1-ft) thick charcoal layer over the natural soil and a 30-cm (1-ft) compact soil layer on top (Figure 14).

Adjacent to the fenced disposal site is a helicopter pad provided for any medical emergencies that may occur.

In a separately fenced area, there are two buildings, one for equipment maintenance and one for storage. Twenty to twenty-five 190ℓ (55-gal) drums full of PCB or PCB rinsate were observed in the storage building during October 1978.

There are also two fenced-in evaporation ponds at the site. One pond receives liquid acid waste, the other receives caustics.

Environmental Factors

Soil. The site is located in an area underlain by 61 m (200 ft) of soil with permeabilities ranging from 4 x 10^{-4} to 5 x 10^{-7} cm/sec (Figure 15). Between the soil and the ground water is a layer of impermeable basalt which confines the ground water under pressure.

Hydrology. The site is located in the Columbia Plateau basaltic province of north central Oregon and is more than 61 m (200 ft) above the nearest stream bed located in adjacent Alkali Canyon (111). No flood data are available for this area; however, the disposal site is apparently above the 100-yr floodwater elevation. No runoff occurs in the area of the disposal site. Occasional rain or snow melt that accumulates in the wind-blown depressions either sublimates, evaporates, or infiltrates into the shallow soil, usually to be evapotranspired during the dryer months. Ground water beneath the site is under confined conditions at a depth of about 171 m (560 ft). The head on this aquifer creates a piezometric pressure approximately 130 m (426 ft) below the surface (164).

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The closest surface waters are Rock Creek and the Columbia River, which are about 10 to 11 km (6 to 7 mi) away. There is no known hydraulic connection between the site and these surface water bodies (164). As a result of the hydrological characteristics and the local climate of the site, the EPA has determined the following 164:

- A leachate collection system for the site is deemed unnecessary.
- The land surface around Trench No. 5 shall be graded or trenched to prevent any overland runoff from flowing into the PCB landfill.
- The two existing ground water wells are adequate for ground water monitoring.

Climate. Climatic data of Pendleton, Oregon, approximately 120 km (73 mi) east of the APCC are presented in Table 3 (17). The monthly average temperature for the entire year is 12°C (53°F), ranging from a low of 6°C (42°F) to a high of 17°C (63°F). January is the coldest month with a mean temperature of -1°C (31°F). Normal total precipitation (rainfall and snowfall) is 81 cm (32 in), occurring over 107 days per year. At the disposal site, however, the recorded rainfall is much less: 25 cm (10 in) (164). On the other hand, pan evaporation measurement at the site is approximately 160 cm (63 in) per year (164). As a result, surface runoff at the site is relatively rare.

PCB-CONTAMINATED WASTE HANDLING

Disposal Procedure

A permit through the Oregon Department of Environmental Quality is required to haul PCB-contaminated materials to the APCC. Chem-Nuclear Systems, Inc., does not own or operate any waste transportation equipment. The company, however, will arrange for PCB material hauling with a qualified trucking firm if its customer so desires.

At the site, PCB-contaminated materials (i.e., sealed capacitors, drained transformers, PCB-contaminated containers, etc.) are stacked into 2-m (7-ft) layers within Trench No. 5 (Figures 16 and 17). The layers are separated from each other by a 30-cm (1-ft) layer of charcoal which is sandwiched between two 30-cm layers of soil. Consequently, three layers of PCB-contaminated material can be placed in the

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trench. It is planned to place 1 m (3 ft) of compacted soil on top of the last layer.

Quantity Received and Gate Charge

The APCC site receives an average of one truckload of PCB-contaminated material per week (approximately 15,890 kg or 35,000 lb/wk). The major customers are Hewlett Packard, Exxon, Resource Recovery, Inc., U.S. Navy, Weyerhauser Lumber, and local public utilities. The gate charge is $137 per m^3 ($3.90 per ft^3) or $28.50 per 55-gal drum.

The site operates five days per week year-round. If customers desire, special arrangements can be made for waste materials to be received on a weekend day.

Monitoring Program

There are two wells (the site water well and the office water wells) used for ground water monitoring purposes. These wells are partially cased, with portland cement used to cement the bottom of the casing into the underlying basalt. The annular spaces are backfilled with well cuttings from the site. EPA requires monthly sampling of these wells and analysis for the following parameters: PCBs, pH, specific conductance, total chlorinated organics, and chlorides.

In addition, three test wells in Trench No. 5 (Figure 17) placed approximately 60 cm (2 ft) below the trench are required to be checked monthly for the presence of liquid in the well bore. If any liquid is detected, a sample will be taken and analyzed for the aforementioned parameters. All analytical results (and a summary of any spilled PCB material received during the month) are submitted monthly to the Solid Waste Management Program, EPA Region X.

After site closure, water from the two ground water wells must be sampled semi-annually for 10 years.

Equipment and Personnel Summary. The following equipment is used for disposal activities at the APCC site:

- 1 front-end loader.
- 1 tractor.
- 1 forklift.

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- 1 track dozer and scraper.
- 1 pickup truck.

Five persons are employed at the site: the manager, one secretary, and three laborers/equipment operators.

PUBLIC ACCEPTANCE

Arlington is a small farming community with a population of about 600. Chem-Nuclear Systems has received no major public objection. Management occasionally invites local citizens and students to observe the waste disposal operations during site tours.

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CASMALIA DISPOSAL SITE

OVERVIEW

The Casmalia Disposal Site is located on NTU Road, approximately 11 km (7 mi) south of Guadalupe, Santa Barbara County, California. The site is underlain by 229 to 458 m (750 to 1500 ft) of diatomaceous shale and claystone. EPA approval for disposal of PCB-contaminated wastes was granted to the site on November 17, 1978. An area of 2.2 ha (5.5 ac) at the site was designated for nonliquid PCB-contaminated material. The gate charge for PCBs is $165 per t ($150 per ton). The water quality monitoring program includes monthly sampling at five monitoring wells and one surface water sampling point. No major public objection or operational problems have been encountered.

HISTORY OF PCB LANDFILL ACTIVITY

The Casmalia Disposal Site is owned and operated by Mr. Kenneth H. Hunter, Jr. The site was opened in 1972, accepting all types of chemical wastes except radioactive materials. Prior to the promulgation of the EPA disposal regulations for PCBs, approximately 4.5 t (5 tons) of PCB-contaminated waste were received. On April 25, 1978, Casmalia Disposal applied to EPA Region IX for approval to accept PCBs. The approval was formally granted on November 17, 1978.

SITE DESCRIPTION

Location/Operator

The site is located on NTU Road, approximately 11 km (7 mi) south of Guadalupe, Santa Barbara County, California (Figure 18). It is managed by Mr. Kenneth H. Hunter, Jr., telephone (805) 969-4703.

Site Area

The site has approximately 80 ha (197 ac) with 1740 ha (4300 ac) set aside as buffer zones from surrounding property. Both the disposal site and the buffer zones are fenced with five-strand barbed wire. The site is 3.2 km (2 mi) from the nearest community and 1.6 km (1 mi) from the nearest public road. An area of 2.2 ha (5.5 ac) is designated for PCB disposal.

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Environmental Factors

Geology. The underlying geology of the site consists of Sisquoc formation varying from 229 to 458 m (750 to 1500 ft) thick and comprised of diatomaceous shale and claystone (79). The soil is essentially impervious, and 78 percent of its components passes through a No. 200 sieve. Useable ground water does not exist beneath the site.

Climate. Climatic data of Santa Maria, approximately 16 km (10 mi) northeast of the site, are presented in Table 4. The monthly temperature varies from 3 to 23°C (38 to 74°F). January is the coldest month, and September is the warmest. Annual precipitation is 34 cm (13.4 in).

PCB-CONTAMINATED WASTE HANDLING

The following PCB wastes are authorized for disposal at the site:

- Nonliquid PCB mixtures in the form of soil or debris which have been contaminated by PCB as a result of a spill.
- Contaminated materials not resulting from a spill (these can be landfilled only until January 1, 1980).
- Drained transformers.
- Small PCB capacitors (to be landfilled only until January 1, 1980).
- Dredged material and municipal sewage sludge that contain PCBs.

To be acceptable for disposal at the Casmalia site, PCB wastes should be packed in 55-gal drums or cardboard. Cardboard containers must be further sealed in 5-mil plastic bags. At the site, all PCB wastes are carefully placed into the burial cells at least 0.9 m (3 ft) below the natural land surface. The waste is covered daily with native soil. The gate charge for PCB wastes is $165 per t ($150 per ton).

Monitoring Program

Three existing monitoring wells and one monitoring spring are sampled monthly and analyzed for PCBs, pH, specific conductance, and chlorinated organics. In addition, two new monitoring wells have been installed, one at a location near the southern boundary of the 2.2-ha (5.5-ac) PCB site and the other at a location immediately below the disposal trench at the original solid waste disposal area. The depths of these wells are below the deepest PCB cell. Each well is checked monthly for the

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presence of liquid in the well bores. If any liquid is detected, samples will be taken and analyzed for the aforementioned parameters.

PUBLIC ACCEPTANCE

There have been no public objections against landfill activity at the Casmalia site. Site management offers site tours for groups and/or individuals who express interest in the site operation.

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GRAND VIEW, "B" SITE - IDAHO

OVERVIEW

The Grand View "B" site is located approximately 16 km (10 mi) northwest of Grand View, Idaho, and 63 km (39 mi) south of Mountain Home, Idaho. The site is an obsolete missile launch complex with several deep reinforced concrete silos available for waste disposal. EPA Region X approval allows disposal of PCB-contaminated materials from July 11, 1978, to January 1, 1980.

The missile silo with total volume capacity of 5700 m^3 (201,000 ft^3) has been designated for the disposal of PCB wastes. As of October 5, 1978, 2490 m^3 (87,800 ft^3) of the silo have been used. At the present loading rate, the remaining volume will be filled by the end of 1979. The site monitoring program includes regular air sampling (for chemical waste other than PCBs) and annual sampling of artesian well water. The well water is analyzed for PCBs, pH, specific conductance, total chlorinated organics, and chloride. Gate charge in late 1978 is $0.13 per kg ($.06 per lb). Rates are subject to change in the immediate future.

HISTORY OF WES-CON, INC., AND ITS PCB DISPOSAL ACTIVITY

Wes-Con, Inc., an Idaho corporation, formally began operations on November 9, 1973, as a hazardous waste management company. It is comprised of three major stockholders: (1) Mr. Gene Rinebold, Twin Falls, (2) Mr. Warren Shillington, Twin Falls, and (3) Mr. Roger Ling Rupert.

The company purchased the deactivated Titan missile site near Grand View from the U.S. Air Force in 1973 for waste containment. The facility consists of three silos, six silo-secondary structures, two antenna holes, one elevator shaft, several smaller holes (formerly used for fuel storage), and two major underground vaults (Figure 19).

Initially, the Grand View site was approved by the State of Idaho for receipt of all hazardous wastes except radioactive materials and military poisonous gas. About 95 percent of the total wates handles before 1978 were pesticides or pesticide contaminated solids. The other wastes included miscellaneous hazardous materials (including PCBs), laboratory wastes, and electroplating sludges.

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On March 27, 1978, the company applied to EPA Region X for a permit to receive PCB materials. No comments were received from the public regarding the proposed PCB disposal activities.

In addition, Idaho's Department of Health and Welfare (Environmental Service Division) in its letter dated March 30, 1978, to EPA Region X, agreed to certify the Wes-Con "B" site. The state submitted a technical evaluation report on May 8, 1978, endorsing approval of the Wes-Con "B" site for disposal of approved types of PCBs.

EPA Region X formally issued a permit for PCB waste disposal on July 11, 1978, after reviewing the State of Idaho's information and site observations.

SITE DESCRIPTION

Location

The Wes-Con "B" site is located in the W 1/2 of the NE 1/4 and E 1/2 of the E 1/2 of the NW 1/4 of Section 19, Township 4 South, Range 2 East, B. M., Owyhee County, Idaho. This is approximately 16 km (10 mi) northwest of Grand View and 63 km (39 mi) south of Mountain Home, as shown in Figure 20. The designation "B" is assigned to clearly distinguish this site from another Wes-Con site (called Site "A") near Bruneau, Idaho. (See Table 7 for description of Site "A", a possible location for another PCB material disposal facility.)

Operating Agency

The site is owned and operated by Wes-Con, Inc., P.O. Box 564, Twin Falls, Idaho 83301, telephone (208) 734-7711.

Site Area

This Grand View site occupies a total of 48.6 ha (120 ac). The primary working area, however, is 8.1 ha (20 ac) and consists of a former missile launching complex enclosed by 1615 lineal m (5300 ft) of 2-m (7-ft) fencing plus three top strands of barbed wire.

The abandoned missile launch structures are underground and are designed to withstand a ground zero atomic blast. They are capable of containing an internal explosion and fire in the event of accidental ignition of the missile propellant fluids (liquid oxygen) (Figure 21). The walls and floors of each silo are of concrete reinforced with 1.9 cm (3/4 in) of steel and treated with asphalt emulsion

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on the outside to withstand complete water immersion. The silo receiving PCBs is approximately 49 m (160 ft) deep with 1.8-m (6-ft) thick walls and 4-m (13-ft) thick floors.

Site Capacity

The total capacity of the site inside the fenced area is approximately 42,600 m^3 (1.5 million ft^3). Of this, 5700 m^3 (201,000 ft^3) are set aside for PCB and compatible waste materials.

Environmental Factors

Soil. The site is located in an area underlain by thick and relatively impermeable formations of blue clay (165). Another factor that further minimizes the probability of liquid leaks is that approximately 49 m (160 ft) of soil were completely excavated to construct the silos and then backfilled with extensive compaction. This process eliminated any naturally occurring permeable layers which would otherwise allow lateral water movement.

Hydrology. The first water-bearing stratum is found at a depth of 909 m (2980 ft) in what is referred to as the Banbary aquifer located in the geological formation of the same name (165). This ground water is highly saline and therefore nonpotable. The slightly deeper Idavada volcanic formation yields the Idavada aquifer which is at sufficient pressure to make the 939-m (3080-ft) deep well artesian and flow at 76 m^3 per hr (335 gal per min) at 4.92 kg per cm^2 (70 psi) of gauge pressure.

The silo floors are substantially above the closest aquifer and readily comply with the EPA stipulated separation distance of 15 m (50 ft).

There is no hydraulic connection between the site and any surface or ground water. The site is 4.8 to 6.4 km (3 to 4 mi) south of the Snake River and on an upland plain approximately 107 m (350 ft) above the river. No flood data are available for this area; however, the EPA presumed that the disposal site is above the 100-yr floodwater elevation. Little or no runoff occurs in the area of the disposal site.

Due to the special silo construction and local hydrological characteristics at the site, the EPA has determined the following:

- A leachate collection system for the site is deemed unnecessary.
- The construction of diversion structures capable of diverting surface water runoff is not required.

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Observation of water quality at a single artesian well will provide for adequate water quality monitoring.

Climate. Climatic data for Boise, Idaho, approximately 100 km (60 mi) north of the Grand View "B" site, are presented in Table 5 (17). The monthly average temperature for the entire year is 11°C (51°F), ranging from a low of 4°C (39°F) to a high of 17°C (63°F). January is the coldest month, with a mean temperature of -2°C (29°F), and July is the warmest, with a mean temperature close to 24°C (75°F). Normal total precipitation (rainfall and snowfall) is 83.4 cm (32.8 in), occurring over an average of 99 days per yr. The annual evaporation is 157 cm (62 in).

PCB-CONTAMINATED WASTE HANDLING

Disposal Technique

When containerized PCB-contaminated materials arrive on-site, the carriers generally pull to within 12 m (40 ft) of the silo. Wastes are unloaded into the silo via a forklift. A crane or bucket loader is used to handle heavy transformers. Bentonite clay, hauled from a nearby hill on Bureau of Land Management property, is added to cover waste material in the silo after each loading. Wes-Con does not provide services for draining or rinsing of transformers, nor does it own or operate its own waste-hauling trucks.

Gate Charge

The gate charge is $0.13 per kg ($0.06 per lb) for PCB-contaminated materials. The gate charge at Grand View for other hazardous waste is $0.09 per kg ($0.04 per lb). For example, a 20-ton transformer would cost $2400 for disposal, exclusive of transportation cost to the site.

All gate fees are subject to change without notice.

Quantity Received

Less than 5 percent (weight basis) of accepted hazardous waste is PCB-contaminated materials, e.g., capacitors, drained transformers. At present, 65 different electric companies deliver PCB wastes to the Grand View site. Major customers are Bonneville Power Company (Oregon), T&R Company (South Dakota), Con Edison (Connecticut), Commonwealth Edison (Chicago, Illinois), General Electric, Westinghouse Electric, Idaho Power Company, Utah Power Company, Colorado City Service of Denver, Colorado, Montana Power Company, and Wyoming Power Company.

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The quantity of PCBs received fluctuates, averaging 1329 kg per day (2911 lb per day) (Table 6). About half of the silo designated for PCBs has been filled. Wes-Con initially expected the remaining volume to last 5 yr. However, given present disposal procedures, the filling efficiency of the silo's space (about 71 kg/m^3) and current average disposal rate, the silo may be filled in less than 9 mo. Wes-Con plans to use three silos at the Bruneau "A" missile site (estimate capacity is 5 yr) for PCB disposal; the company, however, has not officially filed application with EPA Region X (Chapter VII).

The site operates five working days per week year-round. Arrangements can be made to deliver wastes during the weekend.

Monitoring Program

Because the closest ground water is 914 m (3000 ft) deep, the one artesian well will be sampled annually and analyzed for PCBs, pH, specific conductance, total chlorinated organics, and chloride. Wes-Con contracts with commercial laboratories to run these analyses and submits analytical results to the EPA Region X office as required. The EPA permit requires annual sampling of this artesian well water for 10 yr after site closure. Wes-Con also contracts with the Boise State University Chemistry Department to conduct on-site air quality monitoring. Once each month air samples are taken from portions of the site designated for other chemical wastes. Air quality monitoring at the PCB waste disposal silo is not required.

Equipment and Personnel Summary

The following equipment is used at the Grand View site:

- 2 cranes.
- 2 track dozers.
- 2 forklifts.
- 2 dump trucks.
- 1 bucket loader.
- 1 boom truck.
- 1 tractor.
- 1 steam cleaner.
- 1 fire truck.

Wes-Con has on-site repair shops for equipment maintenance and buys electricity for their shops and administrative office from the city of Grand View. Eight full-time and four part-time workers are employed at the site. Each of these employees is trained to operate the equipment.

PUBLIC ACCEPTANCE

In general, the public has accepted the Grand View disposal operations without major complaints.

Wes-Con has a public information/education program to ensure that its operations are open to public inspection. It is estimated that the overall public information/education program costs the company approximately $15,000 during its first 5 yr of operation.

To avoid adverse publicity that could arise from misunderstandings, Wes-Con accepts no radioactive or nerve gases waste, even through the site is considered to be the most suitable for such wastes.

In addition, Wes-Con provides several public services, including the following:

- Free pesticide and container disposal to residents of Owyhee County.
- Free disposal to approved educational establishments in Idaho.
- Free disposal for materials within Idaho generated during emergency conditions, i.e., highway wrecks. This service is provided when requested by state or federal agencies.
- Free disposal for materials within Idaho (when ownership cannot be established) that may be hazardous.
- The disposal facilities will be made available to state and federal agencies or institutions for experimental studies, and for demonstrations for training purposes.
- Wes-Con has donated steel stairs, valves, pipes, and other materials salvaged from the site to local schools, farmers, and private citizens.
- Wes-Con equipment is available to local residents for use in case of emergencies.

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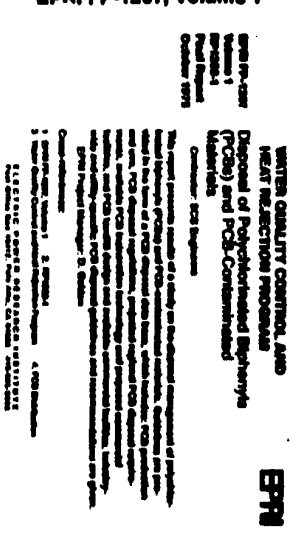
EPRI FP-1207, Volume 1

Below are five index cards that allow for filing according to the four cross-references in addition to the title of the report. A brief abstract describing the major subject area covered in the report is included on each card. For information regarding index card subscriptions to past and future EPRI publications contact the Research Reports Center, P.O. Box 50490, Palo Alto, California 94303. Telephone (415) 961-9043.



EPRI

EPRI FP-1207
Volume 1
RP1268-1
Final Report
October 1979

Disposal of Polychlorinated Biphenyls (PCBs) and PCB-Contaminated Materials

Contractor: SCS Engineers

This report presents results of a study on the disposal management of polychlorinated biphenyls (PCBs) and PCB-contaminated materials. Guidelines are provided in the form of a PCB disposal data base, which includes: PCB production and use, PCB disposal regulations, projected regional PCB disposal requirements, available PCB incineration technology and proposed commercial facilities, and PCB landfill design and available commercial facilities. Industry-wide and utility-specific PCB disposal guidelines and recommendations are given.

EPRI Project Manager: D. Golden

Cross-references:

1. EPRI FP-1207, Volume 1 2. RP1268-1
3. Water Quality Control and Heat Rejection Program 4. PCB Distribution

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EPRI FP-1207, Volume 1

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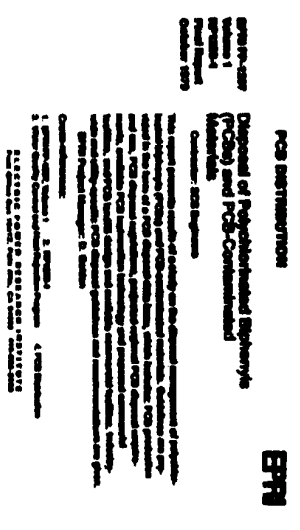

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APPENDIX A

CRITERIA FOR ALLOWABLE BURNING RATES OF PCBS
IN ELECTRIC UTILITY BOILERS*

1. Based on Scrubbing Requirements:

To keep chlorine content of total feed below 0.5 percent and, presumably, avoid the requirement for scrubbing, the PCB feed rate must be less than

$$\frac{0.5}{0.53} = 1.0 \text{ percent by weight of the total fuel feed rate to the boiler.}$$

Based on Boiler Tube Corrosion:

Chlorides are known to increase corrosion rates on boiler tubes, but relatively large changes in chloride levels are required to cause significant changes in corrosion or "wastage" rates. Waste heat boilers are in use on incinerators firing up to 50 percent chlorine fuels, but the operating conditions are not typical of utility boiler practice. Common practice is as follows:

- Limit combustion temperatures to 1204°C (2200°F).
- Use a fire tube boiler - no radiation section.
- Use low boiler pressures, 250 psig and less, preferably.

Burning 100 percent municipal solid waste (typically 0.4 weight percent chlorine) causes significant increases in corrosion rates of high-temperature boilers, but up to 15 percent of boiler heat input can be supplied by RDF (refuse derived fuel) without noticeable effects. A heating value of 15 percent, as supplied by RDF, implies about 37.3 percent of weight input is from solid waste based on 13,800 Btu/lb coal and 4800 Btu/lb for original solid waste. This corresponds to a PCB feed rate of

$$\frac{0.4\ (0.373)}{0.53} = 0.3 \text{ percent by weight of the total feed rate of the boiler.}$$

Assume that doubling the chloride content of the fuel would not significantly affect corrosion rates in boilers whose tubes are not sensitive to chloride attack. Some coals contain as much as 0.1

*Assume that the typical PCB waste stream contains 53 weight percent chlorine.

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weight percent chlorine (1000 ppm). In this case, 0.1 additional weight percent could safely be added or

$$\frac{0.1}{0.53} = 0.2 \text{ percent by weight of PCBs.}$$

Fuel oils contain very low chloride levels. The same incremental approach would recommend very low feed rates of PCBs in oil-fired boilers.

3. Based on Maximum Downwind Concentration of HCL:

Maximum allowable ambient concentrations of HCL are not yet established, but may be comparable to SO_2 (the TLVs of SO_2 and HCl are identical at 5 ppm).

Chlorine levels comparable to the sulfur content of low sulfur coals (say less than 0.8 percent) would probably meet this ambient limit, assuming plume dispersion is already adequate.

4. Conclusions:

Based on the preceding discussion, a maximum of 0.3 percent by weight of pure PCBs would be acceptable in the fuel for older, smaller, lower temperature boilers. For example, a 100 megawatt (MW) unit requiring 16,000 Btu/kwh (21 percent efficiency) would give

$$\text{PCB feed rate} = \frac{100{,}000\ (16{,}000)(0.003)}{13{,}800} = 348 \text{ lb/hr}$$

A maximum of 0.1 weight percent of pure PCBs would be prudent on a newer, larger, higher temperature boiler. For example, a 500 MW unit requiring 10,000 Btu/kwh (34 percent efficiency) would give

$$\text{PCB feed rate} = \frac{500{,}000\ (10{,}000)(0.001)}{13{,}800}$$

The design feed rate for a typical boiler should therefore be about 350 lb/hr of pure PCBs.

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APPENDIX B

RELATIONSHIP OF OXYGEN CONCENTRATION, COMBUSTION TEMPERATURE, AND NECESSARY RESIDENCE TIME

Generalization of Required Residence Times in Accordance with Federal Regulations

The following general expression relates residence time to oxygen concentration and combustion chamber temperature:

$$t_r \geq (\exp (A/T))/(BO)$$

where

t_r = required residence time(s)

A,B = constants

O = oxygen concentration (percent by volume in exhaust)

T = furnace exit temperature (°K)

Federal regulations specify a temperature of 1200°C (2200°F) for 2 sec with an exhaust O_2 concentration of 3 percent; or alternately, 1600°C (2912°F) for 1.5 sec with 2 percent oxygen. Inserting these values into the above equation:

$$2 = (\exp (A/1473.15)/(3B);$$

$$1.5 = (\exp (A/1873.15)/(2B)$$

Solving these equations simultaneously yields:

A = 4780.25

B = 4.2784

Because of the statutory nature of the above requirements, the equation is assumed to be valid only in the following intervals:

$$1.5 \leq t_r \leq 2$$

$$2 \leq O \leq 3$$

$$1200 \leq T \leq 1600$$

A plot of required residence time versus furnace exit temperature is shown in Figure B-1.

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APPENDIX C

INCINERATOR INSPECTION REPORT*
TECHNOLOGY ASSESSMENT

1. Gather background information:
   - Name.
   - Location.
   - Business.
   - Size.
   - Experience.
2. Characterize waste:
   - Types.
   - Sources.
   - Amounts.
   - Heating value.
   - Percent water.
   - Percent solids.
   - pH
   - Viscosity.
   - Flammability.
   - Toxicity.
   - Hazardous components and concentrations (S, N, halogens, heavy metals, As, etc.).
3. Observe facility appearance - general condition:
   - Odors.
   - Spills.

*EPA publication.

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- Corrosion.
- Vegetation.
- Animal life.
- Neighborhood.
- Geography.

4. Inspect incinerator:
   - Type.
   - Manufacturer.
   - Overall dimensions.
   - Feed capacity.
   - Feed system.
   - Interior configuration.
   - Ash removal mechanism.
   - Flame appearance.
   - Condition of refractory.
   - General equipment condition.
5. Note instrument readings:
   - Temperatures.
   - Feed rates (air, waste, ~~fuel~~).
   - Emission monitors (CO_2, CO, O_2, HCs).
   - Others.
6. Inspect emission controls:
   - Types.
   - Scrubbing solution.
   - Pressure drop.
   - Effluent disposal.
7. Observe materials handling:
   - Continuous.
   - Transfer mechanisms.
   - Storage.

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8. Check safety equipment:

   - Automatic shutdown.
   - Fire extinguisher.
   - Alarms.
   - Personnel safety equipment (respirators, goggles, gloves, etc.).
   - Accidents.
   - Economics.
   - Permit status.
   - OSHA inspection.

9. Interview state and local regulatory authorities' performance history.

10. Additional observations/comments.

11. Persons contacted:

Name	Title	Phone Number

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APPENDIX D

PCB DISPOSAL FACILITY APPROVAL: CHECKLISTS*

In evaluating requests for the approval of PCB disposal facilities, the Regional PCB Site Approval Coordinator will need to make several decisions throughout the site approval process. Attached are several checklists which can be used to assist the Regional Coordinator in making these determinations:

1. Initial Contact by Facility Owner/Operator who Desires Approval.

   The Agency's first contact is likely to be by phone or letter from the facility owner/operator who desires approval. Regardless of who receives these contacts within the Region, they should all be funneled through the appointed Regional PCB Site Approval Coordinator. In this initial interview with the facility owner/operator, the Regional Coordinator may find it useful to use the attached "Initial Interview Checklist" to obtain some basic information which will (1) indicate whether the facility requires EPA approval and (2) assist the Regional PCB Site Approval Coordinator to prioritize the requests that are received.

*EPA publication.

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INITIAL INTERVIEW CHECKLIST

A. Name, address, and phone number of company (include both headquarters and disposal site).

B. Individual making initial contact and phone number.

C. Principal contact within company and phone number.

D. PCBs currently handled:

1. Types of PCBs currently handled, i.e., liquids, sludges, capacitors (whole or shredded), transformers, contaminated soils, etc.

2. Source of PCBs currently handled, i.e., utilities, capacitor or transformer manufacturers, railroads, industry, etc.

3. Estimated concentration and quantity for each type of PCB currently handled (total and rate). (Note: PCB mixture means any mixture, except municipal sewage treatment sludge, which contains 0.05 percent (500 ppm) on a dry weight basis or greater of a PCB chemical substance.)

4. Management techniques for each type of PCB waste currently handled, i.e., landfill, incineration, landspreading, storage, treatment, etc.

5. Approximately how long has the company been handling PCBs?

E. Approval sought:

1. Types of PCBs which will be handled, i.e., liquids, sludge, capacitors (whole or shredded), transformers, contaminated soils, etc.

2. Source of PCBs which will be handled, i.e., utilities, capacitor or transformer manufacturers, railroads, industry, etc.

3. Estimated concentration and quantity for each type of PCB which will be handled (total and rate).

4. Management techniques for each type of PCB waste which will be handled, i.e., landfill, incineration, landspreading, storage, treatment, etc.

5. Are PCBs currently being stored on site; if yes, how are they [illegible]ing stored and how much of each type of PCB is being stored?

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F. Have any state or local permits or approvals been received for the facility? For PCBs specifically? If yes, which state or local agency(s) issued the approval (principal contact from state or local agency(s) and phone number).

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2. Determination as to Whether Sufficient Information Exists in Technical Report.

After receiving the facility's application (technical report) to dispose of PCBs, and assuming that an EPA evaluation is to be conducted (state certification is not available or is not accepted by the Regional Administrator), the Regional PCB Site Approval Coordinator will need to conduct a cursory review of the report and determine whether sufficient information exists from the technical report and other sources with which to proceed. The attached "Technical Report Review Checklist" should be used by the Regional PCB Site Approval Coordinator to assist him in making this determination.

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TECHNICAL REPORT REVIEW CHECKLIST

A. The technical report that is submitted on incinerators should, at a minimum, contain the following information:

1. The technical report should describe the location of the incineration facility with respect to:

   a. Industrial sites (both manufacturing and commercial).

   b. Residential areas.

   c. Navigable streams, i.e., rivers, lakes, etc.

   d. The nearest city, town, or village.

2. The technical report should contain a detailed description of the incinerator, including general site plans and design drawings. The description should include at a minimum:

   a. General description, i.e., rotary kiln, liquid injection, etc., of the incinerator (indicate manufacturer).

   b. Capacity of the incinerator (include the dimensions of the combustion chamber).

   c. Type of feed mechanism into the combustion chamber.

   d. Type of auxiliary fuel used, if any, and method of feeding the auxiliary fuel into the combustion chamber.

   e. Stack height.

   f. Type of air pollution control (APC) equipment, i.e., high-energy venturi scrubber, electrostatic precipitator, afterburner, etc.

   g. Capacity of the APC equipment.

   h. Type of instrumentation on the APC equipment.

   i. Type of residues, i.e., bottom ash, scrubber effluent, dust, generated from incinerator and disposal techniques, i.e. sanitary landfill, etc.

3. The technical report should contain any engineering report, test results, or other information on the performance (anticipated or measured) of the incinerator when PCBs are destroyed. The report should include at a minimum:

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a. Operating temperature of combustion chamber.

b. Operating temperature of afterburner (if appropriate).

c. Dwell time of incinerator (at temperature).

d. Combustion efficiency.

e. Mass emission rate (for incineration of nonliquid PCBs).

f. Quality of stack gases.

g. Quality of residues, including scrubber effluent.

4. The technical report should contain a description of the sampling and monitoring equipment used when PCBs are destroyed and facilities are available. The report should include at a minimum:

a. Description of laboratory facilities on site (if any).

b. Description and frequency of sampling and analytical procedures performed for PCB wastes (description and drawing of sampling train should be included).

c. Description of sampling station at the stack, i.e., portholes, platform, instrumentation.

d. Description of the monitoring equipment on the incinerator for the following:

- Temperature.
- Flow rate of combustion air.
- Flow rate of PCBs being fed into the combustion chamber.
- Stack gases, i.e., O_2, CO, CO_2, NO_x, HCl, total chlorinated organic content, PCB chemical substance, total particulate matter, etc.
- Water pressure on wet scrubber.

e. Description of the automatic shutoff system for the following:

- Failure of the monitoring operations for combustion products and incineration operations.
- Failure of the PCB rate and quantity measuring and recording equipment.
- When the combustion temperature, dwell time, and/or excess oxygen fall below specified criteria.
- Flameout.

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- Loss of water pressure in scrubber.
- Failure of feed mechanism into combustion chamber.

5. The technical report should contain the estimated quantity for each type, i.e., liquids, sludges, capacitors (whole or shredded), transformers, contaminated soil, etc., of PCB to be incinerated.

6. The technical report should include any state, local, or federal permits or approvals.

7. The technical report should include a description of the storage area.

8. The technical report should include a description of the record keeping and reporting procedures.

9. The technical report should include a list of schedules and plans for complying with the approved requirements, i.e., compliance schedule.

(For any requirements of the regulation which the facility owner/operator requests a waiver, a detailed discussion shall be included which describes the requirement(s) the facility owner/operator wants waived and the reason for requesting the waiver.)

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APPENDIX E

DESCRIPTION OF POTENTIAL
PCB INCINERATION FACILITIES

Rollins Environmental Services
Deer Park, Texas

PART I - General Information

A.	Facility name:	Rollins Environmental Services Deer Park Plant
B.	Owner:	RLC Corporation
C.	Plant manager:	Donald C. Matter (Operations) Edgar Henry (Sales)
D.	Address:	P.O. Box 609 Deer Park, Texas 77536
E.	Phone number:	(713) 479-6001
F.	Respondent:	Edgar Henry, Donald Matter, Clark Hickman
G.	Date:	October 17, 1978
H.	Comments:	Contact Edgar Henry relative to contracting for PCB disposal

PART II - Receiving/Storage

A.	Service area:	200-300 mi immediate - continental United States, other
B.	Receiving modes:	Truck, rail, barge
C.	Storage capacity:	
	1. Liquids	450 55-gal drums
	2. Solids	56 yd^3 bins; 2800 ft^2, other
D.	Comments:	Subsidiary Matlack Trucking handles shipping outside 200-300 mi radius

PART III - Preprocessing Capability

A.	Liquid blending:	Comprehensive
B.	Solids shredding:	35-gal fibre packs - 12 per hr

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Comments:	Shredding capacity not yet installed

PART IV - Incineration Equipment

A. Capacity:	
1. Liquids	5-5.5 x 10^6 [lb/mo]
2. Solids	1-1.3 x 10^6 [lb/mo]
B. Feed rate:	
1. Liquids	6600 lb/hr
2. Solids	1440 lb/hr
C. Comments:	Solids are shredded PCB capacitors

PART V - Regulatory Status

5A - Federal

A. Test application:	Submitted - one test completed
B. Certification:	Pending
C. Comments:	Second test burn to be scheduled in 1979

5B - State

A. Comments:	Texas Air and Water Commission working in conjunction with federal EPA

PART VI - Miscellaneous

A. Legal status:	Not permitted to burn PCBs
	Not receiving PCB materials at this time
B. Other wastes handled:	Many
C. Decontamination procedures:	Landfill available for transformer cases
D. Future plans:	Will attempt to certify New Jersey facility if Deer Park tests are positive
E. Comments:	Disposal costs to be determined at a later date

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Energy Systems Company (ENSCO)
El Dorado, Arkansas

PART I - General Information

A.	Facility name:	ENSCO - El Dorado Plant
B.	Owner:	Energy Systems Company, Inc.
C.	Plant manager:	Charles Robertson - Melvin Bell
D.	Address:	P.O. Box 1975 El Dorado, Arkansas 71730
E.	Phone number:	(501) 863-7173
F.	Respondent:	Charles Robertson/George Combs
G.	Date:	November 9, 1978
H.	Comments:	Contact Charles Robertson relative to contracting for PCB disposal

PART II - Receiving/Storage

A.	Service area:	Continental United States
B.	Receiving Modes:	Truck/rail
C.	Storage capacity:	
	1. Liquids	4200 ft^2
	2. Solids	16,800 ft^2

PART III - Preprocessing Capability

A.	Liquid blending:	Comprehensive
B.	Solids shredding:	>2500 [lb/hr]

PART IV - Incineration Equipment

A.	Capacity:	
	1. Liquids	3.66×10^6 [lb/mo]
	2. Solids	1.83×10^6 [lb/mo]
B.	Feed rate:	
	1. Liquids	5000 [lb/hr]
	2. Solids	2500 [lb/hr]
C.	Comments:	Solids represent shredded capacitors

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PART V - Regulatory Status

5A - Federal

A.	Test application:	Submitted
B.	Certification:	Pending
C.	Comments:	Test burn not yet completed. Scheduled for July 1979

5B - State

A.	Comments:	Cleared for test burn and operation by Arkansas Department of Pollution Control and Ecology - March 24, 1979

5C - Local

A.	Other:	County ordinance prohibits waste PCB combustion
B.	Comments:	ENSCO has challenged county ordinance in court and received a favorable ruling

PART VI - Miscellaneous

A.	Legal status:	Not now permitted to burn PCBs. Not receiving PCB materials at this time
B.	Other wastes handled:	Wide range of chemical toxic and hazardous wastes
C.	Decontamination procedures:	Will accept contaminated materials for decontamination or disposal

MONS 028541

APPENDIX F

PCB DISPOSAL FACILITY APPROVAL: STATE CERTIFICATION

In evaluating a facility for the disposal of polychlorinated biphenyls (PCBs), the Regional Administrator and his staff may choose one of two alternatives in conducting the site approval process. The first alternative is to perform the site evaluation in-house, using Regional personnel with support from the Headquarters/ Laboratory Technical Support Team, if necessary. The second alternative is to accept state certification of the facility, thus obviating the need for any EPA investigation. This guidance document addresses the latter option and discusses the state's role with regard to certification and approval of facilities for the disposal of PCBs.

In conducting the initial interview with the facility owner/operator desiring approval and/or in reviewing the applicant's technical report, the Regional PCB Site Approval Coordinator should review and evaluate the technical data and information provided by the applicant. If the facility claims to have a state permit which covers PCB disposal, the Regional PCB Site Approval Coordinator should contact the issuing state agency to determine whether the state ~~is willing to certify~~ in writing ~~that the facility~~ meets the U.S. EPA technical criteria, which are cited in Annex I and/or II of the Federal EPA PCB Marking and Disposal Regulation, or to submit information to the Regional Administrator which indicates that operation of the disposal site will not present an unreasonable risk of injury to health or the environment from PCBs should one or more of the criteria described in Subparts 761.40(a) and (b) and 761.41(b) not be met. (The Regional PCB Site Approval Coordinator should forward a completed copy of the applicant's technical report to the state as soon as possible for their review and consideration.) It is suggested that the Regional PCB Site Approval Coordinator contact the state as soon as possible to discuss the state's role with regard to site evaluation and certification for PCB disposal facilities. In addition, a copy of the PCB Marking and Disposal Regulation should be sent to each state as soon as the regulation is signed by the Administrator.

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It should be noted that, unlike other feder) legislation, e.g., Federal Water Pollution Control Act (FWPCA), Resource Con ervation and Recovery Act (RCRA), etc., the Toxic Substances Control Act does not authorize the Administrator to delegate his authority outside the Agency (e.g., to state or political subdivisions) to carry out any parts of the Act or any requirements prescribed in any subsequent regulations unless the Administrator is unable or is not likely to take action against a chemical substance or mixture under this Act for its prevention or elimination. Therefore, any facility owner/operator who requests permission to dispose of PCBs must seek this approval from the appropriate federal EPA Regional Administrator. Facilities which currently hold a state permit to dispose of PCBs would still require approval from the federal EPA to dispose of PCBs. However, nothing in the Toxic Substances Control Act will affect the authority of any state or political subdivision of a state to establish or continue in effect regulation of any chemical substance, mixture, or article containing a chemical substance or mixture unless the state's authority provides a lesser degree of protection than afforded by the Toxic Substances Control Act or any subsequent regulations. (See Section 18(a) (2) (b) of the Toxic Substances Control Act for more details.) For example, if the state or political subdivision provides the same or a higher degree of protection for PCBs than the requirements under the PCB Marking and Disposal Regulation, the state's standards will remain in effect and not be preempted by the federal standards. In any event, federal approval will be required. (It is intended that the PCB Marking and Disposal Regulation will be amended to allow states to permit all hazardous waste disposal facilities once the RCRA implementation process is instituted.)

If the state is willing to certify that the facility meets the specified U.S. EPA technical criteria or submits a certification which indicates that operation of the facility will not present an unreasonable risk of injury to health or the environment from PCBs when one or more of the criteria described in the regulation is not met, then the Director of the issuing state agency should notify the Regional Administrator by letter certifying the facility and recommending approval of the facility for the disposal of PCBs. A certification letter from the state to the Regional Administrator should include the following:

- The identification and location of the facility.
- A statement which indicates whether or not the facility meets all the criteria specified in Subparts 761.40(a) and (b) and 761.41(b) of the regulation.
- Any waivers on the criteria recommended by the state and why the waiver should be granted.

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- Any conditions which are placed on the state permit.
- A statement which indicates when the permit was issued and when the permit will expire.
- A statement which indicates the last date that the facility was inspected.
- A recommendation as to whether the facility should be granted approval by the Regional Administrator.
- A copy of the state permit.

The Regional Administrator and his staff will then decide whether certification from that particular state obviates the need for any further EPA investigation. In all such decisions, the opinion of the Regional Solid Waste staff should weigh heavily because they have monitored and assisted the development of the state programs and intimately know the quality of these programs. When an incineration facility is involved, the Regional PCB Site Approval Coordinator should confirm that the facility has conducted a trial burn or has monitoring data for incinerating PCBs prior to accepting the state's certification and recommendation to approve the site. A copy of all such monitoring data should be secured from the state.

If the Regional Administrator decides to accept the state's certification and recommendation to approve the facility, then upon receipt of the technical report (a completed copy of the application should be sent to the state for its review and consideration) and after providing the public an opportunity to comment on the applicant's request to dispose of PCBs, the Regional Administrator may issue a letter of approval to the facility for the disposal of PCBs. (The Regional PCB Site Approval Coordinator must confirm that the owner/operator had notified each state and political subdivision at least 30 days prior to when a required disposal may occur before the Regional Administrator may grant approval to the site.) A letter of approval to the facility should indicate the following:

- Any waivers and why the waivers were granted.
- Any conditions which are placed on the approval.
- A statement to the effect that revocation of approval is possible for violation of the standards.
- A statement to the effect that approval will be reevaluated as part of the RCRA permit process.
- Agreement to allow access for purposes of sampling and inspection.

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If the Regional Administrator does not accept the state's certification and recommendation to approve the facility for the disposal of PCBs, the Regional Office will need to perform an evaluation of the facility before any approval is granted.

MONS 028545

APPENDIX G

DESCRIPTION AND COST ESTIMATE FOR PROCESS MODULES

The fully integrated liquid-solid PCB incinerator discussed in Chapter VI can be described in terms of "modules," each of which performs a specific function. These modules are identified by letters in Figure 6-17. The capital cost of the overall facility is obtained by adding the installed cost of the individual modules. This approach allows considerable flexibility in design through deletion or addition of certain modules.

The discussion of each module uses the data for the large (72.5×10^6 Btu/hr) facility. However, costs are given for both the large and the small (11×10^6 Btu/hr) facility.

All costs are updated to January 1979 using the appropriate CE Plant Cost Indices. Cost estimates are obtained from vendors' quotes and the literature. The excellent book by Guthrie (46) is used as a source of economic data, such as exponents for economy of scale and ratios of installed cost to purchased equipment cost. The modules are based on commercially available state-of-the-art designs.

MODULE A - RECEIVING AND STORAGE

This module will provide unloading facilities for 1680 55-gal size barrels of liquid PCBs and contaminated wash solvents, and 392,000 lb of capacitors per week. Unloading operations are scheduled only for a 5-day, 40-hr week, so 336 barrels (about 4 truckloads) and 78,400 lb of containerized capacitors (approximately 3 truckloads) must be unloaded and stored per work day. The facility will provide about a 10-day storage capacity, i.e., 2400 barrels and 560,000 lb of capacitors. Material-handling equipment, such as forklifts, is included in the cost of this module.

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Itemized Costs

Covered receiving dock (35 ft x 75 ft) with lighting and fire prevention	$ 34,900
Warehouse (75 ft x 120 ft) with lighting, fire prevention, and 6-in curbing	144,000
Forklifts (2 - 2500 lb, LPG)	30,000
	$208,900

The smaller incinerator will need only one forklift. The receiving dock and warehouse areas vary in proportion with the capacity of the unit, as do their costs. The total cost for the smaller unit is $42,200.

MODULE B - BARREL AND CAPACITOR SHREDDING AND FEED SYSTEM

MB Associates (see Appendix H and Chapter VI) have designed a sophisticated system for loading, shredding, and feeding solids to a rotary kiln. The following description is taken from their report (137):

Loader

The loader design consists of several ground level nestable loading hoppers that can be filled at remote areas with debris and solids to be processed through the shredder. These ground-level loading hoppers are transportable by either forklift or boom-type overhead carriers with hooks. The bins are loaded onto the extended forks of the loading mechanism and are mechanically/hydraulically lifted up to the edge of the shredder hopper, where the ground-level hopper is rotated and dumped into the main hopper. The ground-level hopper is returned to a vertical position where it, in conjunction with a fabric dust cover, acts as a seal for preventing excessive dusting. The fabric section acts as a potential explosion relief should some type of explosive material inadvertently enter the shredder hopper. The enclosed area above the shredder hopper is vented to the primary kiln so that the shredder hopper is effectively under negative pressure for improved dust control.

Shredder

The shredder is basically a shear type counter rotating shaft unit with 1-in teeth capable of processing a wide range of materials. The shredder's capability for debris processing includes 55-gal containers, radial tires, wood pallets, batteries, brittle and soft metals such as lead or aluminum, 4-in x 4-in fence posts, small logs, shrubs, sand, gravel, dirt, paper, and other items of trash. The system will

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automatically reverse for jam clearing and does not require manual clearing unless the item causing a jam is of nonshreddable nature (e.g., steel gears, shafts, large rocks, and so forth). The potential for drawing through long shredded pieces, such as wire, metal strapping or slender sticks, is recognized. In order to compensate for this problem, three transaxial plate bars are installed to prevent excessively long, slender objects from being generated.

Ram Feed Subsystem

A ram feeder loads all solid wastes into the rotary kiln. The ram feeder is hydraulically operated with a 3 ¼-in diameter x 121-in stroke cylinder. It has the capacity of ramming up to 2 cu ft in 30 sec, as well as partial volumes over longer periods. The rate of ram feed is determined by the characteristics of the material being destroyed and can easily be field controlled for both volume and speed.

The ram cylinder rod is protected from the shredder by a sliding steel-cover plate, which is attached to and moves with the ram face. The plate seals off the ram trough from the shredder intermediate hopper and prevents shredded debris from piling up behind the advancing ram. During shredding, the ram is positioned such that the trough is closed to the shredder. The ram face provides an additional barrier to the kiln atmosphere, in addition to the two swing gates which are operated independently but sequentially as the ram advances and retracts. The ram cover plate limits the amount of material volume that the shredder can process to that volume between the cover plate and the rotating jaws, thereby, in effect, reducing potential trough overfill and ram jamming. This controlled volume represents 75 percent of the volume in the fully opened ram trough. The leading edge of the ram has a shearing edge to further reduce potential ram jamming.

The solids volume feed control is effected by controlling the ram pullback position so that the kiln can be charged frequently with partial loads and thereby reduce combustion transients or localized starved air conditions to the kiln. Swing-up gates have been incorporated in the trough bottom to isolate the shredder from the kiln atmosphere. Each swing gate functions sequentially as the ram advances and retracts. Swing gates were chosen in order to avoid slots and slide grooves which can easily be fouled with sand, dirt, oil, or debris. Additionally, the elimination of slots and grooves reduces ambient air leaks into the kiln and eliminates potential hazardous material leaks to the ground. Gate position switches control and limit ram movement in order to prevent the possibilities of uncontrolled air entering the kiln. The gate closest to the kiln is an insulated, sandwich

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construction faced with Inconel 671. The ram trough section in the kiln atmosphere will also be made of Inconel 671 for corrosion and heat considerations.

The unit can shred and feed 240 ft^3/hr. There is no cost saving for smaller incinerators because (1) the components must still be sized to handle the same size objects and (2) instantaneous peak loads are typically of the same magnitude. The cost estimate for the small incinerator shred and feed system is $117,700 (Appendix H). The larger size incinerator requires additional automatic material-handling equipment (conveyors, hoists, etc.) which is not justified with the smaller unit. The cost estimate for this unit has been adjusted to $147,700 to provide for these facilities.

MODULE C - BARREL PUMPING, LIQUID STORAGE, AND FEED PUMPS

The barrels are pumped with an air-powered stainless steel diaphragm pump. These pumps are self-priming and also pump air, so the drums can be completely drained. The bulk liquid is stored in a stainless steel tank with a capacity of 21,000 gal (1-3/4 days' production). The feed pump is a stainless steel centrifugal pump. It is oversized so that a recycle stream can be returned to the storage tank to mix it continuously.

A separate fuel oil system must be provided for warming the plant up to operating temperatures and to maintain temperatures when PCB feed is interrupted.

The estimated cost for this module is given below:

Item	Installed Cost
Pumps (diaphragm barrel pump, centrifugal feed pump, with spares)	$ 29,000
Scraped "Y" strainers	4,000
Storage tank	61,000
Fuel oil feed system	48,000
	$142,000

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The cost of this module will scale up exponentially (0.6 power) with capacity. The estimated cost for the small incinerator is, therefore, computed as follows:

$$\$142,000 \left(\frac{11}{72.5}\right)^{.06} = \$45,800$$

MODULE D - ROTARY KILN WITH ASH REMOVAL SYSTEM AND BURNER

The volume of the kiln is 966 ft^3, with a heat release rate of 25,000 Btu/ft^3/hr. A length to diameter ratio of 2:1 to 4:1 is considered reasonable, so internal dimensions of 7 ft I.D. by 25 ft long were selected as satisfactory. The portable unit, designed by MB Associates (137), uses a kiln with a volume of 236 ft^3 and dimensions of 4.33 ft I.D. by 16 ft long. The cost estimate for the kiln, drive, burners, ash removal, etc., is $176,300. The cost of kilns increases as the 0.78 power of the kiln volume; thus, the estimated cost for the 7-ft by 25-ft kiln would be:

$$\$176,300 \left(\frac{966}{236}\right)^{0.78} = \$529,000$$

This is the cost for the large incineration system. The MB Associates' kiln is a reasonable size for the small incineration system, and the associated cost is used directly in this report.

MODULE E - COMBUSTION AIR BLOWER

The total combustion air required is 17,070 scfm. However, due to leakage at the kiln seals, only 11,170 scfm must be provided by the blower. The blower should also be oversized about 25 percent (to 14,000 scfm) to allow for temporary operation at higher excess air than the design value. The design pressure to the burners is 16 in of water. The purchase cost of the fan is $8,400; the installed fan cost is $32,500, including associated ductwork, controls, electrical, etc.

The cost of blowers increases with the 0.68 power of flow rate. The cost for the small incineration system is computed as follows:

$$\$32,500 \left(\frac{11}{72.5}\right)^{0.68} = \$9,000$$

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MODULE F - ATOMIZING AIR COMPRESSOR

The air compressor is a standard, air-cooled, screw-type package unit. It delivers 360 scfm at 110 psig with a 75-hp motor. A recent price quote is available:

Equipment cost	$12,150
Installation, at 31 percent	3,770
Total installed cost	$15,920

The capacity exponent for the air compressor is about 0.28; thus, the compressor cost for the smaller system is as follows:

$$\$15,920 \left(\frac{11}{72.5}\right)^{0.28} = \$9,390$$

MODULE G - AFTERBURNER CHAMBER WITH BURNER AND ACCESSORIES

The preferred configuration of the afterburner is a vertical cylinder with a 3:1 length to diameter ratio and a conical bottom. The gases should have a strong rotary or vortex motion in order to provide rapid mixing of the gases from the rotary kiln with those from the burners in the afterburner. The vertically up-fired Peabody Vortex-type incinerator (105) meets these requirements.

The flow rate of flue gases is 105,000 acfm at 2200°F, with 40 percent excess air and 1 lb of water per pound of combustibles. However, if different combustion parameters are used, this volume can be higher. For example, at 2200°F, 72 percent excess air and 0.5 lb water per pound combustibles, the exhaust flow increases to 120,000 acfm. A residence time of 2.5 sec at design conditions will allow some flexibility in operation while maintaining a minimum 2-sec residence time. The associated internal dimensions of the afterburner are 12 ft in diamter by 36 ft long.

The cost of the afterburner and interconnecting ductwork based on recent quotes is as follows:

Incinerator, refractory, burners	$ 72,000
Interconnecting ductwork and refractory	15,000
Total base equipment cost	87,000
Installation at 136 percent of base equipment cost	118,300
Total installed cost	$205,300

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The cost of the smaller unit, based on a capacity exponent of 0.6, is as follows:

$$\$205,300 \left(\frac{11}{72.5}\right)^{0.79} = \$146,500$$

MODULE H - SCRUBBING SYSTEM WITH PUMPS, FAN, AND ALL ACCESSORIES

The 72.5×10^6 Btu/hr incinerator produces 48,000 acfm of flue gas which are saturated with water at 185°F. No reduction in flue gas volume is assumed by using large volumes of cool water to condense water vapor and reduce the dew point of the gases. This is normally an economically attractive option because it reduces the size of the induced draft fans and also improves the scrubbing efficiency. The scrubbing system consists of a venturi, two absorption trays, and a demister, with a total pressure drop of 60 in of water for the entire system. The design is conservative in terms of both flow rate and pressure drop.

Materials of construction must be adequate for highly corrosive conditions where both low pH and chlorides are present. Acid brick, rubber-lined steel, high alloys (such as Hastelloy C-276), fiberglass-reinforced polyester, and vinylester plastics are suitable materials of construction.

The literature revealed two different scrubber cost estimates for this same capacity. Ackerman, et al. (3), developed a cost estimate for a system similar to that used at the Rollins plant in Deer Park, Texas (see Chapter VI). After updating costs to January 1979 and adjusting for relative capacities, a total installed cost of $621,000 for the scrubber system without stack was obtained. Also, using cost data given by Perry (108), and by correcting for inflation and materials of construction, a cost of $678,000 was obtained. The average value of $650,000 was used in the analysis.

The cost of a high-energy venturi scrubbing system scales with a 0.79 capacity exponent. Thus, the scrubbing system for the smaller system will cost approximately:

$$\$650,000 \left(\frac{11}{72.5}\right)^{0.79} = \$146,500$$

MODULE I - LIME STORAGE AND SLAKING

This package unit includes a 3000 ft^3 storage bin, bin activator, lime slaker (2500 lb/hr), slurry storage tank, slurry, pump, dust controls, wiring, lighting, and

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motor controls. Vendors' quotes on this unit (May 1978) ra ged from $100,000 to $120,000. The estimated cost, as of January 1979, is as follows:

Equipment cost	$116,000
Installation @ 30 percent of equipment cost	34,800
Total installed cost	$150,800

This system has a storage capacity of 180,000 lb or a 5 ½-day supply (4 truckloads of bulk lime) for the large incineration system.

There are limitations on the size reduction that is possible with the smaller unit. The storage volume must be a ast 1 ½ truckloads or 60,000 lb. The 2500 lb/hr slaker is the smallest size a ble, and many other components have fixed costs. A 60,000 lb storage system c ts about $112,000 installed.

MODULE J - SETTLING AND SLUDGE LAGOON

A lined lagoon is needed to clarify scrubber water and to accumulate sludge and calcium chloride brine for disposal. A 45-m by 45-m lagoon is adequate for the large unit. The liner is chlorinated polyethylene reinforced with polyester fibers.

Estimated costs are as follows:

Liner @ $5.92/m^2 (49 m x 49 x liner)	$14,000
Dirt work and liner installation @ $5.25/m^2	12,800
Total cost	$26,800

A 0.10-hec lagoon is adequate for the smaller unit; its cost is an estimated $13,400, based on recent quotes for a similar system.

MODULE K - STACK

The stack is sized for a flow of 48,000 acfm of combustion gases saturated with water at 185°F. The most economical materials of construction for stacks handling high-corrosive gases are fiberglass-reinforced polyester and vinylester plastic. The cost for a 1.8-m by 30.5-m stack with test platform and ladder for the large incinerator unit is as follows:

Bare stack*	$18,200
Platform and ladder*	10,600
Total equipment	28,800

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Installation @ 50 percent of equipment cost	$14,400
Total installed cost	$43,200

A 1-m x 23-m stack is adequate for the small unit. Its cost is:

Bare stack*	$ 9,100
Platform and ladder*	9,300
Total equipment	18,400
Installation @ 50 percent of equipment cost	9,200
Total installed cost	$27,600

*These costs are based on vendors' quotes obtained in May 1978 and are adjusted for inflation to January 1979.

MODULE L - INJECTION WELL

The injection well will dispose of 736 gal/hr of 30 percent calcium chloride brine (specific gravity - 1.28). The depth of the well and the injection pressure required will be dependent upon local geological conditions. This cost estimate is for a median depth of 1700 m and average formation pressures and permeability. The injection rates are relatively low, so little reduction in cost can be expected for the small incinerator injection system.

The following cost estimate, therefore, is used for both the large and the small incinerators:

Site preparation	$ 5,500
Drilling rig service	90,500
Cementing (materials and service)	12,000
Testing, perforating, stimulation services	50,700
Tubular goods	45,750
Consultant fees (including permit application)	15,000
Well equipment	7,000
Contingency	16,500
Subtotal - Deep Well	$242,950

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TRANS. STATION

Storage tank (84,000 gal capacity)	$ 12,000
Pumps, motors, filters, electrical controls, etc	15,200
Contract labor	3,500
Contingency	3,000
Subtotal - Transfer Station	$ 33,700
Total cost	$276,650

MODULE M - INSTRUMENTATION AND CONTROLS

A sophisticated control system is needed both because of the relative complexity of a combined liquid-solid incinerator and because of the monitoring and automatic shutdown requirements of the PCB disposal regulations. MB Associates has designed an appropriate control and monitoring system for PCB incinerators (137), which is recommended for this application.

The control system is a rugged industrial-grade programmable controller utilizing relay ladder logic. This system is therefore capable of being programmed by personnel familiar with standard electrical diagrams. A visual display provides the operator with critical operating data, adjustments being made by the controller at a given moment, and alarms that are both visual and audible. The audible alarms are dual level so that operating personnel can distinguish between critical conditions requiring rapid attention and emergency demands for shutdown procedural action.

The controller scans all pertinent operating conditions several times a second, compares these data to standard operating data in the memory bank, indicates the control adjustment required, and provides a visual display of the adjustment in-process. Extreme or abnormal conditions trigger a buzzer alarm signifying rapid operator attention. Dangerous and very critical system failures result in both an emergency horn and flashing lights.

The cost estimate for this system is $123,400 (see Appendix H). The addition of carbon monoxide and carbon dioxide stack gas monitors, and of the interlocks to stop the feed of PCBs as required by the regulations, is estimated to raise the total cost to about $145,000. This cost is independent of the size of the incinerator.

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MODULE N - LABORATORY

Because of the strict regulations imposed on the operation of a PCB incinerator, an on-site laboratory is needed. This laboratory should be able to measure PCBs at low concentrations in the scrubber water or ash, surface runoff, ground water samples, etc. It should be able to determine the PCB content, heating value, chlorine, and ash content of the feed streams. The estimated cost of the laboratory, instruments, and supplies is given below:

Basic laboratory area and services, (20 ft x 30 ft = 600 ft^2) @ \$50/ft^2	\$30,000
Additional cost for equipment (hoods, benches, etc.) @ \$31/ft^2	18,600
Gas chromatograph: dual columns, dual detectors (electron capture and flame ionization)	15,000
Bomb calorimeter and accessories	2,000
Assorted glassware, reagents for titrations, distillation and concentration equipment for PCB analyses	2,500
Gas chromatograph accessories: installation (copper tubing, fittings, gas cylinders, regulators)	1,000
Gas chromatography supplies: columns, column packing materials, syringes	2,000
pH meter with specific ion capabilities	1,500
Analytical balance	3,000
Refrigerator/freezer (sample and reagent storage)	600
Drying oven, centrifuge, vortex mixer, hotplate stirrer, constant temperature water bath, and various other peripheral items of equipment	5,000
Total cost	\$81,200

MODULE O - OFFICE, MAINTENANCE SHOP, CHANGE ROOM

The large plant requires offices for six people, change and break room for 28 people, and adequate maintenance shop space. The estimated cost for these facilities is itemized below:

Office building - 900 ft^2 @ \$46/ft^2	\$ 41,400
Office equipment @ \$12/ft^2	10,800

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Change and break room - 900 ft^2 $46/$ft^2$	$ 41,400
Equipment @ $12/$ft^2$	10,800
Maintenance shop - 1200 ft^2 @ $26.50/$ft^2$	31,800
Shop equipment @ $18/$ft^2$	21,600
Total for buildings	$157,800

The small incinerator requires office space for three people, and change and break room space for nine people. The estimated cost for these facilities is itemized below:

Office building - 450 ft^2 @ $46/$ft^2$	$20,700
Office equipment @ $12/$ft^2$	5,400
Change and break room - 300 ft^2 @ $46/$ft^2$	13,800
Equipment $12/$ft^2$	3,600
Maintenance shop - 400 ft^2 @ $26.50/$ft^2$	10,600
Shop equipment @ $18/$ft^2$	7,200
Total for Buildings	$61,300

MODULE P - GROUND WATER, SURFACE RUNOFF, AND AMBIENT AIR MONITORING

The proposed regulations for hazardous disposal facilities require a minimum of four ground water monitoring wells. Surface runoff will be collected in a single lagoon where it can be tested and either discharged or incinerated.

At least one upwind and one downwind ambient air monitoring station will likely be required as well, although not specified in existing regulations. The ambient air monitors must be capable of sampling both particulate and organic vapors (PCBs in particular). The estimated costs are as follows:

6 ground water monitoring wells	$15,000
2 portable ambient air monitoring stations	10,000
0.6 hec-m clay-lined lagoon	25,000
Total cost	$50,000

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Estimated costs for the small incinerator are as follows:

4 ground water monitoring wells	$10,000
2 portable ambient air monitoring stations	10,000
0.12 hec-m clay-lined lagoon	10,000
Total cost	$30,000

MODULE Q - LAND

Two philosophies of site selection and acquisition are considered for locating the PCB incinerator:

1. Purchase of 6 hec in an industrialized area at approximately $50,000/hec.

2. Purchase of 60 hec in a rural area at approximately $5,000/hec.

The cost of land in either case would be $300,000.

For the case of the small incinerator, a 1.5-hec industrial site or a 15-hec rural site would be required, with an associated price of $75,000.

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APPENDIX H

COST ESTIMATE FOR PORTABLE PCB
INCINERATOR - HB ASSOCIATES

Capacity:	Dry sand or dirt:	Up to 9000 lb/hr
	Water or sludges:	Up to 1400 lb/hr
	Oil (18,000 Btu/lb):	Up to 725 lb/hr

Total estimated cost: $1,137,800.

Detailed cost breakdown:

Control Subsystem	
• Programmable controller	
• Display console	
• Dual-level alarm	
• Gas stream monitoring	
• Control values	$123,400
Feed Subsystem	
• Solids loader	
• Solids shredder	
• Solids ram feeder	
• Sludge and liquid feed systems	$117,700
Incinerator Subsystem	
• Kiln and drive	
• Economizer chains	
• Burners and blowers	
• Ash removal	
• Protective cowling	$176,300

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Afterburner Subsystem

- Primary afterburner
- Burners and blowers
- Inlet swirl plate
- Outlet molar flow nozzle
- Protective cowling $125,600

Exhaust Gas Treatment Subsystem

- Venturi quench
- Particle scrubber
- Absorption scrubber
- Induced draft blower
- Blower drive
- Sound attenuation
- Stack $312,800

Equipment Interconnects

- Inconel ducting
- Water plumbing
- Electric power system
- Fuel plumbing
- Control wiring $70,200

Auxiliary System

- Hydraulic
- Diesel alternator
- Air compressor
- Emergency water $82,800

Trailers

- Basic trailers
- Material handling cranes
- Steps, rails, and platforms
- Equipment storage rack $130,000

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APPENDIX I

DESCRIPTION OF LAND DISPOSAL SITES
PERMITTED FOR RECEIPT
OF PCB MATERIALS

Niagara Falls, New York	I- 2
Model City, New York	I- 7
Sumter County, Alabama	I-12
Arlington, Oregon	I-17
Casmalia, California	I-23
Grand View, Idaho	I-26

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NIAGARA FALLS, NEW YORK

OVERVIEW

The Niagara Falls, New York, site is located in the industrial sector of the city of Niagara Falls, New York. Relatively wet climate and near surface ground water (<15 m) have necessitated construction of special water quality protection facilities for this secure landfill.

Region II has approved the area of this site known as secure landfill No. 2 for receipt of PCB-contaminated materials. The permit is valid for a period of three years, commencing August 18, 1978. Twenty-five units within subcell I of secure landfill No. 2, occupying a volume of 26,600 m^3 (937,500 ft^3) have been designated for PCB-contaminated materials. Site operations are interrupted temporarily during heavy rains or snowstorms. There is no public objection to the PCB landfill activity. The monitoring program at secure landfill No. 2 includes monthly sampling ground water monitoring wells, surface water sampling points, and accumulated leachate. A total of 44 water sampling points is used for the monitoring purpose.

HISTORY OF PCB LANDFILL ACTIVITY

The Niagara Falls landfill site is operated by NEWCO Chemical Waste Systems, Inc. (NEWCO). Site operations began in 1976, and PCBs were received through 1978. On January 30, 1978, NEWCO applied to the New York State Department of Environmental Conservation (DEC) to construct secure landfill No. 2 for disposal of hazardous waste. A construction permit was granted by DEC on May 9, 1978, and one month later (June 8, 1978) NEWCO received the operation permit.

NEWCO also applied to EPA Region II on April 24, 1978, for approval of secure landfill No. 2 as a PCB material disposal site. EPA approval of a three-year permit was formally granted on August 18, 1978, following a one-month public comment period (from May 29, 1978, to June 28, 1978) and a review of submitted documents.

MONS 028562

SITE DESCRIPTION

Location

NEWCO's Niagara Falls site is located at 56 Pine Avenue, Niagara Falls, New York, and is about 32 km (20 mi) northwest of Buffalo International Airport (Figure 1).

Operating Agency

The site is owned and operated by NEWCO. The company's headquarters is located at 4626 Royal Avenue, Niagara Falls, New York 14303, telephone (716) 278-1811.

Site Area

The disposal site was constructed on the outskirts of the city of Niagara Falls and is surrounded by industrial factories and plants. It is fenced and covers approximately 266 ha (658 ac). Only authorized personnel are permitted to enter the site. There are four separate sections inside the fenced area: (1) an office, maintenance shop, and laboratory to the northwest; (2) an acid-base neutralization pond and an aqueous pretreatment system to the east; (3) a municipal solid waste sanitary landfill to the southeast; and (4) an area designated as secure landfill to the southwest of the site (Figure 2).

The secure landfill areas have three cells: Secure Landfill (SL) No. 1, which has been filled; SL No. 2 is in operation; and SL No. 3 is being prepared. SL No. 2 was built 20 percent below and 80 percent above ground. It is 7.6 m (25 ft) deep and is divided into three subcells by clay berms. Subcell I is designated for general chemical and halogenated organic wastes; Subcell II is for pseudo-metals; and Subcell III is for heavy metals. Each subcell is, in turn, divided into grids of 15 m x 9 m (50 ft x 30 ft) to ensure that incompatible wastes are segregated. In SL_3 No. 2, Subcell I, 25 units with a total volume of 26,600 m^3 (937,500 ft^3 or 25 ft x 50 ft x 30 ft x 25) are designated for PCB-contaminated materials.

Secure Landfill Construction

In constructing SL No. 2, the land was excavated to a depth of 1.5 m (5 ft). Part of the excavated soil was used to construct compacted soil berms on the edge of the cell to provide an additional height of 6.1 m (20 ft). As a result, the total depth of the cell is 7.6 m (25 ft). The cell is lined with 30 mil B. F. Goodrich Flexseal 30 HP membrane liner which is sandwiched between 90-cm (3-ft) thick recompacted clay

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underneath and 60-cm (2-ft) thick recompacted clay on top. After liner placement, clay berms were built to divide the cell into subcells.

Provisions for containing and collecting any leachate are also installed. Two concrete standpipes for leachate collection are located in each subcell, and each pair of standpipes is hydraulically connected with perforated vitrified clay pipes overlayed with stone. Each subcell floor is sloped towards the leachate standpipes at a 2 percent gradient.

Environmental Factors

Soil. The base of SL No. 2 consists of 6 m) ft) of compacted clay with a moisture content of greater than 30 percent a plasticity inc.x exceeding 15. The clay obtains a permeability of about 10 .m/sec (160). Permeability of recompacted clays is even lower (10^{-9} cm/sec).

Hydrology. Local topography is generally flat. The site is less than 15 m (50 ft) above the ground water and is about 3.2 km (2 mi) north of the Niagara River. Ground water contains a very high concentration of chloride and is considered not potable (109). There is no hydraulic connection between this river and the site (160). The landfill perimeter is bermed to an elevation of 6 m (20 ft) above the datum and, consequently, is capable of diverting all off-site, upstream surface water runoff from a 24-hr, 25-yr storm.

Climate. Climatic data from Buffalo, which is approximately 32 km (20 mi) southeast of NEWCO's secure landfill site, are presented in Table 1 (17). The monthly average temperature at the site is approximately the same as that of Buffalo. However, normal precipitation is about one fourth that registered at Buffalo.

PCB-CONTAMINATED WASTE HANDLING

Disposal Procedures

Prior to delivery of PCB-contaminated materials to the site, the waste characteristics are documented by NEWCO's customers and verified by chemical analysis at the site. The waste specification is then recorded, using a six-digit code which specifies the following:

- Designated location for the wast SL No. 2.
- Characteristics of the waste.
- Cover material required.

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The coded waste is then containerized in barrels or cardboard boxes and hauled to the site. NEWCO provides hauling service to its customers if they so desire or receives the delivered waste materials in customer vehicles.

The PCB-contaminated materials received consist of sealed capacitors, drained transformers, PCB-contaminated earth, rags, etc. These materials are unloaded to a designated unit in Subcell I by front-end loader and/or forklift, and are covered with 45-cm (1.5-ft) thick soil-lime mixture. The lime material is available at the site as a by-product of a former acetylene production process. The amount of lime stockpiled at the site is estimated at up to 50 million m^3. The lime additive helps keep pH high to minimize potential for heavy metal movement from the disposal area.

For PCB-contaminated wastewater treatment sludges, the sludge must be thoroughly dewatered before shipment. As a handling procedure, the percentage of free liquid is checked by NEWCO's on-site laboratory prior to disposal. The sludge must have less than 15 percent by volume of free liquid.

Quantity Received and Gate Charge

NEWCO's Niagara Falls site is relatively busy. On the average, 10 to 15 truckloads of chemical waste material per day (200-300 t/d, or 200-300 m^3/d) are received. Less than 10 percent of the shipment contains PCBs. NEWCO expects to accept a larger quantity of PCBs in the near future from new customers. Some large utility industries are negotiating for service contracts.

The site operates five working days per week year-round. Off-hour delivery schedules, however, can be arranged.

The gate charge for PCBs is negotiated with each customer. No information on charges was disclosed for publication.

Monitoring Program

Thirty-two ground water monitoring wells are in place at the site. These wells are cased, and the annular space between the monitored zone (zone of saturation) and the surface is backfilled with portland cement to prevent percolation of surface water into the well bore. The well opening at the surface has a removable cap to provide access and to prevent the entrance of rainfall or storm water runoff.

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During the operational life of the site, each monitoring well and six surface sampling points are investigated monthly. Samples are analyzed for the following parameters: PCBs, pH, total chlorinated organics, and specific conductance. After closure of the SL No. 2 cells, the sampling frequency will be reduced to every six months indefinitely.

Leachate from SL No. 2 is monitored monthly. Leachate is pumped out via a portable pump or vacuum truck when leachate level in the standpipe exceeds 46 cm (18 in). Based on analysis, leachate will be collected and treated on-site accordingly, prior to discharging to nearby streams. A water treatment facility is provided on-site by NEWCO.

Equipment and Personnel Summary

For the NEWCO PCB disposal activity, the following equipment is used:

- One small track dozer.
- One front-end loader.
- One to two forklift(s) equipped with drum grabber.
- One pickup truck.

Three to five persons are assigned to the SL No. 2 (including a supervisor), depending upon the work load.

OPERATIONAL PROBLEMS

Inclement weather causes slippery soil conditions for mobile equipment. In addition, during extreme heavy rain or snowstorms, site activity may be temporarily interrupted. However, NEWCO has on-site snow removal capability to keep the site open under adverse conditions.

PUBLIC ACCEPTANCE

The NEWCO Niagara Falls site is surrounded by factories and industrial plants. The landfilling operation appears to be of little concern to the public because air pollution and other impacts from surrounding industrial operations are more obvious. During the summer of 1978, CBS and NBC television networks were inivited to visit the site while covering a report on the Love Canal incident (water contamination due to improper chemical waste disposal in the 1950s). Such media coverage on NEWCO's activities has resulted in a positive impact for the site operation.

MONS 028566

MODEL CITY, NEW YORK

OVERVIEW

The Model City, New York, site is about 55 km (34 mi) north of Buffalo International Airport. The PCB secure landfill portion of this site involves features to protect surface waters and near surface ground water (<15 m) from contamination.

EPA approval for disposal of PCB-contaminated materials has been granted to secure landfill No. 7 at the site for a period of three years, commencing October 2, 1978. Total volume of the available fill is about 177,500 m^3 (6,250,000 ft^3) and one fifth is designated for PCBs. The site monitoring program includes monthly sampling of five ground water monitoring wells, eight surface water sampling points, and accumulated leachate. Gate charge is \$388/m^3 (\$11/ft^3) or about \$80 per each 55-gal drum of PCB-contaminated waste.

Local environmental groups have expressed concern with the site's chemical waste disposal operations.

HISTORY OF PCB LANDFILL ACTIVITY

The Model City, New York, secure landfill is owned and operated by SCA Chemical Waste Services, Inc. (SCA). The site covers 348 ha (860 ac), one quarter of which was purchased in 1972 and the remainder in 1974. The site housed TNT production facilities during World War II. After the war, some radioactive wastes were buried here. Prior to conversion to a secure landfill, the site was decontaminated (by removal of radioactive waste) to reduce radioactivity levels to below 50$_\mu$ Ci.

All chemical wastes, except radioactive and explosive substances, are accepted at this site. Before promulgation of final EPA regulation for PCB, approximately 10 percent by volume of total waste accepted were PCB materials. On April 24, 1978, SCA filed application with EPA Region II for approval of secure landfill No. 7 for PCB disposal. The EPA approval was formally granted on October 2, 1978, for a three-year period following one month of public comments (from June 2 to July 2, 1978) and review of submitted documents. In addition, the New York Department of

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Environmental Conservation granted SCA state permit to construct a secure landfill at this site.

SITE DESCRIPTION

Location

SCA's Model City secure landfill is located on Balmer Road, Model City, New York, and is about 24 km (15 mi) north of the NEWCO's Niagara Falls site (Figure 3). A local map showing directions to the SCA site from the Buffalo area is shown in Figure 4.

Operating Agenc

The site is own- and operated by SCA, which provides collection, treatment, recovery and dis. osal of solid and chemical wastes. Its stock is traded on the New York Stock Exchange under the symbol SCA. Its executive offices are located at 60 State Street, Boston, Massachusetts 02109, telephone (617) 367-8300.

SCA has other major waste processing and disposal facilities in New Jersey, New York; Illinois; and South Carolina.

Site Area

The Model City, New York, secure landfill has an area of approximately 348 ha (860 ac). It is fenced and posted to warn of hazardous chemical storage and dissuade unauthorized entry. There are three separate sections inside the fenced area: (1) a laboratory and offices area; (2) a storage building; and (3) the secure landfill area.

Secure landfill No. 7 has a volume capacity of 177,500 m^3 (6.25 million ft^3 or 500 ft x 500 ft x 25 ft) and consists of five subcells. Each subcell is designated for a special type of waste, as follows:

Subcell No.	Waste Type or Constituents
1	Heavy metal
2	Pseudo-metals
3	Organics
4	Halogenated organics (including PCBs)
5	Sludge

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Figure 5 shows the general configuration of this area.

Secure Landfill Construction

The land was first excavated to a depth of 5.2 m (17 ft). Part of the excavated soil was used to construct a compacted earthen berm on the perimeter of the pit to a height of 2.7 m (9 ft). Thus, the effective pit depth before liner and clay barrier installation is 7.9 m (26 ft). These construction features are designed to create a higher upward piezometric pressure underneath the pit, preventing downward movement of any leachate that may be generated. Unused soil was stockpiled and will be used as cover material.

The pit was next lined with 50-mil hypalon membrane liner (Figure 6). The membrane is protected from mechanical damages by a 90-cm (3-ft) thick compacted clay layer. After liner placement, clay berms were built to divide the fill into subcells (Figure 5). Two vitrified clay collection pipes were laid on the sidewall of each subcell. These pipes are hydraulically connected with a sump to provide for leachate collection.

Leachate Factors

Soil. The base of SCA's secure landfill No. 7 consists of 9-m (30-ft) clay with permeability of less than 10^{-7} cm/sec, plasticity index of greater than 15, and liquid limit of greater than 30 (161).

Hydrology. Ground water is at less than 15 m (50 ft) beneath the fill and is nonpotable. Piezometric pressure beneath the fill tends to oppose downward movement of liquids or leachate from the waste containment areas. The closest surface water bodies are two small creeks, called Twelve Mile Creek and Six Mile Creek, which are on or immediately adjacent to the site. These streams flow intermittently. There is no hydraulic connection between these water bodies and the fill. There is no surface water on the site, other than lagooned wastewater that is part of the disposal operation.

The landfill perimeter is bermed to an elevation of 3 m (9 ft) above the datum. These berms are capable of diverting all of the surface water runoff from a 24-hr, 25-yr storm.

Topography. The site is relatively flat. Little or no evidence of erosion is apparent.

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Climate. The climatic data of Buffalo, located 55 km (34 mi) south of the site, are presented in Table 1 in the previous section (Niagara Falls, New York). Generally, the area is relatively wet with 145 cm per yr (57 in per yr) rainfall and 69 cm per yr (27 in per yr) evaporation.

PCB-CONTAMINATED WASTE HANDLING

Disposal Procedure/Quantity Received

SCA individually negotiates the details of PCB waste delivery and disposal with each customer. The generator provides SCA with a description of its waste characteristics which SCA can verify in its laboratory prior to disposal.

At the disposal site, PCB-contaminated materials are unloaded to subcell No. 4 by use of a front-end loader and/or a forklift. The waste is covered with clay on an "as required" basis. PCB-contaminated sludge is not containerized but spread on the fill floor and covered with clay.

Landfill No. 7 was originally projected to be filled in 3 yr, but will probably be filled within about one year because PCB-contaminated soils from a highway spill are being deposited here. The gate charge is $388 per m^3 ($11 per ft^3) or $80 per 55-gal drum. Identity of the company's present customers are considered proprietary information.

The site operates year-round on a 5-day per week schedule. However, special arrangements can be made for waste materials to be delivered on weekends.

Monitoring Program

Five ground water monitoring wells and eight surface water sampling points are sampled monthly and monitored for the following parameters: PCBs, pH, specific conductance, and chlorinated organics. After site closure, the sampling frequency will be reduced to every 6 mo for an indefinite period.

Any leachate that collects in the collection sump in each subcell is also monitored monthly. Leachate is pumed out via a vacuum truck when the leachate level in the standpipe exceeds 30 cm (1 ft). The leachate is then neutralized, settled, filtered, and treated by flow through a carbon bed. When its PCBs, other chlorinated organics, and salt content meet the state and federal regulatory standards, the treated effluent is discharged to nearby streams.

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Equipment and Personnel Summary

For the PCB disposal activity at the site, SCA utilizes front-end loaders and forklifts. The number of each type of machinery and personnel working at the site varies, depending upon the work load.

PUBLIC ACCEPTANCE

Local environmental groups and some candidates for political office have expressed concern about the SCA site. One court case challenging the site location was recently settled in favor of SCA because operations adhere to all state and federal regulations.

Presently, SCA has no formal public relations programs. The company, however, does offer site visits to those citizens who want to know more about its chemical waste handling activities.

MONS 028571

SUMTER COUNTY, ALABAMA

OVERVIEW

The Sumter County, Alabama, site is located in Emelle, on State Road 17, Mile Marker 163. The site is underlain by 152 m (500 ft) of dense gray to blue limey clay and chalk, with an average permeability of 4×10^{-8} cm/sec and a plasticity index of 10.8.

EPA approval for disposal of PCB-contaminated materials was granted to the site on June 28, 1978. Trench No. 5, which has a total volume of 34,000 m^3 (1.2 million ft^3), has been designated for PCB-contaminated material disposal. On the average, 25 m^3 waste (e.g., capacitors, drained transformers, etc.) and forty 55-gal drums containing PCB-contaminated materials are received daily. Gate charges are not published; they are negotiable depending on waste type and volume.

The site monitoring program includes monthly sampling at three monitoring wells downstream from the PCB trench; quarterly sampling at nine other wells on the site, and semiannual sampling of nine state wells. Leachate from Trench No. 5 is monitored via two standpipes hydraulically connected to a sump inside the trench. No major public objections or operational problems have been encountered.

HISTORY OF PCB LANDFILL ACTIVITY

The Sumter County, Alabama, landfill is owned and operated by Waste Management of Alabama, Inc. It was opened in May 1977 and accepts all types of hazardous wastes, except radioactive and pathogenic wastes. Municipal refuse are excluded as well. Prior to promulgation of final EPA regulations for PCBs, approximately 0.5 percent by volume of the total accepted waste was PCB. On March 10, 1978, Waste Management of Alabama filed application with EPA Region IV for approval of the site as a PCB disposal site.

EPA Region IV formally granted a permit for PCB waste disposal on June 28, 1978, following the requisite 30-day public review period (no public comments were submitted). The Alabama Division of Solid Waste and Vector Control recommended that EPA approve the site for PCB disposal.

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SITE DESCRIPTION

Location

The Sumter County, Alabama, site is located in Emelle, on State Road 17, Mile Marker 163, and is about 17 km (10 mi) northwest of Livingston, Alabama (Figure 7).

Operating Agency/Site Manager

The site is owned and operated by Waste Management of Alabama, also known as Resource Industries of Alabama, a division of chemical Waste Management, Inc. The company addresses are as follows:

Resource Industries of Alabama
P.O. Box 1200
Livingston, Alabama 35470
Telephone: (205) 652-9529

Chemical Waste Management, Inc.
900 Jorie Boulevard
Oak Brook, Illinois 60521
Telephone: (312) 654-8800

Site manager is Mr. Mark Gregory, telephone (205) 652-9529.

Site Area

The site covers approximately 365 ha (900 ac), all suitable for landfilling. About 41 ha (100 ac) are partially enclosed with a 1.8-m (6-ft) chain-link fence. Presently, three trenches (Trench Nos. 4, 5, and 6) are in operation (Figure 8). Trench No. 5, which has a total volume of 34,000 m^3 (1.2 million ft^3 or 100 ft x 200 ft x 60 ft), is designated for PCB-contaminated material.

In addition to the landfill trenches, there is one large evaporation pond on site. Other facilities are a new office and laboratory building and a maintenance shop.

Environmental Factors

Soil. The main geologic units found at and around the landfill site are the Demopolis and Ripley formations of the Selma Group (162). The outcrop of Demopolis at the site consists of dense gray to blue limey clay (containing up to 82 percent

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agricultural grade lime) and chalk, which are approximately 152 m (500 ft) thick. Seashells present on site indicate the area was formerly under seawater. Average soil permeability is 4×10^{-8} cm/sec, and the plasticity index is 10.8.

Topography and Hydrology. The site can be described as gently rolling, with low relief in a northward direction. The average site evaluation is approximately 45 m (148 ft) above sea level. The PCB-designated disposal trench is located on the crown of a ridge at an approximate elevation of 61 m (200 ft). This is well above the 100-yr floodwater elevation (38 m or 125 ft). The ground water table generally is at 46 m (150 ft) or deeper, although occasionally perched water seams are noted at the 3 m (9 ft) level (162). The closest surface waters are a small creek 1.6 km (1 mi) north of the site and Tombigbee River, 11 km (7 mi) to the northeast.

Climate. Climatic data of Whitfield, approximately 48 km (30 mi) southeast of the site, are presented in Table 2. The monthly average temperature for the entire year is 19°C (66°F), ranging from a low of 10°C (51°F) in December to a high of 27°C (81°F) in July. Annual precipitation is 133 cm (52 in) and evaporation 127 cm (50 in).

PCB-CONTAMINATED WASTE HANDLING

Disposal Procedures

Containerized PCB-contaminated materials, e.g., drained transformers, sealed small capacitors, drums, etc., are unloaded from the delivery truck by a forklift and delivered to the trench by a front-end loader (Figures 9 and 10). Wastes are covered daily with native soil. PCB-contaminated sludge is not containerized but spread on the fill floor and may be left uncovered for several days (Figure 11). After loss of excess moisture by evaporation, the sludge is covered, also with native soil.

Quantity Received

The site is relatively active. An average of 26 truckloads of chemical waste are delivered each day. This is equivalent to 85 m^3 (3000 ft^3) or 400 drums of waste. Before the final EPA's PCB regulations were issued, about 0.5 percent of the total waste received was PCBs. This rate has increased to more than 10 percent since July 1978 (to 25 m^3 waste and 40 drums daily). The company's major customers were not disclosed nor were the specific gate charges for PCBs. Indications are that disposal rates here are comparable to those elsewhere. Rates are negotiable.

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The site operates five working days per week year-round. Special arrangements can be made for waste materials to be delivered on weekends.

Monitoring Program

There are nine wells located nearby off-site (called state wells) and nine wells at the site. Water samples from the state and site wells are taken every six and three mo, respectively. In addition, water is also sampled from three downstream wells installed 5 m (15 ft) below the bottom of the PCB trench (Figure 8).

For leachate collection, a 10-cm (4-in) graded gravel blanket is provided in the PCB trench bottom. This blanket allows liquids to drain easily to a sump. Leachate monitoring is conducted monthly via two standpipes (ID = 15 cm) hydraulically connected to the sump (Figures 8 and 10).

Equipment and Personnel Summary

The site has the following equipment for trench construction, waste hauling, and disposal:

- 1 forklift.
- 2 front-end loaders.
- 3 bulldozers.
- 4 scrappers.
- 6 tractors.
- 3 vans.

Twenty-five persons are employed at this site. Assignments to the PCB disposal operations vary with waste loadings. Waste Management of Alabama also provides hauling service upon request. The company has a fleet of 12 trucks for this purpose.

PUBLIC ACCEPTANCE

The local community is small and agriculturally oriented. There has been no public opposition to disposal operations.

The apparent public acceptance is likely the result of an effective public information/education program initiated by Waste Management, Inc. For example, Waste Management personnel offer site tours, visits for community groups and

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individuals, and otherwise assist the public in understanding the disposal operations. In addition, ground-up agricultural grade lime (mined from the site during trench excavations) is provided to the local farmers at no cost.

ARLINGTON POLLUTION CONTROL CENTER, OREGON

OVERVIEW

Arlington Pollution Control Center (APCC) is located southwest of Arlington, Oregon. The site is underlain by 61 m (2000 ft) of soil with permeabilities ranging from 4×10^{-4} to 5×10^{-7} cm/sec (1.6×10^{-4} to 2.0×10^{-7} in/sec). Between the soil and the ground water is a layer of impermeable basalt which confines the ground water under pressure. Evaporation at the site is 160 cm (63 in) as compared to the total annual precipitation of 25 cm (10 in). EPA Region X has approved disposal of PCB-contaminated materials at the APCC for a period of 1.5 years (from June 30, 1978, to January 1, 1980).

The northerly part of Trench No. 5, which has a total volume capacity of 1278 m^3 (45,000 ft^3), has been designated for PCB-contaminated material disposal. On the average, one truckload of the waste (approximately 15,890 kg or 35,000 lb) is received each week. The monitoring program at Trench No. 5 includes monthly sampling of two existing ground water wells and monthly checking of the presence of liquid at three test wells. No major public objection and/or operational problems have been encountered. The gate charge is \$137 per m^3 (\$3.90 per ft^3) or \$28.5 per 55-gal drum.

HISTORY OF PCB LANDFILL ACTIVITY

The Arlington landfill site, called the Pollution Control Center, is operated by Chem-Nuclear Systems, Inc. It was opened in August 1976 and, as of August 1978, has accepted approximately 32,200 m^3 (1.13 million ft^3) of wastes. Less than 10 percent of the total wastes is PCB materials. On March 10, 1978, Chem-Nuclear Systems, Inc., applied to EPA Region X for approval of Trench No. 5 as a PCB disposal site. Public notice of the application was published on May 1, 1978. Response to the public notice consisted of one letter stating opposition to the disposal of radioactive materials at the site. No comments were received regarding PCB disposal.

EPA Region X formally granted an approval for PCB waste disposal for Trench No. 5 on June 30, 1978, following a review of applicant information (including the document,

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"Geological and Subsurface Investigations, Arlington Disposal Site, Gilliam County, Oregon") and observation of the site. The permit is valid through January 1, 1980.

SITE DESCRIPTION

Location

APCC is located in Section 25 and 26, Township 2 North, Range 20 East, W. M., Gilliam County, Oregon. This is about 20 km (12 mi) southwest of the city of Arlington, Oregon (Figure 12).

Operating Agency/Site Manager

The site is owned and operated by Chem-Nuclear Systems, Inc., which has offices in four states. The regional addresses of the company are as follows:

- Corporate and Western Operations' Office
  P.O. Box 1866
  Bellevue, Washington 98009
  (206) 827-0711

- Southeast/Southwest Operations' Office
  P.O. Box 726
  Barnwell, South Carolina 29812
  (803) 259-3588

- Northeast/Midwest Operations' Office
  3625 Eggert Road
  Orchard Park, New York 14127
  (716) 662-2562

- Compliance Assistance and Technical Services:
  Cosmopolitan Center North
  6135 Barfield Road
  Atlanta, Georgia 30328
  (404) 392-4507

The Arlington site manager is Mr. Frank G. Dement, telephone (503) 454-2777.

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Site Area

The site is located in a hilly area and covers approximately 130 ha (320 ac). Figure 13 shows the site entrance. Six ha (15 ac), fenced with 2-m (7-ft) fencing, plus three top strands of barbed wire, are used to enclose the hazardous waste disposal area. Three trenches are presently in operation. The northerly part of one of these trenches, Trench No. 5, has a total volume of 12,780 m^3 (450,000 ft^3, or 150 ft x 100 ft x 30 ft). Trench No. 5 is used for the deposit of PCB-contaminated materials. Trench No. 5 was prepared by first evenly spreading a 30-cm (1-ft) thick charcoal layer over the natural soil and a 30-cm (1-ft) compact soil layer on top (Figure 14).

Adjacent to the fenced disposal site is a helicopter pad provided for any medical emergencies that may occur.

In a separately fenced area, there are two buildings, one for equipment maintenance and one for storage. Twenty to twenty-five 190ℓ (55-gal) drums full of PCB or PCB rinsate were observed in the storage building during October 1978.

There are also two fenced-in evaporation ponds at the site. One pond receives liquid acid waste, the other receives caustics.

Environmental Factors

Soil. The site is located in an area underlain by 61 m (200 ft) of soil with permeabilities ranging from 4×10^{-4} to 5×10^{-7} cm/sec (Figure 15). Between the soil and the ground water is a layer of impermeable basalt which confines the ground water under pressure.

Hydrology. The site is located in the Columbia Plateau basaltic province of north central Oregon and is more than 61 m (200 ft) above the nearest stream bed located in adjacent Alkali Canyon (111). No flood data are available for this area; however, the disposal site is apparently above the 100-yr floodwater elevation. No runoff occurs in the area of the disposal site. Occasional rain or snow melt that accumulates in the wind-blown depressions either sublimates, evaporates, or infiltrates into the shallow soil, usually to be evapotranspired during the dryer months. Ground water beneath the site is under confined conditions at a depth of about 171 m (560 ft). The head on this aquifer creates a piezometric pressure approximately 130 m (426 ft) below the surface (164).

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The closest surface waters are Rock Creek and the Columbia River, which are about 10 to 11 km (6 to 7 mi) away. There is no known hydraulic connection between the site and these surface water bodies (164). As a result of the hydrological characteristics and the local climate of the site, the EPA has determined the following 164:

- A leachate collection system for the site is deemed unnecessary.
- The land surface around Trench No. 5 shall be graded or trenched to prevent any overland runoff from flowing into the PCB landfill.
- The two existing ground water wells are adequate for ground water monitoring.

Climate. Climatic data of Pendleton, Oregon, approximately 120 km (73 mi) east of the APCC are presented in Table 3 (17). The monthly average temperature for the entire year is 12°C (53°F), ranging from a low of 6°C (42°F) to a high of 17°C (63°F). January is the coldest month with a mean temperature of -1°C (31°F). Normal total precipitation (rainfall and snowfall) is 81 cm (32 in), occurring over 107 days per year. At the disposal site, however, the recorded rainfall is much less: 25 cm (10 in) (164). On the other hand, pan evaporation measurement at the site is approximately 160 cm (63 in) per year (164). As a result, surface runoff at the site is relatively rare.

PCB-CONTAMINATED WASTE HANDLING

Disposal Procedure

A permit through the Oregon Department of Environmental Quality is required to haul PCB-contaminated materials to the APCC. Chem-Nuclear Systems, Inc., does not own or operate any waste transportation equipment. The company, however, will arrange for PCB material hauling with a qualified trucking firm if its customer so desires.

At the site, PCB-contaminated materials (i.e., sealed capacitors, drained transformers, PCB-contaminated containers, etc.) are stacked into 2-m (7-ft) layers within Trench No. 5 (Figures 16 and 17). The layers are separated from each other by a 30-cm (1-ft) layer of charcoal which is sandwiched between two 30-cm layers of soil. Consequently, three layers of PCB-contaminated material can be placed in the

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trench. It is planned to place 1 m (3 ft) of compacted soil on top of the last layer.

Quantity Received and Gate Charge

The APCC site receives an average of one truckload of PCB-contaminated material per week (approximately 15,890 kg or 35,000 lb/wk). The major customers are Hewlett Packard, Exxon, Resource Recovery, Inc., U.S. Navy, Weyerhauser Lumber, and local public utilities. The gate charge is $137 per m^3 ($3.90 per ft^3) or $28.50 per 55-gal drum.

The site operates five days per week year-round. If customers desire, special arrangements can be made for waste materials to be received on a weekend day.

Monitoring Program

There are two wells (the site water well and the office water wells) used for ground water monitoring purposes. These wells are partially cased, with portland cement used to cement the bottom of the casing into the underlying basalt. The annular spaces are backfilled with well cuttings from the site. EPA requires monthly sampling of these wells and analysis for the following parameters: PCBs, pH, specific conductance, total chlorinated organics, and chlorides.

In addition, three test wells in Trench No. 5 (Figure 17) placed approximately 60 cm (2 ft) below the trench are required to be checked monthly for the presence of liquid in the well bore. If any liquid is detected, a sample will be taken and analyzed for the aforementioned parameters. All analytical results (and a summary of any spilled PCB material received during the month) are submitted monthly to the Solid Waste Management Program, EPA Region X.

After site closure, water from the two ground water wells must be sampled semi-annually for 10 years.

Equipment and Personnel Summary. The following equipment is used for disposal activities at the APCC site:

- 1 front-end loader.
- 1 tractor.
- 1 forklift.

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- 1 track dozer and scraper.
- 1 pickup truck.

Five persons are employed at the site: the manager, one secretary, and three laborers/equipment operators.

PUBLIC ACCEPTANCE

Arlington is a small farming community with a population of about 600. Chem-Nuclear Systems has received no major public objection. Management occasionally invites local citizens and students to observe the waste disposal operations during site tours.

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CASMALIA DISPOSAL SITE

OVERVIEW

The Casmalia Disposal Site is located on NTU Road, approximately 11 km (7 mi) south of Guadalupe, Santa Barbara County, California. The site is underlain by 229 to 458 m (750 to 1500 ft) of diatomaceous shale and claystone. EPA approval for disposal of PCB-contaminated wastes was granted to the site on November 17, 1978. An area of 2.2 ha (5.5 ac) at the site was designated for nonliquid PCB-contaminated material. The gate charge for PCBs is $165 per t ($150 per ton). The water quality monitoring program includes monthly sampling at five monitoring wells and one surface water sampling point. No major public objection or operational problems have been encountered.

HISTORY OF PCB LANDFILL ACTIVITY

The Casmalia Disposal Site is owned and operated by Mr. Kenneth H. Hunter, Jr. The site was opened in 1972, accepting all types of chemical wastes except radioactive materials. Prior to the promulgation of the EPA disposal regulations for PCBs, approximately 4.5 t (5 tons) of PCB-contaminated waste were received. On April 25, 1978, Casmalia Disposal applied to EPA Region IX for approval to accept PCBs. The approval was formally granted on November 17, 1978.

SITE DESCRIPTION

Location/Operator

The site is located on NTU Road, approximately 11 km (7 mi) south of Guadalupe, Santa Barbara County, California (Figure 18). It is managed by Mr. Kenneth H. Hunter, Jr., telephone (805) 969-4703.

Site Area

The site has approximately 80 ha (197 ac) with 1740 ha (4300 ac) set aside as buffer zones from surrounding property. Both the disposal site and the buffer zones are fenced with five-strand barbed wire. The site is 3.2 km (2 mi) from the nearest community and 1.6 km (1 mi) from the nearest public road. An area of 2.2 ha (5.5 ac) is designated for PCB disposal.

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Environmental Factors

Geology. The underlying geology of the site consists of Sisquoc formation varying from 229 to 458 m (750 to 1500 ft) thick and comprised of diatomaceous shale and claystone (79). The soil is essentially impervious, and 78 percent of its components passes through a No. 200 sieve. Useable ground water does not exist beneath the site.

Climate. Climatic data of Santa Maria, approximately 16 km (10 mi) northeast of the site, are presented in Table 4. The monthly temperature varies from 3 to 23°C (38 to 74°F). January is the coldest month, and September is the warmest. Annual precipitation is 34 cm (13.4 in).

PCB-CONTAMINATED WASTE HANDLING

The following PCB wastes are authorized for disposal at the site:

- Nonliquid PCB mixtures in the form of soil or debris which have been contaminated by PCB as a result of a spill.
- Contaminated materials not resulting from a spill (these can be landfilled only until January 1, 1980).
- Drained transformers.
- Small PCB capacitors (to be landfilled only until January 1, 1980).
- Dredged material and municipal sewage sludge that contain PCBs.

To be acceptable for disposal at the Casmalia site, PCB wastes should be packed in 55-gal drums or cardboard. Cardboard containers must be further sealed in 5-mil plastic bags. At the site, all PCB wastes are carefully placed into the burial cells at least 0.9 m (3 ft) below the natural land surface. The waste is covered daily with native soil. The gate charge for PCB wastes is $165 per t ($150 per ton).

Monitoring Program

Three existing monitoring wells and one monitoring spring are sampled monthly and analyzed for PCBs, pH, specific conductance, and chlorinated organics. In addition, two new monitoring wells have been installed, one at a location near the southern boundary of the 2.2-ha (5.5-ac) PCB site and the other at a location immediately below the disposal trench at the original solid waste disposal area. The depths of these wells are below the deepest PCB cell. Each well is checked monthly for the

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presence of liquid in the well bores. If any liquid is detected, samples will be taken and analyzed for the aforementioned parameters.

PUBLIC ACCEPTANCE

There have been no public objections against landfill activity at the Casmalia site. Site management offers site tours for groups and/or individuals who axpress interest in the site operation.

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GRAND VIEW, "B" SITE - IDAHO

OVERVIEW

The Grand View "B" site is located approximately 16 km (10 mi) northwest of Grand View, Idaho, and 63 km (39 mi) south of Mountain Home, Idaho. The site is an obsolete missile launch complex with several deep reinforced concrete silos available for waste disposal. EPA Region X approval allows disposal of PCB-contaminated materials from July 11, 1978, to January 1, 1980.

The missile silo with total volume capacity of 5700 m^3 (201,000 ft^3) has been designated for the disposal of PCB wastes. As of October 5, 1978, 2490 m^3 (87,800 ft^3) of the silo have been used. At the present loading rate, the remaining volume will be filled by the end of 1979. The site monitoring program includes regular air sampling (for chemical waste other than PCBs) and annual sampling of artesian well water. The well water is analyzed for PCBs, pH, specific conductance, total chlorinated organics, and chloride. Gate charge in late 1978 is $0.13 per kg ($.06 per lb). Rates are subject to change in the immediate future.

HISTORY OF WES-CON, INC., AND ITS PCB DISPOSAL ACTIVITY

Wes-Con, Inc., an Idaho corporation, formally began operations on November 9, 1973, as a hazardous waste management company. It is comprised of three major stockholders: (1) Mr. Gene Rinebold, Twin Falls, (2) Mr. Warren Shillington, Twin Falls, and (3) Mr. Roger Ling Rupert.

The company purchased the deactivated Titan missile site near Grand View from the U.S. Air Force in 1973 for waste containment. The facility consists of three silos, six silo-secondary structures, two antenna holes, one elevator shaft, several smaller holes (formerly used for fuel storage), and two major underground vaults (Figure 19).

Initially, the Grand View site was approved by the State of Idaho for receipt of all hazardous wastes except radioactive materials and military poisonous gas. About 95 percent of the total wates handles before 1978 were pesticides or pesticide contaminated solids. The other wastes included miscellaneous hazardous materials (including PCBs), laboratory wastes, and electroplating sludges.

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On March 27, 1978, the company applied to EPA Region X for a permit to receive PCB materials. No comments were received from the public regarding the proposed PCB disposal activities.

In addition, Idaho's Department of Health and Welfare (Environmental Service Division) in its letter dated March 30, 1978, to EPA Region X, agreed to certify the Wes-Con "B" site. The state submitted a technical evaluation report on May 8, 1978, endorsing approval of the Wes-Con "B" site for disposal of approved types of PCBs.

EPA Region X formally issued a permit for PCB waste disposal on July 11, 1978, after reviewing the State of Idaho's information and site observations.

SITE DESCRIPTION

Location

The Wes-Con "B" site is located in the W 1/2 of the NE 1/4 and E 1/2 of the E 1/2 of the NW 1/4 of Section 19, Township 4 South, Range 2 East, B. M., Owyhee County, Idaho. This is approximately 16 km (10 mi) northwest of Grand View and 63 km (39 mi) south of Mountain Home, as shown in Figure 20. The designation "B" is assigned to clearly distinguish this site from another Wes-Con site (called Site "A") near Bruneau, Idaho. (See Table 7 for description of Site "A", a possible location for another PCB material disposal facility.)

Operating Agency

The site is owned and operated by Wes-Con, Inc., P.O. Box 564, Twin Falls, Idaho 83301, telephone (208) 734-7711.

Site Area

This Grand View site occupies a total of 48.6 ha (120 ac). The primary working area, however, is 8.1 ha (20 ac) and consists of a former missile launching complex enclosed by 1615 lineal m (5300 ft) of 2-m (7-ft) fencing plus three top strands of barbed wire.

The abandoned missile launch structures are underground and are designed to withstand a ground zero atomic blast. They are capable of containing an internal explosion and fire in the event of accidental ignition of the missile propellant fluids (liquid oxygen) (Figure 21). The walls and floors of each silo are of concrete reinforced with 1.9 cm (3/4 in) of steel and treated with asphalt emulsion

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on the outside to withstand complete water immersion. The silo receiving PCBs is approximately 49 m (160 ft) deep with 1.8-m (6-ft) thick walls and 4-m (13-ft) thick floors.

Site Capacity

The total capacity of the site inside the fenced area is approximately 42,600 m^3 (1.5 million ft^3). Of this, 5700 m^3 (201,000 ft^3) are set aside for PCB and compatible waste materials.

Environmental Factors

Soil. The site is located in an area underlain by thick and relatively impermeable formations of blue clay (165). Another factor that further minimizes the probability of liquid leaks is that approximately 49 m (160 ft) of soil were completely excavated to construct the silos and then backfilled with extensive compaction. This process eliminated any naturally occurring permeable layers which would otherwise allow lateral water movement.

Hydrology. The first water-bearing stratum is found at a depth of 909 m (2980 ft) in what is referred to as the Banbary aquifer located in the geological formation of the same name (165). This ground water is highly saline and therefore nonpotable. The slightly deeper Idavada volcanic formation yields the Idavada aquifer which is at sufficient pressure to make the 939-m (3080-ft) deep well artesian and flow at 76 m^3 per hr (335 gal per min) at 4.92 kg per cm^2 (70 psi) of gauge pressure.

The silo floors are substantially above the closest aquifer and readily comply with the EPA stipulated separation distance of 15 m (50 ft).

There is no hydraulic connection between the site and any surface or ground water. The site is 4.8 to 6.4 km (3 to 4 mi) south of the Snake River and on an upland plain approximately 107 m (350 ft) above the river. No flood data are available for this area; however, the EPA presumed that the disposal site is above the 100-yr floodwater elevation. Little or no runoff occurs in the area of the disposal site.

Due to the special silo construction and local hydrological characteristics at the site, the EPA has determined the following:

- A leachate collection system for the site is deemed unnecessary.
- The construction of diversion structures capable of diverting surface water runoff is not required.

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Observation of water quality at a single artesian well will provide for adequate water quality monitoring.

Climate. Climatic data for Boise, Idaho, approximately 100 km (60 mi) north of the Grand View "B" site, are presented in Table 5 (17). The monthly average temperature for the entire year is 11°C (51°F), ranging from a low of 4°C (39°F) to a high of 17°C (63°F). January is the coldest month, with a mean temperature of -2°C (29°F), and July is the warmest, with a mean temperature close to 24°C (75°F). Normal total precipitation (rainfall and snowfall) is 83.4 cm (32.8 in), occurring over an average of 99 days per yr. The annual evaporation is 157 cm (62 in).

PCB-CONTAMINATED WASTE HANDLING

Disposal Technique

When containerized PCB-contaminated materials arrive on-site, the carriers generally pull to within 12 m (40 ft) of the silo. Wastes are unloaded into the silo via a forklift. A crane or bucket loader is used to handle heavy transformers. Bentonite clay, hauled from a nearby hill on Bureau of Land Management property, is added to cover waste material in the silo after each loading. Wes-Con does not provide services for draining or rinsing of transformers, nor does it own or operate its own waste-hauling trucks.

Gate Charge

The gate charge is $0.13 per kg ($0.06 per lb) for PCB-contaminated materials. The gate charge at Grand View for other hazardous waste is $0.09 per kg ($0.04 per lb). For example, a 20-ton transformer would cost $2400 for disposal, exclusive of transportation cost to the site.

All gate fees are subject to change without notice.

Quantity Received

Less than 5 percent (weight basis) of accepted hazardous waste is PCB-contaminated materials, e.g., capacitors, drained transformers. At present, 65 different electric companies deliver PCB wastes to the Grand View site. Major customers are Bonneville Power Company (Oregon), T&R Company (South Dakota), Con Edison (Connecticut), Commonwealth Edison (Chicago, Illinois), General Electric, Westinghouse Electric, Idaho Power Company, Utah Power Company, Colorado City Service of Denver, Colorado, Montana Power Company, and Wyoming Power Company.

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The quantity of PCBs received fluctuates, averaging 1329 kg per day (2911 lb per day) (Table 6). About half of the silo designated for PCBs has been filled. Wes-Con initially expected the remaining volume to last 5 yr. However, given present disposal procedures, the filling efficiency of the silo's space (about 71 kg/m^3) and current average disposal rate, the silo may be filled in less than 9 mo. Wes-Con plans to use three silos at the Bruneau "A" missile site (estimate capacity is 5 yr) for PCB disposal; the company, however, has not officially filed application with EPA Region X (Chapter VII).

The site operates five working days per week year-round. Arrangements can be made to deliver wastes during the weekend.

Monitoring Program

Because the closest ground water is 914 m (3000 ft) deep, the one artesian well will be sampled annually and analyzed for PCBs, pH, specific conductance, total chlorinated organics, and chloride. Wes-Con contracts with commercial laboratories to run these analyses and submits analytical results to the EPA Region X office as required. The EPA permit requires annual sampling of this artesian well water for 10 yr after site closure. Wes-Con also contracts with the Boise State University Chemistry Department to conduct on-site air quality monitoring. Once each month air samples are taken from portions of the site designated for other chemical wastes. Air quality monitoring at the PCB waste disposal silo is not required.

Equipment and Personnel Summary

The following equipment is used at the Grand View site:

- 2 cranes.
- 2 track dozers.
- 2 forklifts.
- 2 dump trucks.
- 1 bucket loader.
- 1 boom truck.
- 1 tractor.
- 1 steam cleaner.
- 1 fire truck.

Wes-Con has on-site repair shops for equipment maintenance and buys electricity for their shops and administrative office from the city of Grand View. Eight full-time and four part-time workers are employed at the site. Each of these employees is trained to operate the equipment.

PUBLIC ACCEPTANCE

In general, the public has accepted the Grand View disposal operations without major complaints.

Wes-Con has a public information/education program to ensure that its operations are open to public inspection. It is estimated that the overall public information/education program costs the company approximately $15,000 during its first 5 yr of operation.

To avoid adverse publicity that could arise from misunderstandings, Wes-Con accepts no radioactive or nerve gases waste, even through the site is considered to be the most suitable for such wastes.

In addition, Wes-Con provides several public services, including the following:

- Free pesticide and container disposal to residents of Owyhee County.
- Free disposal to approved educational establishments in Idaho.
- Free disposal for materials within Idaho generated during emergency conditions, i.e., highway wrecks. This service is provided when requested by state or federal agencies.
- Free disposal for materials within Idaho (when ownership cannot be established) that may be hazardous.
- The disposal facilities will be made available to state and federal agencies or institutions for experimental studies, and for demonstrations for training purposes.
- Wes-Con has donated steel stairs, valves, pipes, and other materials salvaged from the site to local schools, farmers, and private citizens.
- Wes-Con equipment is available to local residents for use in case of emergencies.

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