TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 440/9-76-020	2.
3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE PCBs Water Elimination/Reduction Technology and Associated Costs, Manufacturers of Electrical Capacitors and Transformers (Addendum to Final Report, Task II)	5. REPORT DATE July 2, 1976
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Dr. Robert Durfee and Staff	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Versar, Inc. 6621 Electronic Drive Springfield, Virginia 22151	10. PROGRAM ELEMENT NO. Task II
	11. CONTRACT/GRANT NO. 68-01-3259
12. SPONSORING AGENCY NAME AND ADDRESS Office of Water Planning and Standards U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	13. TYPE OF REPORT AND PERIOD COVERED
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

None

16. ABSTRACT

This addendum report summarizes the quantities and sources of wastewaters in the manufacture of electrical transformers and capacitors; describes the alternate available technologies for reducing or eliminating the discharges on a source-by-source basis; and tabulates the estimated costs for achieving such reduction or elimination.

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Wastewater Waste Treatment Cost Analysis Cost Comparison Manufacturers	Toxic Pollutant Effluent Standards Federal Water Pollution Control Act	

18. DISTRIBUTION STATEMENT RELEASE UNLIMITED	19. SECURITY CLASS (This Report) Unclassified	21. NO. OF PAGES 41
	20. SECURITY CLASS (This page) Unclassified	22. PRICE

EPA Form 2220-1 (9-73)

1.0 INTRODUCTION

The Task II Final Report, "Assessment of Wastewater Management, Treatment Technology, and Associated Costs for Abatement of PCBs Concentrations in Industrial Effluents,"[1] discussed the diverse sources of PCB-contaminated wastewaters within the askarel capacitor and transformer manufacturing industry. These contaminated waters, in addition to contact process waters, also included "non-contact" cooling waters, stormwater runoff from the manufacturing plants, and sanitary wastewaters.

The general potential for reduction of water use in this industry is favorable, since water has to be carefully excluded from the internals of both transformers and capacitors in order for the units to meet product and performance specifications. Newer plants in these categories, particularly those of smaller size, use much less water per unit of PCB usage than the older plants. However, the existing plants in the industry would require a combination of process and plant modifications and wastewater treatment and recycle to achieve a goal of no discharge of PCB-contaminated waters. This addendum to the Task II report summarizes the quantities and sources of the wastewaters; describes the alternate available technologies for reducing or eliminating the discharges on a source-by-source basis; and tabulates the estimated costs for achieving such reduction or elimination.

Section 2.0 of this addendum addresses the point sources from the capacitor and transformer manufacturing industry with the absolute goal (with a single exception from one plant) of no point-source discharges of any waters. Extensive applications of process changes (from wet to dry unit processes or unit operations), of water segregation practices, of water treatment and recycle practices, and of water-quantity reduction practices were investigated. The residual contaminated wastewaters not eliminated by these practices were then hypothesized to be "incinerated," e.g., heated to a sufficiently high

temperature for a sufficiently long time to ensure destruction of PCB contaminants.

Section 3.0 presents the technologies and costs for eliminating PCB contamination of rainwater runoff from manufacturing plants in this industry.

Section 4.0 presents the technical basis and estimated costs for three alternative approaches to PCBs reduction in the direct discharges from this industry to waterways. The technology and costs presented are based on those of Reference 1 and Sections 2.0 and 3.0 of this Addendum. The approaches were selected to offer a range of PCBs control at various levels of costs.

The estimated costs contained herein are as accurate as was possible within the scope of work. Based on previous experience in this area, we feel that the least reliable costs tabulated are those for waste stream segregation. Costs for segregation are highly variable from plant to plant, and accurate estimation is only possible as a result of detailed study of plant layout, piping, etc., which was beyond the scope of this study.

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2.0 TECHNOLOGY AND COST TO ACHIEVE ZERO DISCHARGE FROM POINT SOURCES IN THE ASKAREL CAPACITOR AND TRANSFORMER MANUFACTURING INDUSTRY

2.1 Present Sources of Point-Source Discharges

The wastewater discharges from the askarel capacitor and transformer manufacturing industry, which have been shown to contain measurable quantities of PCBs,[1a] are from the following sources:

2.1.1 Non-contact cooling water. The major uses include cooling of impregnation tanks, of vacuum pumps, and of vapor degreasing units. Minor uses include cooling of compressors and welders.

2.1.2 Water-sealed vacuum pumps and steam-jet ejectors, used in some of the plants to evacuate impregnation tanks or individual product assemblies for moisture removal prior to filling with askarel.

2.1.3 Detergent washing of components and of assemblies. Detergent washing occurs in two general areas. One area is cleaning and degreasing components such as cans, tops, terminals, etc., prior to assembly. These components may be produced at the plant from metal stock or brought in already fabricated. The second area of use is in removal of excess oil from the filled units after the sealing operation.

2.1.4 Boiler blowdowns, air conditioning condensates, and contact cooling water (from welding and soldering operations).

2.1.5 Contaminated process wastewaters, including vacuum pump condensates, laboratory wastewaters, and wastewaters from surface treatment operations such as plating, phosphatizing, painting, fluoride treatment, and caustic baths. Surface

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treatments prior to painting typically involve phosphatizing of steel and fluoride treatment of aluminum, both of which involve the use of water baths. Plants which fabricate capacitor components on site (several of the larger plants do so) perform tin plating of the covers and studs as a corrosion protection at joints. Water usage includes the plating bath and rinse water. The water usage is small.

2.1.6 Sanitary and personal hygiene wastewaters. Sanitary and personal hygiene water usage in this industry, although small in comparison to cooling water usage, typically becomes highly contaminated with PCBs. Water uses in this category include handwashing, showers, safety purposes including eye washing, drinking fountains, laundry, and toilet flush.

2.1.7 The wet scrubber for the waste incinerator flue gas at one plant (Plant 103). This plant operates its own incinerator to destroy liquid PCB wastes. The scrubber water used to cleanse the stack gases must be regarded as process water, and, based on the PCBs concentration in the scrubber effluent of Monsanto's incinerator (150 ppb), this water is very likely to be contaminated with PCBs.

The quantities and disposition of these existing point-source discharges have been tabulated in the Task II report for the eight plants surveyed. (1b)

2.2 Technologies for Eliminating Point-Source Discharges

The technologies for eliminating the discharges are:

2.2.1 Segregation of non-contact cooling water supply and discharge lines from all other plant waters (e.g., process

waters, sanitary waters, etc.); replacement of open sewers and channels with closed discharge piping to a common location; cooling of these discharge waters in a closed non-evaporative heat exchanger (e.g., a tower with forced circulation of water through finned tubes, cooled by a forced-air draft); and recycle of the cooled waters. Bleed from this closed circulation system would be added to boiler blowdowns for treatment and return.

One of the eight plants surveyed in the Task II effort (Plant 101) already has segregated non-contact cooling water; however, this plant has an evaporative-type cooling tower. Closed heat exchangers are, however, the recommended technology to prevent losses of PCBs to the atmosphere.

2.2.2 Replacement of water-sealed vacuum pumps and steam-jet systems with mechanical, oil-sealed vacuum pumps. Non-contact cooling water for these pumps would be added to the circuit discussed above. Condensate, after separation from the oil phase, would be disposed of as contaminated process water.

Mechanical oil-sealed vacuum pumps are presently in wide use in the industry.

2.2.3 Replacement of all aqueous detergent washing operations with organic-vapor degreasing; for both the cleaning of components prior to assembly and the cleaning of assemblies containing askarel. Solvent recovery would be accomplished by distillation; the still bottoms (sludges highly contaminated with PCBs) would be incinerated.

Detergent cleaning was the original method used, and was largely replaced by vapor degreasing with trichloroethylene.

However, several plants, including the newest plant, now use detergent washing.

A possible alternative (not considered in the cost estimation because it is highly site-dependent) is the complete segregation of detergent-washing of components from the plant areas where PCBs are used, so that the detergent wash wastewaters would not be contaminated by PCBs. This complete segregation would include controlled employee access and other techniques used in the pharmaceutical manufacturing and other industries.

2.2.4 Collect the boiler blowdown water, the bleed from the closed non-contact cooling water circuit, air conditioning condensates, and contact cooling waters, in an appropriate equalization basin; filter these waters, demineralize, and return to the non-contact cooling water circuit.

2.2.5 Incinerate the contaminated process wastewaters in a specially-designed incinerator to achieve the temperature/residence time conditions for complete PCBs destruction (as described previously).[1c] It is assumed that the incineration of water with only very small quantities of contaminants requires no flue gas wet scrubbing system, but that exhaust gas dehumidification would be included as necessary (to prevent steam clouds).

A possible alternative (not included in the cost estimations) is the complete segregation of component plating from the plant areas where PCBs are used, similar to the alternative discussed above for detergent washing of components.

Another possible alternative (not included in the cost estimation) is the conversion of conventional painting

operations (which require a water spray) to dry electrostatic painting and labeling processes. Such conversion has already been made in the industry, but it is not known whether it can be generally applied.

Final painting and labeling of capacitors is only done on units which have passed performance tests. Painting and labeling prior to filling, as performed with transformers, does not appear to be an acceptable alternative for capacitors.

2.2.6 Install sanitary and personal hygiene facilities which use a minimum of water. These include waterless cleaners, closed sinks, and airplane-type or chemical toilets as appropriate. Coincinerate the reduced sanitary discharges with the contaminated process wastewaters.

A closed sink system is already used by one company in the industry, in which sink water is collected, drummed, and incinerated. Use of dry cleaners prior to handwashing is also practiced at that plant. This material, as well as paper towels, etc., is collected and disposed of with the other solid wastes from the plant.

2.2.7 For the one plant with a waste incinerator using a wet scrubber, collect the scrubber liquor in an equalization basin, filter, and treat by carbon adsorption (to one ppb or less PCBs). This treated water would be discharged to receiving waters. There does not appear to be an alternative dry process to replace wet scrubbing. This discharge would be the sole exception to the elimination of all point-source discharges from the industry. It should be noted that this single existing incinerator at one plant is for disposing of waste oils contaminated with PCBs. It should not be

confused with the hypothesized "incinerators" for disposing of contaminated waters – these latter units should not require wet scrubbers.

2.3 General Method for Estimating Costs

The Task II effort included a detailed characterization of six askarel capacitor manufacturing plants (100, 101, 102, 104, 105, and 106) and of two askarel transformer manufacturing plants (103 and 114). The six capacitor plants are approximately 50 per cent of that industrial sector, and the two transformer plants are approximately 20 per cent of that sector.[1d] Since on the basis of PCBs usage the capacitors are 65 per cent of the total industry and the transformers are 35 per cent,[1d] the eight characterized plants represent 40 per cent of the total PCB-consuming industry.

Based upon the data for the individual eight plants as published in the Task II final report,[1] and upon more process-specific data contained in trip reports for each of the eight plants, estimated costs were developed for each of the eight plants for implementing each of the seven discharge-elimination technologies outlined in the previous section. Table 2-1 lists the pertinent technical data used for developing these costs, the cost elements, and the total estimated costs for each of the eight plants.

Under the assumption that the eight plants were representative of the entire industry (with respect to wastewater sources and quantities and the distribution of plant sizes), the eight-plant-sum for each cost element was divided by 0.40 to estimate the corresponding value for the entire askarel capacitor and transformer manufacturing industry.

Throughout the analysis represented by Table 2-1, annual capital recovery costs were calculated based upon a ten-year lifetime and an 8 per cent

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TABLE 7-1 - ESTIMATED COSTS TO ACHIEVE ZERO DISCHARGE

Technology	Cost Element	Plant 100	Plant 101	Plant 102	Plant 103	Plant 104	Plant 105	Plant 106	Plant 114	Total of 8 Plants Surveyed	Extrapolated Industry Total
Aggregate Non-Contact Cooling Water, Closed-System Cooling, Recycle	Non-Contact Cooling Water, MGD	7.615	0.25	0.288	1.648	1.195	0.267	0.327	0.030	4.895	12.715
	Non-Contact Cooling Water, gpm	5283	200	200	1,716	1,245	424	341	30.6	5,098	13,725
	Cap. Inv. for Construction	74,000	0	43,000	194,000	82,000	69,000	39,000	23,000	$524,000	1,310,000
	Cap. Inv. for Dry Cooling Tower	111,000	43,000	65,000	370,000	215,000	65,000	54,000	12,000	$931,000	2,655,000
	Total Cap. Investment	185,000	43,000	108,000	564,000	297,000	134,000	93,000	35,000	1,455,000	3,965,000
	Annual Op. Power Costs	28,100	6,400	16,100	69,165	43,500	20,000	13,920	5,300	202,300	575,000
	Annual Maint. Costs	33,000	8,600	13,000	54,000	42,000	13,000	10,800	2,000	166,000	417,000
	Annual Water Costs	29,200	11,000	17,300	72,150	51,500	17,300	10,600	1,700	210,600	546,100
	Total Annual Costs	90,400	26,000	46,400	195,660	139,000	50,300	35,320	9,300	587,530	1,468,000
Upstream Water Seal Ver. Steam & Steam Jets with Mechanical Pumps	No. Vacuum Pumps Needed	0	0	0	0	0	10	0	0	10	25
	Cap. Invest. for Pumps	0	0	0	0	0	$66,300	0	0	$66,300	430,950
	Annual Op. Power Costs	0	0	0	0	0	29,100	0	0	29,100	62,100
	Annual Plant Maint. Costs	0	0	0	0	0	16,300	0	0	16,300	35,130
	Total Annual Costs	0	0	0	0	0	39,400	0	0	39,400	98,300
Upstream Seawater, Cooling with Water Engineering	Capital Invest. for Water Eng.	0	53,000	0	174,000	288,000	48,000	0	0	$81,000	1,227,563
	Annual Op. Power Costs	0	6,000	0	26,200	29,200	9,000	0	0	73,100	182,700
	Annual Maint. Costs	0	3,000	0	10,000	12,000	3,000	0	0	28,000	70,000
	Annual Fuel Costs	0	1,000	0	5,000	1,000	1,000	0	0	12,000	30,000
	Total Annual Costs	0	12,000	0	41,200	42,000	13,000	0	0	114,000	287,000
Filter & Recirculate Blowdown, Add to Cooling Water Circuit	Boiler Blowdown, GPD	20,000	3,100	5,000	25,000	15,000	7,300	3,000	100	78,100	195,100
	Cooling Water Blowdown, GPD	6,500	3,500	3,000	16,570	12,000	3,900	3,300	400	49,000	122,500
	Constant Cooling Water, GPD	0	0	0	163,000	0	0	0	0	163,000	412,500
	Total GPD to Treatment	26,500	9,000	8,000	206,500	27,000	11,200	6,300	500	290,100	730,000
	Total gpm to Treatment	17.1	5.7	5.3	215	70.1	11.7	4.4	0.3	305	761
	Cap. Inv.-Equal & Filt.	150,000	67,000	67,000	600,000	180,000	150,000	71,000	15,000	1,255,000	3,127,500
	Cap. Inv.-Chemicals	32,000	6,000	4,000	113,000	22,000	11,000	7,000	1,000	191,000	473,500
	Total Cap. Investment	182,000	67,000	99,000	713,000	202,000	161,000	78,000	16,000	1,446,000	3,615,000
	Ann. Op. Power.-Equal & Filt.	21,000	9,100	13,000	99,463	23,920	15,000	10,100	2,000	193,500	483,200
	Ann. Oper. Costs-Equal & Filt.	3,300	2,000	2,000	19,000	3,300	2,300	2,000	900	41,000	102,500
	Total Ann. Costs-Equal & Filt.	29,100	11,100	15,000	109,270	29,100	18,300	12,000	2,700	229,300	573,150
	Ann. Power.-Chemicals	3,300	900	1,300	14,800	3,200	1,500	1,000	100	25,200	70,000
	Ann. Oper. Costs-Chem.	4,000	1,700	2,700	31,500	6,700	3,000	1,030	300	72,970	182,500
	Total Ann. Costs-Chem.	9,900	3,100	3,500	46,300	10,000	4,500	2,030	700	101,130	252,500
	Total Annual Costs	39,000	13,200	19,500	177,150	39,100	22,800	13,500	3,300	330,400	833,617
Sorbent & Carbon Adsorb. Sanitary Water from Submersion	GPD Sanitary Water	0	0	0	122,000	0	0	0	0	122,000	305,023
	gpm (12 Hr/day)	0	0	0	127	0	0	0	0	127	316
	Cap. Inv.-Equal & Filt.	0	0	0	430,000	0	0	0	0	430,000	1,075,000
	Cap. Inv.-Carbon Adsorp.	0	0	0	70,000	0	0	0	0	70,000	175,000
	Total Capital Investment	0	0	0	500,000	0	0	0	0	500,000	1,250,000
	Ann. Op. Power-Equal & Filt.	0	0	0	64,000	0	0	0	0	64,000	160,000
	Ann. Op. Costs-Equal & Filt.	0	0	0	14,000	0	0	0	0	14,000	35,000
	Total Ann. Costs-Equal & Filt.	0	0	0	78,000	0	0	0	0	78,000	195,000
	Ann. Op. Power.-Carbon Adsorp.	0	0	0	11,000	0	0	0	0	11,000	27,000
	Ann. Op. Costs-Carbon Adsorp.	0	0	0	39,000	0	0	0	0	39,000	97,000
	Total Ann. Costs-Carbon Adsorp.	0	0	0	50,000	0	0	0	0	50,000	125,000
	Total Annual Costs	0	0	0	128,000	0	0	0	0	128,000	320,000
Wastewater Pressure Maintenance and Sanitary Wastewater; Other Water-Saving Steps, Chemical Toilets; Installation for Sanitary	GPD Pressure Water	200	0	0	10,000	0	12,100	3,000	1,500	43,000	108,500
	GPD Sanitary Water (Pressure)	44,000	5,000	12,000	50,000	10,000	65,000	5,000	9,300	207,700	519,250
	Est. No. Toilets Employees	250	10	20	100	1,000	130	30	10	1,550	4,650
	Cap. Inv. for Water Saving	17,000	7,000	10,000	33,000	90,000	15,000	8,000	2,000	132,000	331,250
	Cap. Inv. for Recov. Cost	7,000	1,000	1,500	3,000	7,000	2,000	1,000	300	19,000	47,500
	Total Cost, Con.	7,000	1,000	1,500	3,000	7,000	2,000	1,000	300	19,000	47,500
	Ann. Op. Cost, Wat. Saving	3,000	1,000	2,000	7,000	15,000	4,000	2,000	600	41,000	102,500
	Total Ann. Cost, Wat. Saving	3,000	1,000	2,000	7,000	15,000	4,000	2,000	600	41,000	102,500
	GPD Sanitary Water (Future)	3,500	1,000	2,000	2,150	10,000	3,000	1,700	100	26,500	66,250
	GPD Total to Incinerate	3,730	1,000	2,000	22,000	10,000	15,500	6,730	4,000	66,700	166,750
	GPD Total to Incinerate	2.1	1.1	2.1	23.4	10.1	16.1	7.0	5.1	66.5	173.0
	Prin. Cap. Investment	93,000	40,000	91,000	280,000	140,000	200,000	110,000	100,000	1,129,000	2,822,513
	Ann. Op. Power. Costs	13,000	13,000	11,000	44,700	21,000	29,000	16,000	14,000	166,000	410,750
	Ann. Labor & Maint. Costs	19,000	19,000	18,000	68,000	19,000	98,000	22,000	20,000	325,000	812,500
	Total Incremental	$42,000	$64,000	$129,000	$.04,270	$.270,000	$.870,000	$.300,000	$.134,000	$.1,670,000	$3,877,163
	GPD Incinerated	19,000	7,730	10,730	110,000	51,500	79,500	35,000	26,700	366,130	915,325
	Ann. Fuel Costs	11,530	28,700	43,100	270,750	102,100	146,500	74,000	61,100	740,320	1,850,799
	Total Annual Costs-Inc.	11,000	28,000	43,000	270,000	102,000	146,000	74,000	61,000	740,000	1,777,363
	Ann. Op. Inc.-Sanitary	18,000	28,000+	91,000	68,000	149,000	36,700	28,000	8,000	348,700	871,750
	Ann. Oper. Costs-Sanitary	46,730	28,700	43,100	44,100	102,100	29,000	18,700	5,000	320,000	821,500
	Total Ann. Inc. for Sanitary	209,500	99,000	301,000	82,500	195,000	13,700	36,500	10,700	961,400	1,702,500
	Total Ann. Costs for Sanitary	54,100	99,000	69,000	91,100	117,000	22,000	21,000	5,000	369,000	922,463
	Total Ann. Inc. for Process W.	5,000	0	0	260,000	0	161,000	69,000	91,000	980,100	1,450,250
	Total Ann. Costs for Process W.	7,000	0	0	170,000	0	170,000	55,500	56,100	411,500	1,028,800
	Total Capital Investment	119,500	97,000	101,000	327,500	195,000	215,000	110,500	102,000	1,263,300	3,113,750
	Total Annual Costs	56,500	60,000	65,700	227,700	117,000	154,300	77,100	61,700	761,700	1,903,000
TOTALS	Total Capital Investment	481,500	262,000	305,000	2,107,500	869,000	689,300	299,500	153,000	5,317,500	13,292,950
	Total Annual Costs	176,300	93,100	131,000	767,900	362,500	250,700	131,900	73,900	1,977,300	4,943,250

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interest rate, consistent with the Task II report.[1] The capital recovery factor is then:

$$\frac{i(1+i)^N}{(1+i)^N-1} = \frac{(0.08)(1.08)^{10}}{(1.08)^{10}-1} = 0.1490.$$

In each cost category, the annual capital recovery cost is explicitly shown in Table 2-1 so that different combinations of lifetimes and interest rates may be used by the reader to generate alternate annual costs.

Consistent with average practices in this industry, the plants were treated as operating two shifts (16 hours per day), five days per week; or 260 days or 4,160 hours per year. The primary wastewater data as tabulated in the Task II report[1] and in the trip reports is in terms of gallons per day. The necessary abatement units were sized (in terms of instantaneous flow rates) based upon the daily discharges and the operating hours above; in some cases, this sizing was not consistent with assumptions in the Task II report[1] of 24 hours per day and 365 days per year.

Two parameters in this analysis were scaled on a plant-by-plant basis using PCBs consumption rate as the size factor. These two parameters are the number of vapor degreasing units needed and the number of production employees. Since the scaling factor (PCBs use) has been treated as proprietary data throughout the Versar study, the presentation of the corresponding unit costs in Table 2-1 is necessarily not explicit. For all other cost elements, however, every effort was made to make the unit costs very explicit.

2.4 Development of Estimated Costs

2.4.1 Costs for Segregation, Cooling, and Recycling Non-Contact Cooling Water

The primary data in Table 2-1 is the flowrate of non-contact cooling water. These data were taken directly from the Task II report[1e] except for Plant 101. This plant already has a recirculating cooling water system with an evaporative-type cooling tower and with a daily makeup water addition of 3,000 gallons; it was estimated that the recirculation rate in this plant is 250,000 gpd.

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No added costs should therefore be incurred by this one plant for cooling water segregation, but this plant (as all the rest) would require the installation of an enclosed cooling-water/air heat exchange.

The capital costs for segregation, for the remaining seven plants, were taken directly from the Task II report.[1f] These costs were generated on the basis of plant acreage (as a scaling factor for the extent of existing piping and sewers) as well as on the basis of the flowrate of non-contact cooling water.

The capital costs for the dry cooling tower were based upon the instantaneous flowrate of non-contact cooling water (in gpm) for each plant, using the correlation shown in Figure 1, which was taken from the Task II report.[1g]

The annual maintenance costs for the segregated water system were assumed to be the same as existing maintenance costs for unsegregated systems; hence, a net cost of zero was used. For the dry cooling tower, annual maintenance costs were taken as 20 per cent of the dry cooling tower capital investment, consistent with the Task II report.[1h] Electrical energy costs for the water side of the dry cooling tower, for the air side of the dry cooling tower, and for added pumping needed for recirculation (as opposed to once-through) of the water; were calculated on the basis of 0.7 HP (total) for each gpm of water, 4,160 hours per year of operation, and $0.02 per KWH.

2.4.2 Costs for Mechanical Vacuum Pumps

The characterization of the eight plants in the Task II effort (final report[1] and trip reports) resulted in the determination that only one of these plants, Plant 105, made significant use of water-sealed vacuum pumps and/or steam ejectors with condensers. The other seven plants utilize mechanical vacuum pumps for the impregnation chambers. Although vacuum is generally used in PCB storage tanks and possibly for other unit processes, the major use appears to be in the impregnation step.

It was estimated that Plant 105 has ten impregnation tanks, each of approximately 128 cubic feet in volume, and each served by a vacuum pump that is required to reduce the pressure from one atmosphere to 0.1 torr in 5 minutes.

FIGURE 1
CAPITAL INVESTMENT CURVES
INSTALLED CAPITAL COST, THOUSAND DOLLARS
FLOW RATE, GALLONS PER MINUTE
INCINERATION
PRE-TREATMENT (EQUALIZATION AND FILTRATION)
CARBON ADSORPTION
CLOSED COOLING TOWER
DEMINERALIZATION

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Then for each pump,

$$Q = \frac{M}{60\ \rho_o\ P/760} = \frac{V_o}{t} \ln \frac{P_i}{P}$$

where: Q = constant volumetric pumping rate, cubic feet per minute
M = mass air evacuation rate, pounds per hour
P = pressure in tank, torr, at time t, minutes
ρ_o = density of air at one atmosphere = 0.0749 lbs/ft^3
P_i = initial pressure = 1 atm = 760 torr
V_o = volume of tank, cubic feet

Hence, for V_o = 128 and for P = 0.1 at t = 5,

$$Q = 170\ \frac{M}{P} = \frac{128}{5} \ln 7{,}600$$

$$Q = 230 \text{ cubic feet per minute}$$

and M/P = 230/170 = 1.35 pounds/hour/torr

A typically suitable mechanical vacuum pump is the Stokes/Pennwalt Corporation "Microvac" oil-sealed single-stage piston pump model 412H, with a displacement of 300 cubic feet per minute at a pump speed of 490 RPM. This pump has a constant performance of 270 cubic feet per minute from 760 torr to 10 torr, and a slowly decreasing performance down to 230 cubic feet per minute at 0.1 torr. It is driven by a 10 HP motor running at 1800 RPM, and uses 2 GPM cooling water. The vacuum pump has an oil capacity of 10 gallons. The f.o.b. cost, including motor, V-belt drive, belt guard, oil solenoid valve, initial charge of oil, gas-ballast, and visual oil flow indicator, is $4,680.[2]

An independent cost estimate was made using the size factor M/P = 1.35. According to Huff,[3] the f.o.b. cost is about $4,800, closely checking the first cost estimate. Using $4,680, the installed cost is calculated according to Huff[3] to be:

$$\text{Installed Cost} = 55.2 \times (\text{f.o.b. costs})^{0.678}$$
$$= 55.2 \times (4{,}680)^{0.678}$$
$$= \$16{,}830.$$

This number is used as the capital investment per vacuum pump in Table 2-1.

Again according to Huff,[3] the annual maintenance costs are 9 per cent of the capital costs, or $1,515 per pump. However, the system (e.g., steam ejectors) which the mechanical vacuum pump replaces has a maintenance cost which must be subtracted from the $1,515 to derive a net maintenance cost. According to Huff,[3] the f.o.b. cost of a steam ejector with M/P of 1.35 is $570; this results in an estimated installed cost of $4,090. At an annual maintenance cost of 2 per cent of the capital cost for steam ejectors,[3] this cost would be $82. Hence, the net annual maintenance cost for the mechanical vacuum pump would be $1,433.

There would be a net energy saving for mechanical vacuum pumps over either steam ejectors or water-sealed liquid-ring vacuum pumps. For each, evacuation cycle, the 10 HP mechanical pump uses

$$(10\ \text{HP}) \left(0.745\ \frac{\text{KW}}{\text{HP}}\right) \left(\frac{5}{60}\ \text{Hours}\right) \ (\$0.02/\text{KWH})$$
$$= \$0.0124 \text{ of electric energy}$$

Assuming one cycle per hour and 4,160 operating hours per year, the annual electrical cost would be $52. In comparison, an equivalent steam ejector would require, for each evacuation cycle, about 22 pounds of steam (which is calculated according to the method of Patton and Joyce)[4]. At a steam cost of $2 per thousand pounds, the steam cost per cycle would be $0.044; or about $175 per year. Hence, the net saving would be about $123 per year per impregnation tank. For the purposes of this analysis, these small net energy savings are assumed to be negligible.

2.4.3 Costs for Vapor Degreasing

The capital investment requirement to replace detergent washing with vapor degreasing at Plant 101 was estimated by that plant to be $55,000.

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that plant presently employs detergent washing in two areas: in the initial cleaning of purchased capacitor components (cans, covers, and other metallic components) to remove oily protective coatings; and in the cleaning of the outer surfaces of complete assembled capacitors after soldering and plugging.

Of the other seven plants characterized in the Task II effort, four presently employ no detergent washing (Plants 100, 102, 106, and 114). Plants 103, 104, and 105 use detergent washing techniques for only some cleaning operations: Plant 103 utilizes a kerosene flushing technique on transformer subassemblies prior to filling with PCBs, but uses some detergent washing as well; Plant 104 uses trichloroethylene vapor degreasing of sealed capacitor assemblies but uses either vapor degreasing, ultrasonic cleaning, or detergent washing of metallic components prior to capacitor assembly; and Plant 105 utilizes trichloroethylene vapor degreasing of metallic components and detergent washing of completed capacitor assemblies. The capital investment requirements for replacing detergent washing at Plants 103, 104, and 105 were estimated using the Plant 101 number as a basis, and scaling by both quantity of PCBs consumption and the estimated present mix (at each plant) of detergent washing vs. vapor degreasing.

The annual maintenance costs for vapor degreasing equipment were estimated as 6 per cent of the capital investment. The annual costs for fuel in the vapor degreasing boiler and solvent recovery still were estimated at 2.5 per cent of the capital investment; this is equivalent to vaporizing about 600 pounds per hour of trichloroethylene at Plant 101 (heat of vaporization of 103 Btu/lb; 20 per cent overall thermal efficiency, 4,160 hours per year, and $1.083 per thousand cubic feet of natural gas).

2.4.4 Costs for Treatment of Blowdowns and Miscellaneous Non-Process Waters

The daily quantities of water used as boiler feed makeup for Plants 100, 104, 105, and 114 are listed in the Task II Final Report.[1e] For Plant 100, the boiler bleed discharge is half of the boiler feed makeup; hence, Table 2-1 shows half of the boiler feed makeup for the above four plants as wastewater to be treated and recycled. The boiler bleed discharge for the remaining

four plants was estimated from the first four data points based upon PCBs consumption as a scaling factor.

With the installation of a recycle non-contact cooling water circuit, a blowdown from this system would be required for each plant. The flowrates in Table 2-1 were taken as one per cent of the non-contact cooling water circulation rate.

Plant 103, as shown in the Task II report,[1e] has a discharge of 183,000 GPD of contact cooling water. The sources of this discharge are contact cooling in welding and plating operations and in phosphate treatment of steel surfaces prior to painting (as discussed in the Versar trip report for this plant). It was estimated that 90 per cent of this water, or 165,000 GPD, is relatively uncontaminated contact cooling water, subject to treatment and recycle; and that the remaining 18,000 GPD are relatively contaminated process waters not amenable to treatment.

The technology to eliminate these discharges (of boiler blowdown, non-contact cooling water blowdown, contact cooling waters, and minor amounts of air conditioning condensates, etc.) is to collect these waters in an equalization basin, filter them through multimedia beds (e.g., sand and anthracite), demineralize them with a combination of ion exchange resins, and then recycle these waters to the non-contact cooling water circuit.

The capital investments required for pretreatment (equalization and multimedia filtration) shown in Table 2-1 are based upon the pretreatment curve of Figure 1, which was taken from the Task II Final Report.[1i] The capital investments required for demineralization are based upon the demineralization curve of Figure 1, which was taken from a prior Versar study for EPA.[6] The annual operating costs for equalization and multimedia filtration, including operation, maintenance, and electrical power, were taken as 3.3 per cent of the pretreatment capital investment, consistent with the estimates of the Task II report.[1i] The annual operating costs for demineralization (labor, maintenance, resin costs, and chemical costs) were taken as $1.00 per thousand gallons of water treated, commensurate with a total dissolved solids content of about 1,000 mg/liter.[6]

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2.4.5 Costs for Treatment of Scrubber Water from Waste Incinerator at Plant 103

The waste incinerator at Plant 103 is the only one in the industry. This plant has a scrubber liquor discharge of 122,000 GPD. The pretreatment technology for this wastewater is the same as for the blowdown waters described in the previous section: equalization and multimedia filtration. Hence, the capital investment requirement is based upon the pretreatment curve of Figure 1; and the annual operation costs were taken as 3.3 per cent of the capital investment.[1i] The capital investment for carbon adsorption is based upon the corresponding curve of Figure 1, which was taken from the Task II Final Report.[1j] Annual operating costs for carbon adsorption (labor, maintenance, carbon costs, and pumping costs) were taken as 45 per cent of the capital investment, equivalent to the operating costs in the Task II report.[1j]

2.4.6 Costs for Reducing Sanitary Wastewater Quantities and for Incinerating Sanitary Waters and Contaminated Process Waters

Table 2-1 lists the quantities of contaminated process waters from each of the eight plants surveyed in the Task II effort. These wastewaters include vacuum pump condensates, laboratory wastewaters, and wastewaters from the various surface treatment techniques used in the industry (plating, painting, phosphatizing, and fluoride treatment). For Plant 103, these process waters include an estimated 10 per cent of the "contact cooling water" discharged; it was previously estimated that the remaining 90 per cent of these waters could be treated and recycled. The technology for eliminating these process waters is to incinerate them for two seconds residence time at 2200°F, thereby destroying any PCBs. No wet scrubber would be required, as the flue gases should have only very minor quantities of particulates and HCl.

Sanitary wastewaters (including personal hygiene wastewaters) amount to rather large quantities, as Table 2-1 shows. These are actual data for each plant, except for the sanitary wastes from Plant 103, which was estimated based upon plant size. The technology for eliminating these wastewaters is incineration together with contaminated process wastewaters. However, it was also assumed that prior to incineration, the quantity of sanitary wastewaters would be reduced to an absolute minimum. All lavatory sinks would be closed, with the maximum use of waterless hand cleaners. Toilets would be replaced by airplane-type

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or chemical toilets. It was estimated that such water-saving techniques would result in a minimum sanitary wastewater flow of 10 gallons per production employee per day. The number of production employees at each plant was estimated based upon PCBs consumption as the scaling factor, using the actual number of production employees at Plant 106 as a baseline. It was also estimated that the capital investment for installing the closed sinks and toilets would be $1,000 for each 20 employees. The annual costs for maintenance, chemicals, and supplies was estimated as 16 per cent of the capital costs.

The capital investment for the incinerators is based upon the total of contaminated process wastewaters and projected sanitary wastewaters. The incinerator curve of Figure 1, taken from the Task II report,[1k] provided the basis for capital costs. The annual labor and maintenance costs were taken as 20 per cent of the incinerator capital investment. Fuel costs per year were based upon the gallons of water incinerated per year, assuming 260 operating days per year. It was assumed that a total of 2,200 Btu were required per pound of water to achieve 2200°F, and that the fuel (natural gas) costs $1.083 per thousand cubic feet (or per million Btu). These unit values are consistent with the Task II report.[1k]

Since the contaminated process waters and the sanitary wastewaters would be coincinerated, the capital and annual costs for eliminating each were calculated from the total costs on the basis of relative quantities for each of the eight plants.

2.4.8 Quantities of Eliminated Discharges

Table 2-2 lists the current wastewater discharges from each of the eight plants surveyed in the Task II report.[1e] These quantities were extrapolated to the entire industry on the same basis as the estimated costs. Based upon the technology discussed previously, all of these point-source discharges would be eliminated with the exception of the waste incinerator scrubber water, which would be discharged after treatment to reduce the PCBs content to one part per billon.

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Table 2-2

Summary of Present Wastewater Quantities, Gallons Per Day

	Plant 100	Plant 101	Plant 102	Plant 103	Plant 104	Plant 105	Plant 106	Plant 114	Total of 8 Plants Surveyed	Extrapolated Industry Totals
Non-Contact Cooling Water	655,000	250,000	388,000	1,646,000	1,195,000	387,000	327,800	38,000	4,886,000	12,215,000
Vacuum Pump Seal Water	0	0	0	0	0	44,000	0	0	44,000	110,000
Detergent Wash Water	0	8,000	0	2,000	25,000	200	0	0	35,200	88,000
Blow-down, Contact Cooling	20,000	2,500	5,000	190,000	15,000	7,500	3,000	100	243,100	607,750
Incinerator Scrubber	0	0	0	122,000	0	0	0	0	122,000	305,000
Process Wastewater	200	0	0	18,000	0	12,500	5,000	4,500	40,200	100,500
Sanitary Wastewater	44,900	1,500	52,000	50,000	10,000	65,000	5,000	9,300	237,700	594,250
TOTALS	720,100	262,000	445,000	2,028,000	1,245,000	516,200	340,000	51,900	5,608,200	14,020,500

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2.5 Estimated Costs for Hypothetical Plants

Three hypothetical plants were defined on the basis of PCBs consumption:

Large Plant	2,500,000 pounds per year
Medium Plant	500,000 pounds per year
Small Plant	100,000 pounds per year

Each of these hypothetical plants is assumed to require wastewater-elimination techniques in all wastewater categories; e.g., these plants each require an upper-bound set of costs.

Table 2-3 lists the individual wastewater quantities and the individual capital and annual cost elements for each of the three plants and for each of the several technologies for discharge elimination. The costs were derived in the same manner as previously described in Section 2.0, and include the cost elements of Section 3.0.

Figure 2 graphically shows the total capital investment and the total annual costs as functions of plant size.

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Table 3-3
Estimated Costs for Hypothetical Plants

Technology	Cost Element	Large Plant 2,500,000 lbs/yr PCB Use	Medium Plant 500,000 lbs/yr PCB Use	Small Plant 100,000 lbs/yr PCB Use
Segregate Non-Contact Cooling Water, Closed-System Cooling, Recycle	Non-Contact Cooling Water, GPD	1,000,000	200,000	40,000
	Non-Contact Cooling Water, gpm	1,041	208	41.7
	Cap. Inv. for Segregation	165,000	37,000	13,000
	Cap. Inv. for Dry Cooling Tower	175,000	36,500	12,600
	Total Capital Investment	280,000	73,500	25,600
	Annual Cap. Recov. Costs	41,700	10,900	3,800
	Annual Maint. Costs	39,800	7,300	2,500
	Annual Power Costs	44,000	8,800	1,900
	Total Annual Costs	120,700	27,000	8,600
Replace Water-Seal Vacuum Pumps and Steam Jets with Mechanical Pumps	Pump Seal Water, GPD	80,000	20,000	5,000
	No. Vacuum Pumps Needed	16	4	1
	Cap. Inv. for Pumps	240,000	67,000	16,000
	Annual Cap. Recov. Costs	48,000	10,000	2,500
	Annual Fuel Plus Maint. Costs	14,500	3,700	1,000
	Total Annual Costs	62,500	13,700	3,500
Replace Reservoir Washers with Vapor Degreasing	Degreaser Wash Water, GPM	20,000	5,000	1,500
	Cap. Inv. for Vapor Degreasing	150,000	40,000	10,000
	Annual Cap. Recov. Costs	21,000	6,000	1,500
	Annual Maint. Costs	5,600	1,600	400
	Annual Fuel Costs	4,000	1,000	300
	Total Annual Costs	77,600	9,600	2,700
Filter and Demineralize Effluent, Add to Cooling Water Circuit	Filter Effluent, GPD	25,000	5,000	1,000
	Evaluate Water Treatment, GPD	10,000	2,000	500
	Total GPD to Treatment	35,000	7,000	1,400
	Total gpm to Treatment	36.5	7.3	1.46
	Cap. Inv. - Pretreatment	140,000	32,000	10,000
	Cap. Inv. - Demineralize	37,500	7,500	2,200
	Total Cap. Investment	215,750	49,500	12,500
	Annual Cap. Recov. - Pretreatment	29,000	10,700	4,200
	Annual Oper. Costs - Pretreatment	6,200	2,500	900
	Total Annual Costs - Pretreatment	34,200	13,100	5,100
	Annual Cap. Recov. - Demineral.	4,100	1,100	300
	Annual Oper. Costs - Demineral.	8,700	1,700	600
	Total Annual Costs - Demineral.	12,800	2,800	900
	Total Annual Costs	47,000	15,900	5,800
Pretreatment and Chlorination - Adsorption - Sanitary Water from Waste Incinerator	Sanitary Water, GPD	250,000	50,000	10,000
	Sanitary Water, gpm	261	52.1	10.41
	Cap. Inv. - Pretreatment	700,000	225,000	90,000
	Cap. Inv. - Carbon Adsorb.	132,000	40,000	25,000
	Total Cap. Investment	832,000	265,000	115,000
	Annual Cap. Recov. - Pretreatment	104,300	35,000	13,600
	Annual Oper. Costs - Pretreat.	23,100	7,900	3,000
	Total Annual Costs - Pretreat.	127,400	42,900	16,600
	Annual Cap. Recov. - Carbon Ads.	17,700	7,000	2,700
	Annual Oper. Costs - Carbon Ads.	59,500	21,600	11,300
	Total Annual Costs - Carbon Ads.	76,200	28,800	15,000
	Total Annual Costs	204,600	71,600	31,600
Incinerate Process GPD Process Water		25,000	5,000	1,000
Wastewater and Sanitary GPD Sanitary Water (Present)		62,500	12,500	2,500
Wastewater After Gpm. No. Adsorb Employees		637	125	25
Water Saving (e.g., Chemical Chemical Installation Cap. Inv. for Water Saving		31,700	6,300	1,300
for Sanitary Water Annual Cap. Recov. Cost		4,730	1,000	300
Annual Oper. Cost		9,000	1,900	700
Total Annual Cost, Wat. Saving		5,700	2,900	600
GPD Sanitary Water (Effluent		6,250	1,250	250
GPD Total to Incinerate		31,250	6,250	1,250
gpm Total to Incinerate		32.6	6.51	1.30
Incin. Cap. Inv.		350,000	105,000	90,000
Annual Cap. Recov. Costs		57,100	15,700	13,600
Annual Labor & Maint. Costs		70,000	21,000	18,000
CPT Incinerated		9,150,000	1,630,000	325,000
Annual Fuel Costs		161,600	33,300	6,600
Total Annual Costs - Incin.		283,500	69,800	27,000
Incin. Cap. Inv. - Sanitary		70,000	21,000	18,000
Incin. Annual Costs - Sanitary		14,700	13,800	7,400
Total Cap. Inv. - Sanitary		101,200	27,300	19,200
Total Ann. Costs - Sanitary		44,600	16,800	7,800
Total Cap. Inv. for Process Water		280,000	84,000	72,000
Total Ann. Costs for Proc. Water		226,800	55,700	20,700
Total Capital Investment		331,200	111,300	91,200
Total Annual Costs		293,200	71,800	28,200
Engineers to Prevent PCBs Fallout and Rainwater Runoff	Cap. Inv. - Sloped Drive.	35,300	19,400	12,000
	Cap. Inv. - Mil. Trenches Drive.	15,900	6,100	5,100
	Total Capital Investment	51,200	25,500	17,500
	Annual Cap. Recov. Costs	5,300	3,600	1,800
TOTALS	Total Capital Investment	2,189,100	690,300	316,800
	Total Annual Costs	773,000	217,300	91,400

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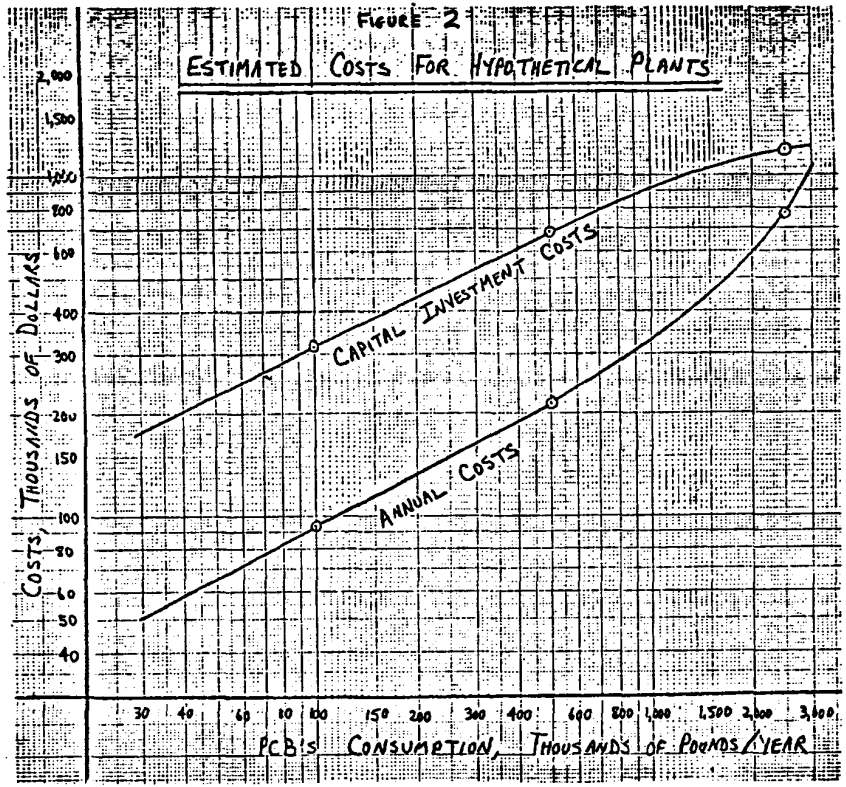
FIGURE 2
ESTIMATED COSTS FOR HYPOTHETICAL PLANTS
CAPITAL INVESTMENT COSTS
ANNUAL COSTS
COSTS, THOUSANDS OF DOLLARS
2,000
1,500
1,000
800
600
400
300
200
150
100
80
60
50
40
30
40
60
80
100
150
200
300
400
600
800
1,000
1,500
2,000
3,000
PCB'S CONSUMPTION, THOUSANDS OF POUNDS/YEAR

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2.6 References for Section 2.0

1. Assessment of Wastewater Management, Treatment Technology, and Associated Costs for Abatement of PCBs Concentrations in Industrial Effluents, Versar Inc., Final Report, Task II, EPA Contract No. 68-01-3259 (Feb. 3, 1976)
   a. Pages 53,54,76,77,78.
   b. Pages 43,45,70,71.
   c. Page 213.
   d. Page 224.
   e. Pages 45 and 71.
   f. Page 211.
   g. Page 215.
   h. Page 217.
   i. Pages 162,163.
   j. Pages 171,172.
   k. Pages 214 and 216.

2. Process Plant Construction Estimating and Engineering Standards Manual, Volume 5, Richardson Engineering Services, Solano Beach, Cal. (1974).

3. Huff, George A., Jr., Selecting a Vacuum Producer, Chemical Engineering, March 15, 1976, p. 83-6.

4. Patton, P.W., and C.F. Joyce, How to Find the Lowest-Cost Vacuum, Chemical Engineering, Feb. 2, 1976, p. 84-8.

5. Private Communication, Plant 101, May 28, 1976.

6. Versar Inc., General Technologies Division, Draft Development Document for Effluent Limitations Guidelines and Standards of Performance, Inorganic Chemicals, Alkali and Chlorine Industries, EPA Contract No. 68-01-1513 (June 1973), pages VIII-18-22.

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3.0 PCB RUNOFF FROM STORAGE AND MATERIAL TRANSFER AREAS

3.1 Problem Areas

Stormwater or meltwater runoff becomes contaminated with PCBs at various points on the premises of capacitor and transformer manufacturing facilities:

1) Unloading areas where raw or premixed PCB materials are transferred from flatbed trucks, tank trucks or rail tank cars to drum storage areas or tank farm storage areas. Very few unloading areas are covered or have methods for containing minor leaks or spills or accidental discharges of large volumes of PCBs; the result is that PCBs are washed from these areas into the environment by rainwater runoff and snowmelt. Horizontal transport to running streams or vertical percolation to the water table results in permanent PCB contamination. Topographic conditions, soil texture and composition, and local precipitation rates all help determine the rate of PCB transfer and contamination.

2) Areas where various solid wastes are stored including drums filled with solid or liquid PCB wastes, spent clay (attapulgite or fuller's earth) filtering material, scrap capacitors or capacitor interiors, scrap transformers or transformer interiors, spill absorbent materials such as floor dry, rags, and newspapers, and sludges from oil separators and other water treatment systems. Storage is generally in the open and may be on a permanent basis or until the materials are hauled to a landfill or incineration. Again, runoff carries PCBs from these solid waste areas into the environment by the same mechanisms as delineated above.

3) PCBs, originating as air emissions from the plant and from undefined remote sources, reaching the ground, roofs, parking

lots, and outlying areas. An intermedia transfer is required prior to the PCBs becoming part of the stormwater runoff. This category will not be considered as arising directly from plant operations.

3.2 Solutions to Runoff Problems

The obvious solution to the above water contamination and concomitant transport of PCBs to the environment is to prevent water contact and mixing with PCB materials. Enclosures around unloading and storage areas, with curbs and impervious floors, will prevent PCB loss. However, the containment of PCBs which settle from the air is more difficult. Until air emissions are controlled, diversion of uncontaminated runoff waters around facilities by dikes and curbs can be envisioned, and the subsequent control, storage, and possible treatment of all contaminated runoff waters may be considered. However, PCB control techniques applicable to PCB contamination from intermedia transfer sources are not within the scope of this study.

3.3 Enclosure Requirements

Handling methods of PCBs and PCB wastes, both solid and liquid, are largely a function of production volume. Very large operations unload raw PCBs from railroad tank cars to storage tanks; over 20,000 gallons are transferred from each car to the "tank farm" area. Large volumes of clay filtering wastes are also generated at very large plants, as PCBs are filtered on site. At intermediate and small sized operations PCBs are generally delivered in tank trucks (4,000-5,000 gallon capacity) or 55-gallon drums, and are premixed and filtered; obviously no filter wastes are generated. In developing costs for Tables 3-1, 3-2, and 3-3, Versar has made several assumptions regarding material unloading and waste storage requirements:

1) Operations using more than 1,000,000 pounds of PCBs per year generate more than 175 55-gallon drums of liquid and solid wastes per month, and will require a large storage area.

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Table 3-1

Building Costs - Waste Storage Areas

1) Large Building (50' x 100')	
Footings	$ 1,203.00
Slab (6" thick)	2,250.00
Curb (6" high)	549.00
Metal Siding (10' high)	4,050.00
Metal Roof (12:3 pitch)	7,020.00
Structural Steel	17,850.00
Misc.	2,530.00
	$35,452.00
2) Medium Building (50' x 50')	
Footings	$ 802.00
Slab (6" thick)	1,215.00
Curb (6" high)	366.00
Metal Siding (10' high)	2,700.00
Metal Roof (12:3 pitch)	3,510.00
Structural Steel	8,925.00
Misc.	1,850.00
	$19,368.00
3) Small Building (25' x 50')	
Footings	$ 601.00
Slab (6" thick)	725.00
Curb (6" high)	274.00
Metal Siding (10' high)	2,025.00
Metal Roof (12:3 pitch)	1,755.00
Structural Steel	4,462.00
Misc.	1,605.00
	$11,447.00

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Table 3-2

Building Costs - PCB Unloading Areas

1) Railroad Tank Car (20' x 70')

Footings	$ 721.00
Slab (12" thick)	1,400.00
Walls (4' high, 8" thick, concrete)	1,872.00
Metal Siding (10' high)	2,430.00
Metal Roof (12:3 pitch)	2,079.00
Structural Steel	4,998.00
Misc.	2,735.00
	$15,875.00

2) Tank Truck or Flatbed Truck (15' x 30')

Footings	$ 361.00
Slab (6" thick)	279.00
Walls (2' high, 8" thick, concrete)	471.00
Metal Siding (10' high)	1,215.00
Metal Roof (12:3 pitch)	648.00
Structural Steel	1,606.00
Misc.	1,518.00
	$ 6,098.00

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Table 3-3

Industry Costs

	Capital Costs		Annual Costs (8% @ 20 yr.)		20 Year Costs
	Per User	Total Industry	Per User	Total Industry	Total Industry
Capacitor Industry					
Storage Buildings					
Large Users (8) (>1,000,000 lbs/yr)	$35,452	$ 283,616	$3,616	$ 28,928	$ 578,560
Medium Users (6) (100,000-1,000,000 lbs/yr)	19,368	116,208	1,975	11,850	237,000
Small Users (5) (<100,000 lbs/yr)	11,447	57,235	1,167	5,835	116,700
TOTALS (19)		$ 457,059		$ 46,613	$ 932,260
Material Transfer Buildings					
Large Users (8) (>1 million lbs/yr)	15,875	127,000	1,619	12,952	259,042
Medium & Small Users (11) (<1 million lbs/yr)	6,098	67,078	621	6,831	136,620
TOTALS (19)		$ 194,078		$ 19,783	$ 395,662
Transformer Industry					
Storage Buildings					
Large Users (4) (>1,000,000 lbs/yr)	$35,452	$ 141,808	$3,616	$ 14,464	$ 289,280
Medium Users (7) (100,000-1,000,000 lbs/yr)	19,368	135,576	1,975	13,825	276,500
Small Users (7) (<100,000 lbs/yr) (7)	11,447	80,129	1,167	8,169	163,380
TOTALS (18)		$ 358,513		$ 36,458	$ 729,160
Material Transfer Buildings					
Large Users (4) (>1 million lbs/yr)	15,875	63,500	1,619	6,476	129,520
Medium & Small Users (14) (<1 million lbs/yr)	6,098	85,372	621	8,694	173,880
TOTALS (18)	$	$ 149,872		$ 15,170	$ 303,400
TOTAL PCB USER INDUSTRY (37)		$1,159,522		$118,024	$2,360,482

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Liquid PCB transfer areas will require a structure large enough for a railroad tank car.

2) Intermediate sized operations using from 100,000 to 1,000,000 pounds of PCBs per year will require less waste storage area as they generate approximately 75 55-gallon drums of liquid and solid waste per month. Liquid PCB transfer areas will require a structure large enough for a tank truck or flatbed truck to unload premixed and filtered liquid or drummed PCBs.

3) Small operations, using less than 100,000 pounds per year will require minimal waste storage area, as available enclosed space in the manufacturing facility can often be utilized. Unloading facilities will require a structure large enough for a flatbed truck to unload drums of premixed PCBs.

4) All facilities will remove liquid and solid wastes to incineration or landfill on a monthly basis.

5) All building structures will include slab floors, curbs, footings, either part concrete and part metal walls or all metal walls, metal roofs, steel superstructure, two normal access doors, one roll type steel door for vehicular access, rudimentary lighting, no ventilation, no insulation and no windows.

3.4 References for Section 3.0

1. Richardson Engineering Services Inc., Process Plant Construction Estimating and Engineering Standards, Solana Beach, California, 1974.

2. Versar Inc., Final Report, Assessment of Wastewater Management, Treatment Technology, and Associated Costs for Abatement of PCBs Concentrations in Industrial Effluents, 1976.

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3. Personal Conversation with Dick Rollends, Vice President of Engineering, Jard Corp., Bennington, Vermont.

4. Personal Conversation with Bill Montgomery, Plant Engineer, General Electric, Hudson Falls, New York.

4.0 SUMMARY AND TABULATION OF TECHNOLOGY AND ESTIMATED COSTS FOR THREE ALTERNATIVE APPROACHES TO REDUCTION OF PCBs IN EFFLUENTS FROM THE CAPACITOR AND TRANSFORMER MANUFACTURING CATEGORIES

4.1 Description of Alternatives

The technology and estimated costs developed under Task II of Contract No. 68-01-3259, as contained in Reference 1 and Sections 2.0 and 3.0 of this document, were reviewed and utilized to develop three alternative approaches to PCBs reduction in effluents from the industry. These alternatives cover a range of both costs and PCBs reduction, and also reflect consideration of technology availability.

The eight individual plants included in the analysis were those plants in the category for which sufficient data were available (from plant visits, telephone contacts, etc.) to justify the cost estimations. Six of these eight plants discharge wastewater directly to waterways. Five other plants in the category are known to discharge directly to waterways, but sufficient data on these facilities as required for the analysis were not available to us.

To our knowledge there are presently no cases of sanitary water (personal hygiene, toilets, etc.) discharge to waterways in this industry category; all such waters are believed discharged to municipal sewage collection and treatment systems. Therefore, although costs were developed for sanitary water under the zero discharge case of Section 2.0 herein, treatment of sanitary water was not included in any of the three alternatives of this section; treatment costs for sanitary wastewaters are thus zero for all three alternatives.

The three alternatives may be summarized, in terms of process change, technology and treatment of the several types of wastewaters by use, as follows:

Wastewater Type	Type of Technology Applied		
	Alternative A	Alternative B	Alternative C
Non-Contact Cooling Water	Cool in Closed System and Recycle	Pretreatment and Carbon Adsorption	Segregate and Discharge Untreated
Steam Jet Condensate	Replace Steam Jets with Mechanical Pumps	Pretreatment and Carbon Adsorption	Pretreatment and Carbon Adsorption
Detergent Washing Water	Replace with Solvent Vapor Degreasing	Pretreatment and Carbon Adsorption	Replace with Solvent Vapor Degreasing
Boiler Blowdowns	Filter, Demineralize and Recycle	Pretreatment and Carbon Adsorption	Discharge Untreated
Incinerator Scrubber Water	Pretreatment and Carbon Adsorption	Pretreatment and Carbon Adsorption	Pretreatment and Carbon Adsorption
Process Associated Wastes*	Pretreatment and Carbon Adsorption	Pretreatment and Carbon Adsorption	Pretreatment and Carbon Adsorption
Sanitary Wastewaters	No Treatment	No Treatment	No Treatment
Rainfall Runoff	Enclose Areas	Enclose Areas	Enclose Areas

4.2 Presentation of Estimated Cost Tabulations

Estimated costs for the three alternatives are tabulated as follows:

Alternative A - Table 4-1
Alternative B - Table 4-2
Alternative C - Table 4-2

4.3 Discussion

In general, the relative costs and effective reduction in PCB discharges for the three alternatives can be summarized by:

	Alternative A (Process Changes, Maximum Recycle)	Alternative B (Maximum Use of Carbon Treatment)	Alternative C (Minimum Treatment)
Relative Cost	Mid-Level	Highest	Lowest
Relative PCB Reduction	Highest	Mid-Level	Lowest

* Process associated wastes include:

- less than 1000 gal/day rinse water from hot solder dip (1 plant)
- more than 1000 gal/day phosphatizing bath wastewater (2 plants)
- more than 1000 gal/day tin plating wastewater (1 plant)
- less than 1000 gal/day fluoride bath wastewater (1 plant)
- less than 1000 gal/day paint stripping wastewater (1 plant)
- more than 1000 gal/day unspecified contact cooling water (1 plant)

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Table 44

Estimated Costs to Achieve Minimum BOD Discharge in Operating Facilities
Alternative #1 - Process & Plant Modifications and Replacement of Process Water Polluted by Cooling Atmosphere for Feasibility

Technology	Cost Element	Plant 100	Plant 101	Plant 102	Plant 103	Plant 104	Plant 105	Plant 106	Plant 107	Total of 8 Plants Surveyed	International Industry Totals
Segregate Non-Contact Cooling Water, Clean-System Cooling, Recycle	Non-Contact Cooling Water, MGD	0.625	0.25	0.300	1.646	1.295	0.307	0.327	0.030	4.880	12.225
	Non-Contact Cooling Water, gpm	682	280	486	1,814	1,295	486	341	20.8	5,000	13,725
	Cap. Inv. for Segregation	30,000	0	43,000	394,000	62,000	62,000	30,000	27,000	524,000	1,350,000
	Cap. Inv. for Dry Cooling Tower	135,000	43,000	45,000	270,000	730,000	54,000	54,000	11,000	936,000	2,000,000
	Total Capital Investment	165,000	43,000	208,000	664,000	292,000	116,000	84,000	38,000	1,460,000	3,350,000
	Annual Cap. Recov. Costs	20,100	6,000	26,000	83,100	43,000	20,000	13,000	5,000	202,000	385,000
	Annual Maint. Costs	23,000	9,000	13,000	50,000	42,000	13,000	10,000	2,000	164,000	417,000
	Annual Power Costs	20,000	11,000	17,000	72,000	33,000	17,000	14,000	1,000	219,000	546,000
	Total Annual Costs	63,000	26,000	56,000	204,000	118,000	50,000	39,000	9,000	587,000	1,448,000
Replace Water Seal Vac. Pumps & Steam Jets with Mechanical Pumps	No. Vacuum Pumps Needed	0	0	0	0	0	30	0	0	30	75
	Cap. Invest. for Pumps	0	0	0	0	0	200,000	0	0	200,000	490,000
	Annual Cap. Recov. Costs	0	0	0	0	0	25,100	0	0	25,100	62,700
	Annual Chgl. Maint. Costs	0	0	0	0	0	14,300	0	0	14,300	35,000
	Total Annual Costs	0	0	0	0	0	39,400	0	0	39,400	98,500
Replace Detergent Washing with Vapor Degreasing	Capital Invest. for Vapor Deg.	0	25,000	0	170,000	200,000	60,000	0	0	455,000	1,137,500
	Annual Cap. Recov. Costs	0	6,200	0	20,200	20,000	6,900	0	0	73,100	181,700
	Annual Maint. Costs	0	3,300	0	10,600	12,000	3,600	0	0	29,500	73,000
	Annual Fuel Costs	0	1,400	0	4,000	3,000	1,500	0	0	12,300	30,670
	Total Annual Costs	0	12,900	0	41,700	45,000	14,000	0	0	114,900	287,370
Filter & Recirculate Blowdown, Add to Cooling Water Circuit	Boiler Blowdown, GPD	20,000	2,500	5,000	25,000	15,000	7,500	3,000	100	78,100	195,250
	Cooling Water Blowdown, GPD	6,500	2,500	3,000	16,500	12,000	3,500	3,500	400	49,000	122,500
	Current Cooling Water, GPD	0	0	0	165,000	0	0	0	0	165,000	412,500
	Total GPD to Treatment	26,500	5,000	8,000	206,500	27,000	11,000	6,500	500	292,100	730,250
	Total gpm to Treatment	17.5	3.5	5.5	215	19.1	11.9	4.5	0.5	205	761
	Cap. Inv. Equip. & Fltr.	300,000	61,000	87,000	600,000	400,000	300,000	75,000	15,000	1,215,000	3,137,500
	Cap. Inv.-Boilerplate	22,000	6,000	9,000	113,000	22,000	11,000	7,000	1,000	191,000	477,500
	Total Cap. Investment	322,000	67,000	96,000	713,000	422,000	311,000	82,000	16,000	1,406,000	3,615,000
	Ann. Cap. Recov.-Equip. & Fltr.	23,000	5,100	12,000	80,000	33,000	25,000	10,000	2,200	190,300	487,750
	Ann. Oper. Costs-Equip. & Fltr.	5,300	2,000	2,000	12,000	3,300	3,300	2,300	500	41,400	101,500
	Total Ann. Costs-Equip. & Fltr.	28,100	11,100	15,000	100,200	29,100	18,000	12,300	2,700	220,300	570,630
	Ann. Cap. Recov.-Boiler	2,300	600	1,300	10,100	2,200	1,600	1,000	100	20,200	70,750
	Ann. Oper. Costs-Boiler	5,600	1,700	2,300	31,100	6,700	2,900	1,600	100	77,800	192,000
	Total Ann. Costs-Boiler	7,900	2,100	3,600	40,200	10,000	4,500	2,600	200	100,100	251,000
	Total Annual Costs	36,000	13,200	18,600	177,500	39,100	22,500	15,500	2,900	320,400	823,500
Pretreat & Carbon Absorp. Boiler Water from Reclamation	CPO Installed Value	0	0	0	122,000	0	0	0	0	122,000	305,000
	gpm (16 hrs/day)	0	0	0	127	0	0	0	0	127	318
	Cap. Inv.-Equip. & Fltr.	0	0	0	436,000	0	0	0	0	436,000	1,075,000
	Cap. Inv.-Carbon Absorp.	0	0	0	78,000	0	0	0	0	78,000	195,000
	Total Capital Investments	0	0	0	500,000	0	0	0	0	500,000	1,270,000
	Ann. Cap. Recov.-Equip. & Fltr.	0	0	0	64,000	0	0	0	0	64,000	160,250
	Ann. Oper. Costs-Equip. & Fltr.	0	0	0	14,700	0	0	0	0	14,700	35,520
	Total Ann. Costs-Equip. & Fltr.	0	0	0	78,700	0	0	0	0	78,700	195,968
	Ann. Cap. Recov.-Carbon Absorp.	0	0	0	11,400	0	0	0	0	11,400	28,250
	Ann. Op. Costs-Carbon Absorp.	0	0	0	35,100	0	0	0	0	35,100	87,870
	Total Ann. Costs-Carbon Absorp.	0	0	0	46,700	0	0	0	0	46,700	116,800
	Total Annual Costs	0	0	0	124,700	0	0	0	0	124,900	312,150
Pretreat & Carbon Absorp. Chromiumed Process Water	CPO Installed Cost	200	0	0	10,000	0	12,000	5,000	4,500	40,700	100,750
	gpm (16 hrs/day)	0.2	0	0	10.75	0	11.0	4.7	4.7	41.35	104.6
	Cap. Inv. Equip. & Fltr.	9,000	0	0	140,000	0	100,000	30,000	25,000	307,000	765,000
	Cap. Inv. Carbon Absorp.	5,500	0	0	30,000	0	20,000	20,000	10,500	107,000	267,500
	Total Capital Investment	14,500	0	0	170,000	0	120,000	70,000	34,500	465,000	1,162,500
	Ann. Cap. Recovery-Equip. & Fltr.	1,341	0	0	20,060	0	14,700	3,642	3,155	51,918	134,845
	Ann. Oper. Cost-Equip. & Fltr.	270	0	0	6,000	0	3,000	2,760	1,650	18,060	37,350
	Total Ann. Costs - Equip. & Fltr.	1,611	0	0	25,060	0	17,700	10,362	4,845	69,790	181,795
	Ann. Cap. Recovery - Carbon Absorp.	826	0	0	4,470	0	4,172	2,960	2,905	15,147	38,368
	Ann. Oper. Cost - Carbon Absorp.	2,475	0	0	13,500	0	12,900	9,000	6,775	44,350	115,875
	Total Ann. Costs - Carbon Absorp.	3,295	0	0	17,970	0	16,772	11,960	13,680	61,197	154,240
	Total Ann. Costs	4,906	0	0	43,030	0	34,472	22,362	25,525	130,495	336,230
Sanitary Wastewater	CPO Installed Cost	61,700	1,300	32,000	30,000	30,000	65,000	5,000	1,300	227,749	0
	Total Cap. Investment	0	0	0	0	0	0	0	0	0	0
	Total Ann. Costs	0	0	0	0	0	0	0	0	0	0
Rain Runoff Water	Cap. Inv. Storage Building	35,452	10,360	35,452	35,452	35,452	35,452	10,360	35,452	251,480
Reclaimed Around Chlorination Area and Fourteen Acres, with Curbs & Impervious Floors	Annual Cost Storage Building	1,616	1,975	1,616	1,616	1,616	1,616	1,975	1,616	25,648
	Cap. Inv. Material Trans. Bldg.	15,975	6,000	15,975	15,975	15,975	15,975	6,000	15,975	107,446
	Annual Cost Material Trans. Bldg.	1,619	621	1,619	1,619	1,619	1,619	621	1,619	10,356
TOTALS	Total Capital Investment	436,027	108,066	256,327	2,092,327	788,327	651,027	254,066	126,417	6,995,106
	Total Annual Costs	130,541	54,000	71,035	500,665	230,175	166,497	70,750	38,960	1,260,197

Table 4-2

Estimated Costs to Achieve One PPB PCBs Concentration in the Effluent from the Existing Facilities
(Maximum Cost Case - Alternate 3)

Technology	Cost Element	Plant 100	Plant 101	Plant 102	Plant 103	Plant 104	Plant 105	Plant 106	Plant 114	Total of 8 Plants Surveyed
Pretreatment & Carbon Adsorp. of all Flows to one ppb PCBs Level for Discharge to Surface Waters	CPO, All Flows ex. Sanitary	675,200	10,500*	393,000	1,970,000	1,235,000	451,200	335,000	42,600	5,129,500
	gpm, All Flow ex. Sanitary (16 hr/day)	703.3	16.9	409.4	2060.6	1286.4	470.0	349.0	44.6	5333.0
	Cap. Inv.-Equal. & Filt.	1,650,000	90,000	1,050,000	4,500,000	2,850,000	1,150,000	900,000	210,000	12,600,000
	Ann. Cap. Recovery-Equal. & Filt.	245,050	13,410	156,450	670,500	426,650	171,350	134,100	31,290	1,847,600
	Ann. Op. Cost-Equal & Filt.	49,500	2,700	31,500	135,000	85,500	34,500	27,000	6,300	372,000
	Cap. Inv.-Carbon Adsorp.	260,000	20,000	165,000	1,000,000	500,000	195,000	150,000	45,000	2,343,000
	Ann. Cap. Recovery-Carbon Adsorp.	38,740	4,172	24,585	149,600	74,500	29,055	22,350	4,705	349,107
	Ann. Op. Costs-Carbon Adsorp.	117,000	12,600	74,250	450,000	225,000	87,750	67,500	20,250	1,054,350
	Tot. Op. Costs-Equal. & Filt.	295,350	14,110	187,950	805,500	510,150	205,850	161,100	37,590	2,219,600
	Tot. Op. Costs-Carbon Adsorp.	155,740	16,772	98,835	599,000	299,500	116,805	89,850	26,955	1,403,457
	Total Cap. Inv.	1,910,000	110,000	1,215,000	5,500,000	3,350,000	1,345,000	1,050,000	255,000	14,743,000
	Total Ann. Cost	451,090	32,882	286,785	1,404,500	809,650	322,695	250,950	64,545	3,473,057
Sanitary Wastewater	CPO, Sanitary Waters	44,940	1,500	52,000	50,000	10,000	65,000	5,000	9,300	237,740
	Total Cap. Inv.	0	0	0	0	0	0	0	0	0
	Total Ann. Costs	0	0	0	0	0	0	0	0	0
Rain Runoff Water: Enclosure Around Unloading & Storage Areas, with Curbs & Impervious Floors	Cap. Inv. Storage Building	35,452	19,360	35,452	35,452	35,452	35,452	19,360	35,452	251,440
	Ann. Cost Storage Building	3,616	1,975	3,616	3,616	3,616	3,616	1,975	3,616	25,646
	Cap. Inv. Material Trans. Bldg.	15,875	6,098	15,875	15,875	15,875	15,875	6,098	15,875	107,446
	Ann. Cost Material Trans. Bldg.	1,619	621	1,619	1,619	1,619	1,619	621	1,619	10,956
TOTALS	Total Cap. Investment	1,961,327	141,466	1,266,327	5,951,327	3,401,327	1,396,327	1,075,466	306,327	15,101,894
	Total Annual Costs	456,325	35,478	292,620	1,409,735	814,885	327,890	253,546	69,780	3,659,658

*This plant has presently a closed system on non-contact cooling water.

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Table 4-8

Low Cost Option - Alternative C

Technology	Cost Element	Plant 500	Plant 501	Plant 502	Plant 503	Plant 504	Plant 505	Plant 506	Plant 514	Total of 8 Plants Surveyed
Segregate Non-Contact Cooling Water & Discharge Untreated	Non-Contact Cooling Water, MGD	0.075	0.25	0.300	1.665	1.195	0.387	0.387	0.031	4.890
	Cap. Inv. for Segregation	74,000	0	61,000	294,000	52,000	69,000	39,000	23,950	534,950
	Annual Cap. Recov. Costs	12,026	0	6,007	39,596	12,718	16,371	9,611	3,427	78,676
Replace Detergent Washing with Vapor Degreasing	Capital Invest. for Vapor Deg.	0	55,000	0	176,000	200,000	88,000	0	0	491,000
	Annual Cap. Recov. Costs	0	9,000	0	26,200	29,000	0,300	0	0	73,100
	Annual Maint. Costs	0	3,000	0	10,000	12,000	3,600	0	0	29,500
	Annual Fuel Costs	0	1,000	0	4,000	9,000	1,500	0	0	12,300
	Total Annual Costs	0	12,000	0	41,200	46,000	14,000	0	0	114,900
Blowdown, Discharge Untreated	Boiler Blowdown, GPD	20,000	2,500	5,000	25,000	15,000	7,500	3,000	100	78,100
	Total Cap. Investment	0	0	0	0	0	0	0	0	0
	Total Annual Costs	0	0	0	0	0	0	0	0	0
Pretreat & Carbon Absorp. Scrubber Water from Incinerator	GPD Scrubber Water	0	0	0	122,000	0	0	0	0	122,000
	gpm (16 hrs/day)	0	0	0	127	0	0	0	0	127
	Cap. Inv.-Equal. & Filt.	0	0	0	430,000	0	0	0	0	430,000
	Cap. Inv.-Carbon Absorp.	0	0	0	70,000	0	0	0	0	70,000
	Total Capital Invest.	0	0	0	500,000	0	0	0	0	500,000
	Ann. Cap. Recov.-Equal. & Filt.	0	0	0	64,000	0	0	0	0	64,000
	Ann. Oper. Costs-Equal. & Filt.	0	0	0	14,200	0	0	0	0	14,200
	Total Ann. Costs-Equal. & Filt.	0	0	0	78,200	0	0	0	0	78,200
	Ann. Cap. Recov.-Carbon Absorp.	0	0	0	11,600	0	0	0	0	11,603
	Ann. Op. Costs-Carbon Absorp.	0	0	0	35,100	0	0	0	0	35,103
	Total Ann. Costs-Carbon Absorp.	0	0	0	46,700	0	0	0	0	46,700
	Total Annual Costs	0	0	0	124,900	0	0	0	0	124,900
Pretreat & Carbon Absorp. all Process Waters	Contact Cooling Water, GPD	0	0	0	16,500	0	0	0	0	16,500
	Proc. Prop Seal Water & Condensate, GPD	0	0	0	0	0	44,000	0	0	44,000
	Other Process Waters, GPD	200	0	0	10,000	0	12,500	5,000	4,500	40,200
	Total Process Waters, GPD	200	0	0	26,500	0	56,500	5,000	4,500	100,700
	Total gpm (16 hrs/day)	0.2	0	0	25.9	0	58.9	5.2	4.7	104.9
	Cap. Inv.-Equal. & Filt.	9,000	0	0	190,000	0	235,000	88,000	53,000	567,000
	Cap. Inv.-Carbon Absorp.	5,500	0	0	41,000	0	51,000	20,000	13,500	137,000
	Total Cap. Investment	14,500	0	0	231,000	0	286,000	78,000	74,500	704,000
	Ann. Cap. Recov.-Equal. & Filt.	1,341	0	0	28,310	0	37,995	8,642	8,195	84,483
	Ann. Oper. Costs-Equal. & Filt.	279	0	0	5,790	0	7,650	1,700	1,650	17,010
	Total Ann. Costs-Equal. & Filt.	1,611	0	0	34,010	0	45,645	10,382	9,845	101,493
	Ann. Cap. Recov.-Carbon Absorp.	829	0	0	6,109	0	7,579	2,900	2,995	20,413
	Ann. Oper. Costs-Carbon Absorp.	2,475	0	0	18,450	0	22,950	9,000	8,775	61,650
	Total Ann. Costs-Carbon Absorp.	3,295	0	0	24,559	0	30,549	11,900	11,680	82,063
	Total Ann. Costs	4,906	0	0	58,569	0	76,194	22,362	21,525	183,556
Sanitary Wastewater	GPD Sanitary Waters	44,940	1,500	52,000	50,000	10,000	65,000	5,000	93,850	237,749
	Total Cap. Inv.	0	0	0	0	0	0	0	0	0
	Total Ann. Costs	0	0	0	0	0	0	0	0	0
Rain Runoff Water: Enclosure Around Unloading & Storage Areas, with Curbs & Impervious Floors	Cap. Inv. Storage Building	35,452	19,360	35,452	35,452	35,452	35,452	19,360	35,452	251,448
	Ann. Cost Storage Building	3,616	1,975	3,616	3,616	3,616	3,616	1,975	3,616	25,646
	Cap. Inv. Material Trans. Bldg.	15,875	6,098	15,875	15,875	15,875	15,875	6,098	15,875	107,446
	Ann. Cost Material Trans. Bldg.	1,619	621	1,619	1,619	1,619	1,619	621	1,619	10,956
TOTALS	Total Capital Investment	139,827	80,466	94,327	1,180,327	333,327	486,327	142,466	140,827	2,585,894
	Total Annual Costs	21,167	15,196	11,642	258,838	64,253	105,710	30,769	30,187	536,834

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The reason why Alternative A is believed able to achieve a greater reduction in PCBs discharged than the higher-cost Alternative B is that Alternative A minimizes the total water discharged through maximum use of cooling water and process water recycle. For the eight plants, Alternative A shows 0.2 MGD versus 5.1 MGD for Alternative B. On the cost side, carbon treatment (plus pretreatment) is more expensive than recycling. It should be noted here that incineration of contaminated waters as utilized in the zero discharge analysis (Section 2.0) was not considered practicable for Alternative A because of the time requirements for development, design, and installation of wastewater incineration equipment.

Alternative A appears equally applicable to both existing and new sources, although in new sources it seems likely that the rate of wastewater discharge (assuming no incinerator for liquid PCBs) could be reduced to even less than the apparent eight-plant average of about 5,000 GPD (40,000 GPD of treated process water (omitting incinerator) from eight plants on Table 4-1).

According to the Task II Final Report (Reference 1), a properly designed pretreatment and carbon adsorption system should reduce PCBs levels in the effluent to one ppb (one µg/lit) or below, which is also a typical limit of detection for PCBs in routine laboratory analysis of industrial wastewaters. In addition, again based on Reference 1 data, a total average PCBs level of 15 ppb in the untreated cooling water and blowdowns from Alternative C appears practicable as a result of relatively minor changes (such as cleanout of existing piping, housekeeping improvements, etc.)

On the above basis, the total projected discharge rates (to waterways) in pounds per 365 day year of PCBs from the eight plants for each alternative are (using one ppb as the PCBs level in carbon-treated water):

Alternative	Projected PCBs Discharge, lb/year
A	0.5
B	15.5
C	227.4
Estimated Present Discharges from Eight Plants	978.0

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