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June 23, 2011

Frank Melbourn  
Water Resource Control Engineer  
San Diego Regional Water Quality Control Board  
9174 Sky Park Court, Suite 100  
San Diego, CA 92123

Re: In the Matter of: Tentative Cleanup and Abatement Order No. R9-2011-0001  
Submissions by the City of San Diego

Dear Mr. Melbourn:

Pursuant to the Third Amended Order of Proceedings in this matter, enclosed herein is the City of San Diego's rebuttal evidence supplement to the Administrative Record in the above-referenced proceedings, consisting of copies of the following documents:

1. Star & Crescent Boat Company "Minutes of Board of Directors Meeting", dated February 9, 1980.
2. Star & Crescent Boat Company "Board of Directors Meeting and Stockholders Meeting", dated June 6, 1980.
3. Obituary for Oakley Josiah Hall, Jr., published in San Diego Union-Tribune August 11, 2005.
4. Santa Ana Regional Quality Water Quality Control Board Resolution No. R8-2007-0024.
5. Mansanto Chemical Company Salesmens' Manual Aroclor, dated October 1, 1944.

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6. United States Environmental Protection Agency Report published February 25, 1976 entitled "PCBs in the United States Industrial Use and Environmental Distribution."

Sincerely,

GORDON & REES LLP

A handwritten signature in black ink, appearing to read "Brian M. Ledger", written over the printed name of the firm.

Brian M. Ledger

BML/mg

Encls.

# **EXHIBIT 1**

STAR & CRESCENT BOAT COMPANY

Minutes of Board of Directors Meeting

Directors present: Stephen P. Carlstrom, Judy E. Hall, Janet E. Miles,  
K. N. Beiriger

Directors absent: Raleigh J. Miles

This meeting was held on February 28, 1980, pursuant to notice of meeting and agenda dated February 7, 1980 at 2:00 P.M. in general office at 570 No. Harbor Drive, San Diego, California. Postponed from February 20 to February 28 by consent of the Directors.

1. Labor Management. This area presents a problem to us. Originally we had a negotiating meeting with IBU Union for January 29, 1980. This meeting was cancelled by IBU and a new date of February 4, 1980 was established and later cancelled by us since San Diego Employers Union was unable to attend. On February 4, 1980 a petition was filed by Seafarers International Union with the Labor Relations Board for representation of Star & Crescent employees. Case #21-RC-16267 was established, and March 7, 1980, 8:45 A.M. to 9:45 A.M., was set for an election by employees for IBU vs SIU or no representation. A hearing was also established for February 20, 1980. On February 15, 1980 the NLRB notified Star & Crescent that an unfair labor practice had been filed by IBU, therefore, the hearings were indefinitely postponed until the labor charge could be settled. The IBU claimed unfair labor in that Star & Crescent Management (they claim) refused to bargain with IBU, the recognized bargaining representative, and that we were aiding the Seamans International Union. A hearing date has not been established
2. Computer review. The Board has seen some demonstrations and reviewed various proposals. Our legal counsel and our public accountants have both recommended that we retain a consultant to determine the best system.

We have proposals from:

- Benchmark Computers (Cado)
- Bosic Decisions (Bosic Four)
- Mesa Services, Inc. (Mesa Two)
- Agency Computers (Qantel)
- IBM (5110 & 5120)
- Compal Computer Systems (Compal)
- MPI Business Systems (Digital Equipment)
- Eyler Business Systems (Mitsubishi)
- Quantum Systems, Asoc. (QSA)

Further, members of the Board have brought in advertisements referring to Computer Office Systems (COS) and Radio Shack (Tandy TRS-80)

Put all of this together with floppy discs vs hard discs, sales pitches, software, etc., and it all comes down to the probability that any single one of these proposals would probably serve our purpose irrespective of competing sales personnel claims of other products.

S&C000309

However, in view of this complexity, plus the economic outlook currently faced by the company in San Diego and Star & Crescent, Nevada, it is advisable that the whole subject of computers be postponed until June or July, at which time a decision will be made on one system, and the vendor so notified.

3. Life Insurance. The program recommended by Connecticut General for increased coverage for Stockholders-Officers has been deferred until a more definitive pattern on summer business is established.

4. Other Business:

a. In connection with current business practice, a policy on the cashing of checks is hereby established:

Star & Crescent employees: 1) Star & Crescent pay checks OK  
2) Personal checks not to exceed \$100 unless approved by S. P. Carlstrom or Judy Hall

Other checks: Maximum of \$25 per check unless paying for tickets at the booth or for charters. Excess not to exceed \$25. Former employees, same as "Other Checks", \$25 maximum.

With business as it is today, there is too much risk on large check cashing. There can be exceptions to the rule of course, but only when prior approval of S. P. Carlstrom or Judy Hall is received.

b. K. N. Beiriger, Treasurer, is relieved of these check approvals because finance reports to him and from an accounting approval viewpoint he should be eliminated to provide adequate control.

c. Star & Crescent Investment: Employee pay checks may be cashed, and personnel employee checks to \$200. If more is required this will be accomplished at the bank when the daily deposit is made.

Meeting adjourned at 3:20 P.M.

  
K. N. Beiriger  
Secretary

February 29, 1980

## **EXHIBIT 2**

STAR & CRESCENT BOAT COMPANY

Board of Directors Meeting

and

Stockholders Meeting

Minutes of meeting held pursuant to agenda notice to Directors (also Stockholders) dated June 6, 1980.

Directors Present: Stephen P. Carlstrom, Judy E. Hall, Janet E. Miles, Raleigh J. Miles, K. N. Beiriger

Stockholders Present: Stephen P. Carlstrom, 500 shares  
Judy E. Hall, 500 shares  
Janet E. Miles, 500 shares  
100% of issued and outstanding shares present

1. Stockholders reviewed fiscal year 1980 results and pursuant to Stockholders Agreement and Stock Redemption Agreement of 21 September 1977 established a per share price of \$985.79 for currently issued stock. (Copy signed and attached for Board Minute Book.)

This action officially terminated Stockholders meeting and Board meeting took place from thence on.

1. The Board reviewed current status of labor/management negotiations with Seamens International Union and San Diego Employers Association. Monetary issues have not as yet been settled.
2. Board reviewed the public accountants' certified statements for fiscal year ending March 31, 1980.
3. Reviewing 1979 vs. 1980 for April and May. For the two months:

	1979	1980
Income	\$235,228	\$275,646
Direct Expense	164,684	163,687
Indirect Expense	94,768	191,064
Operating Loss	24,224	79,105

These months are normally loss months, however largest increase in expenses were:

Bonuses	1,000	71,925
Facility Maintenance (not boats)	3,763	11,706
Salaries & Wages-indirect	17,764	23,834
Salaries & Wages-direct	42,882	39,758
Advertising	7,089	11,346
% of Direct to Income	70.01	59.38
% of Indirect to Income (excludes other income and expense)	40.28	69.31

We obviously have to control some of our indirect expense including automobile, travel, entertainment, telephone, maintenance, etc. The Board reviewed the expense reports of officers for the months of March, April and May. These expenses must be reduced in future months.

3. The Board approved officers' salaries, having received verbal approval of O. J. Hall and Star & Crescent Investment Co. via K. N. Beiriger, a director of said company. Salaries at March 31, 1980 were:

Stephen P. Carlstrom	\$47,256
July E. Hall	39,816
Janet E. Miles	21,360
Raleigh J. Miles	28,104
K. N. Beiriger	22,080

4. The Board reviewed dividends paid in 1980 and approved in retrospect the issuance of same amounting to \$135,982. Looking to fiscal year 1981, the Board is contemplating approximately \$100,000 and has so approved.

As to bonuses to employees and officers, the Board has tentatively approved for 1981 bonus as follows, subject to review by the company's public accountants.

Stephen P. Carlstrom	\$35,846
Judy E. Hall	39,428
Janet E. Miles	56,954

Year bonuses at Christmas tentatively set for same amounts as paid in 1980 fiscal year for all employees and officers. Cost of Living adjustment for 1981 (payable in February 1981) estimated to be same as 1980 for non-union and office employees.

5. Ticket prices: Requests are in for 1981 ticket prices so that catalogs may be produced by tour companies, airlines, etc. The Board discussed a fare as follows:

	Present	Suggested
2 hour adult	5.25	5.50
child	2.65	2.75
1 hour adult	3.50	3.75
child	1.75	1.95

The Board does not like to raise fares, but are faced with new labor rates, fuel increases, social security taxes, etc. As a means of getting around this, the Board discussed a future 1½ hour ride in lieu of 1 and 2 hour trips. This cannot be accomplished until 1982 because of printed schedules. In the meantime, it was decided present fares will be increased and a decision made by informal executive committee meeting within the month of June. S. P. Carlstrom will chair this committee action and results will be contained in the July Board minutes.

There being no further business, the meeting adjourned at 4:20 p.m.

*K. N. Beiriger*

K. N. Beiriger  
Secretary

June 19, 1980

SCHEDULE B

(AGREED VALUE)

Agreed Value of the Company:

\$1394.46 x 1500 sh = 2091690<sup>00</sup>

Date 4-18-79

*Stephen P. Carlstrom*  
STEPHEN P. CARLSTROM

*Judy E Hall*  
JUDY HALL

*Janet Miles*  
JANET MILES

985.79 x 1500 sh = 1478685<sup>00</sup>

Date 6-18-80

*Stephen P. Carlstrom*  
STEPHEN P. CARLSTROM

*Judy E Hall*  
JUDY HALL

*Janet Miles*  
JANET MILES

Based on 10 times earnings.

# **EXHIBIT 3**

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**Oakley Josiah Hall Jr.**

HALL, Jr., OAKLEY JOSIAH La Jolla, CA- Oakley Josiah Hall Jr. passed away at Scripps Memorial Hospital on August 5, 2005. He was born on June 22, 1914 in San Diego, CA, where he spent most of his life. He lived in Hollywood, CA for a short time, where he graduated from Curtiss Wright Aviation School. He returned to San Diego where he joined his Father, Capt. O.J. Hall in the Star and Crescent Companies which included the Old Pedestrian Ferry known as the "Nickel Catcher", the original Harbor Excursion Co., San Diego Marine Construction Co. and various oil barges and tug boats with which he became known as the best Salvage Master on the Pacific Coast. The ship building company built many of the tuna services that are still sailing the seas today. In later years he formed the Star and Crescent Investment Co., which included the Florida Mining Co., the Lake Mead Ferry Boat Co. in Las Vegas and various other business ventures in the Las Vegas area. In 1954 he married Irene Houser Carlstrom where they merged his three daughters and her son and had a remarkable, happy and united family. The family enjoyed many happy years at their second home at Lake Tahoe. Mr. Hall will be remembered by all who knew him as a man of high integrity. He is survived by his wife Irene E. Hall of Escondido, CA; son Stephen P. Carlstrom of Lake Ozark, MO; daughters, Janet E. Miles and Judy E. Hall of San Diego, CA; Joan E. Willis of San Angelo, TX; grandchildren, Bill, Adam, Stephen Jr., Scott, Debbie and Steve. Six great-grandchildren and three great-great-grandchildren. There will be a private family Memorial Service and the family asks in lieu of flowers, donations can be made to the Salvation Army, P.O. Box 269, Alexandria, VA 22313 or the Aztec Doberman Rescue Club, 9821 Dunbar Lane, El Cajon, CA 92021 Please sign the guest book at [obituaries.uniontrib.com](http://obituaries.uniontrib.com)

Published in San Diego Union-Tribune on August 11, 2005

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## **Exhibit 4**

## ATTACHMENT 2 TO RESOLUTION NO. R8-2007- 0024

*(NOTE: The language identified below is proposed to be inserted into Chapter 5 of the Basin Plan. If the amendment is approved, corresponding changes will be made to the Table of Contents, the List of Tables, page numbers, and page headers in the plan. Due to the two-column page layout of the Basin Plan, the location of tables in relation to text may change during final formatting of the amendment. In order to accommodate other new TMDLs adopted as Basin Plan amendments and to maintain their order by watershed, the table and figure identifiers may be modified in future formatting of the Basin Plan for re-publication purposes. However, no substantive changes to the tables/figures would occur absent a Basin Plan Amendment.)*

**Chapter 5 - Implementation Plan, Discussion of Newport Bay Watershed (page 5-39 et seq), add the following to 4. Toxics Substances Contamination**

### **4.b Organochlorine Compounds TMDLs**

Organochlorine compounds, including DDT, PCBs, toxaphene and chlordane, possess unique physical and chemical properties that influence their persistence, fate and transport in the environment. While these characteristics vary among the organochlorine compounds, they all exhibit an ability to resist degradation, partition into sediment, and to accumulate in the tissue of organisms, including invertebrates, fish, birds and mammals. The bioaccumulation of these compounds can adversely affect the health and reproductive success of aquatic organisms and their predators, and can pose a health threat to human consumers.

A TMDL technical report prepared by Regional Board staff [Ref. # 1] describes organochlorine-related problems in Newport Bay and its watershed and delineates the technical basis for the TMDLs that follow.

The waterbody-pollutant combinations for which organochlorine compounds TMDLs were established by the Regional Board are listed in Table NB-OCs-1. These TMDLs differ from those established by USEPA in 2002 in several respects:

First, based on an updated impairment assessment that utilized new data and applied the State Water Board's "Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List" (2004) [Ref. # 2], the Regional Board established TMDLs for a list of organochlorine compound-waterbody combinations different from that of USEPA. As shown in Table NB-OCs-2, USEPA also established TMDLs for dieldrin, chlordane, and PCBs in San Diego Creek and for dieldrin in Lower Newport Bay. In contrast, the Regional Board found no impairment as the result of dieldrin in any of these waters, nor was impairment due to chlordane or PCBs found in San Diego Creek and its tributaries.

As described in the TMDL technical report, Regional Board staff also found no impairment due to DDT in San Diego Creek or its tributaries. However, in adopting the 2006 Section 303(d) list (October 25, 2006, Resolution No. 2006-0079), the State Water Board found impairment due to DDT in Peter's Canyon Channel. In response, the Regional Board established a TMDL for DDT in San Diego Creek and its tributaries, including Peters Canyon Channel.

Second, corrections and modifications were made to loading capacities and existing loads identified in USEPA's TMDLs. Finally, an implementation plan is specified (see Section 4.b.3).

While the Regional Board did not establish TMDLs for chlordane and PCBs for San Diego Creek and tributaries, the Board did develop informational TMDLs for these substances in these waters, pursuant to Clean Water Act Section 303(d)(3). These informational TMDLs are shown in Table NB-OCs-3. This action was taken in light of several factors. First, the largest source of organochlorine compounds to Newport Bay is San Diego Creek. Second, the data suggest that the existing loading of chlordane to the Creek is greater than the loading capacity. This suggests that the lack of finding of impairment due to chlordane may be simply a reflection of a lack of data with which to assess impairment. Finally, these informational TMDLs may forward action to address organochlorine compound problems in the watershed. These informational TMDLs have no regulatory effect but may be used as the basis for further investigation of the relative contributions of the various sources of organochlorine compound inputs to San Diego Creek and thence the Bay. In the long-term, this would be expected to help assure proper apportionment of responsibility for implementation of the TMDLs identified in Table NB-OCs-1.

**Table NB-OCs-1. Waterbody-pollutant combinations for which Organochlorine Compound TMDLs are established**

<i>Waterbody</i>	<i>Pollutant</i>
San Diego Creek and tributaries	DDT, Toxaphene
Upper Newport Bay	Chlordane, DDT, PCBs
Lower Newport Bay	Chlordane, DDT, PCBs

**Table NB-OCs-2. Waterbody-pollutant combinations for which Organochlorine Compounds TMDLs were established by USEPA (2002) and Regional Board (2007)**

<b>Waterbody</b>	<b>TMDLs</b>	
	<b>USEPA</b>	<b>Regional Board</b>
San Diego Creek and tributaries*	Chlordane, dieldrin, DDT, PCBs, Toxaphene	DDT, Toxaphene
Upper Newport Bay	Chlordane, DDT, PCBs	Chlordane, DDT, PCBs
Lower Newport Bay	Chlordane, dieldrin, DDT, PCBs	Chlordane, DDT, PCBs

\*TMDLs are established for San Diego Creek and tributaries, even if impairment was only found in particular reaches (e.g., SWRCB found DDT impairment in Peter's Canyon Channel, a primary tributary to San Diego Creek Reach 1, but the TMDL includes all of San Diego Creek and tributaries).

**Table NB-OCs-3. Informational TMDLs**

<b>Waterbody</b>	<b>Informational TMDLs</b>
San Diego Creek and tributaries	Chlordane, PCBs

#### 4.b.1 Numeric Targets used in Organochlorine Compounds TMDLs

Numeric targets identify specific endpoints in sediment, water column or tissue that equate to attainment of water quality standards, which is the purpose of TMDLs. Multiple targets may be appropriate where a single indicator is insufficient to protect all beneficial uses and/or attain all applicable water quality objectives. The range of beneficial uses identified in this Basin Plan (see Chapter 3) for the waters addressed by the organochlorine compounds TMDLs makes clear that the targets must address the protection of aquatic organisms, wildlife (including federally listed threatened and endangered species) and human consumers of recreationally and commercially caught fish.

Sediment, water column and fish tissue targets are identified for these TMDLs, as shown in Table NB-OCs-4. The sediment and water column targets are identical to those selected by USEPA in the development of their organochlorine compounds TMDLs (2002). Fish tissue targets are added for the protection of aquatic life and wildlife.

The targets employed in the development of informational TMDLs for chlordane and PCBs in San Diego Creek and its tributaries are shown in Table NB-OCs-5.

**Table NB-OCs-4. Numeric Sediment, Fish Tissue, and Water Column TMDL Targets**

	Total DDT	Chlordane	Total PCBs	Toxaphene
<b>Sediment Targets<sup>1</sup>; units are µg/kg dry weight</b>				
San Diego Creek and tributaries	6.98			0.1
Upper & Lower Newport Bay	3.89	2.26	21.5	
<b>Fish Tissue Targets for Protection of Human Health<sup>2</sup>; units are µg/kg wet weight</b>				
San Diego Creek and tributaries	100			30
Upper & Lower Newport Bay	100	30	20	
<b>Fish Tissue Targets for Protection of Aquatic Life and Wildlife<sup>3</sup>; units are µg/kg wet weight</b>				
San Diego Creek and tributaries	1000			100
Upper & Lower Newport Bay	50	50	500	
<b>Water Column Targets for Protection of Aquatic Life, Wildlife &amp; Human Health<sup>4</sup> (µg/L)</b>				
San Diego Creek and tributaries				
<i>Acute Criterion (CMC)</i>	1.1			0.73
<i>Chronic Criterion (CCC)</i>	0.00			0.0002
<i>Human Health Criterion</i>	0.00059			0.00075
Upper & Lower Newport Bay				
<i>Acute Criterion (CMC)</i>	0.13	0.09		
<i>Chronic Criterion (CCC)</i>	0.00	0.004	0.03	
<i>Human Health Criterion</i>	0.00059	0.00059	0.00017	

<sup>1</sup>Freshwater and marine sediment targets, except toxaphene, are TELs from Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA/NAZMAT Report 99-1, Seattle WA, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, 12 pp. Toxaphene target is from N.Y. Dept. of Environmental Conservation.

<sup>2</sup>Freshwater and marine fish tissue targets for protection of human health are OEHHA SVs.

<sup>3</sup>Freshwater and marine fish tissue targets for protection of aquatic life and wildlife are from Water Quality Criteria 1972. A report of the Committee on Water Quality Criteria, Environmental Studies Board, National Academy of Sciences, National Academy of Engineering. Washington, D.C., 1972.

<sup>4</sup>Freshwater and marine targets are from California Toxics Rule (2000).

**Table NB-OCs-5. Numeric Sediment, Fish Tissue, and Water Column Targets used in Informational TMDLs**

	Chlordane	Total PCBs
<b>Sediment Targets<sup>1</sup>; units are <math>\mu\text{g}/\text{kg}</math> dry weight</b>		
San Diego Creek and tributaries	4.5	34.1
<b>Fish Tissue Targets for Protection of Human Health<sup>2</sup>; units are <math>\mu\text{g}/\text{kg}</math> wet weight</b>		
San Diego Creek and tributaries	30	20
<b>Fish Tissue Targets for Protection of Aquatic Life and Wildlife<sup>3</sup>; units are <math>\mu\text{g}/\text{kg}</math> wet weight</b>		
San Diego Creek and tributaries	100	500
<b>Water Column Targets for Protection of Aquatic Life, Wildlife &amp; Human Health<sup>4</sup> (<math>\mu\text{g}/\text{L}</math>)</b>		
San Diego Creek and tributaries		
<i>Acute Criterion (CMC)</i>	24	
<i>Chronic Criterion (CCC)</i>	0.0043	0.014
<i>Human Health Criterion</i>	0.00059	0.00017

<sup>1</sup>Freshwater sediment targets are TELs from Buchman, M.F., 1999, NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle WA, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, 12 pp.

<sup>2</sup>Freshwater fish tissue targets for protection of human health are OEHHA SVs.

<sup>3</sup>Freshwater fish tissue targets for protection of aquatic life and wildlife are from Water Quality Criteria 1972. A report of the Committee on Water Quality Criteria, Environmental Studies Board, National Academy of Sciences, National Academy of Engineering, Washington, D.C., 1972.

<sup>4</sup>Freshwater targets are from California Toxics Rule (2000).

The linkage between adverse effects in sensitive wildlife species and concentrations of the organochlorine pollutants in sediments, prey organisms and water is not well understood at the present time, although work is underway to better understand ecological risk in Newport Bay. In addition, the State is in the process of developing sediment quality objectives that should provide guidance for assessing adverse effects due to pollutant bioaccumulation. Reducing contaminant loads in the sediment will result in progress toward reducing risk to aquatic life and wildlife. During implementation of these TMDLs, additional and/or modified wildlife or other targets will be identified as risk assessment information becomes available. These TMDLs will be revisited (see 4.b.3) and revised as appropriate.

#### 4.b.2. Organochlorine Compounds TMDLs, Wasteload Allocations, Load Allocations and Compliance Dates

The organochlorine compounds TMDLs for San Diego Creek and its tributaries, Upper Newport Bay and Lower Newport Bay are shown in Tables NB-OCs-6 and NB-OCs-7. The TMDLs are expressed on a daily basis (average grams per day) in Table NB-OCs-6, and on an annual basis (grams per year) in Table NB-OCs-7. Expression of the TMDLs on a daily basis is intended to comply with a relevant court decision. However, because of the strong seasonality associated with the loading of organochlorine compounds during storm events, it is appropriate for implementation to occur based on average annual loadings. The TMDLs are to be achieved as soon as possible but no later than December 31, 2015.

**Table NB-OCs-6. TMDLs for San Diego Creek, Upper and Lower Newport Bay (expressed on a "daily" basis to be consistent with the D.C. Circuit Court of Appeals decision in *Friends of the Earth, Inc. v. EPA, et al.*, No. 05-5015 [D.C. Cir.2006])**

Water Body	Pollutant	TMDL (average grams per day) <sup>a</sup>
San Diego Creek and Tributaries	Total DDT	1.08
	Toxaphene	0.02
Upper Newport Bay	Total DDT	0.44
	Chlordane	0.25
	Total PCBs	0.25
Lower Newport Bay	Total DDT	0.16
	Chlordane	0.09
	Total PCBs	0.66

<sup>a</sup> Compliance to be achieved as soon as possible but no later than December 31, 2015.

**Table NB-OCs-7. TMDLs for San Diego Creek, Upper and Lower Newport Bay (expressed on annual basis for implementation purposes)**

Water Body	Pollutant	TMDL (grams per year) <sup>a</sup>
San Diego Creek and Tributaries	Total DDT	396
	Toxaphene	6
Upper Newport Bay	Total DDT	160
	Chlordane	93
	Total PCBs	92
Lower Newport Bay	Total DDT	59
	Chlordane	34
	Total PCBs	241

<sup>a</sup> Compliance to be achieved as soon as possible but no later than December 31, 2015.

Informational TMDLs for San Diego Creek and its tributaries for chlordane and total PCBs are shown in Table NB-OCs-8. Again, these informational TMDLs are expressed on average daily and annual bases.

**Table NB-OCs-8. Informational TMDLs for San Diego Creek and Tributaries (expressed on average daily and annual bases)**

Water Body	Pollutant	TMDL (average grams per day)
San Diego Creek and Tributaries	Chlordane	0.70
	Total PCBs	0.34
		TMDL (grams per year)
San Diego Creek and Tributaries	Chlordane	255
	Total PCBs	125

Wasteload and load allocations to achieve the TMDLs specified in Tables NB-OCs-6 and NB-OCs-7 are shown in Tables NB-OCs-9 and NB-OCs-10, respectively. Like the TMDLs, the allocations are expressed in terms of both average daily and annual loads. An explicit margin of safety (MOS) of ten percent was applied in calculating the allocations. Consistent with the TMDL compliance schedule, these allocations are to be achieved as soon as possible but no later than December 31, 2015.

Wasteload and load allocations necessary to meet the informational TMDLs shown in Table NB-OCs-8 are identified in Tables NB-OCs-11 (expressed as average daily loads) and NB-OCs-12 (expressed as annual loads). These allocations are identified only for informational purposes.

#### **4.b.3. Implementation of Organochlorine Compounds TMDLs**

These TMDLs are to be implemented within an adaptive management framework, with compliance monitoring, special studies, and stakeholder interaction guiding the process over time. Information obtained from compliance monitoring will measure progress towards achievement of WLAs and LAs, potentially leading to changes to TMDL allocations; ongoing investigations and recommended special studies, if implemented, may provide information that leads to revisions of the TMDLs, adjustments to the implementation schedule, and/or improved implementation strategies. Thus, implementation of the TMDLs is expected to be an ongoing and dynamic process.

The implementation plan identified in this section reflects the adaptive management, phased approach to the organochlorine compound TMDLs adopted by the Regional Board. The Board found a phased approach, with compliance schedules, appropriate in light of the following considerations. First, it was recognized that additional monitoring and special studies were either already underway or would be needed to address data limitations and significant uncertainty associated with the TMDL calculations, and that changes to the TMDLs might be appropriate based on the results of those investigations. Second, it was also understood that these data limitations and uncertainties pertained to the impairment assessment itself and the determination of the specific organochlorine compounds for which TMDLs are required. Third, the natural attenuation of these compounds over time is expected to affect significantly the selection, development and implementation of TMDLs. As described in the TMDL technical report [Ref.1], use of the organochlorine compounds addressed by these TMDLs has been banned for many years and trend analyses indicate declining concentrations of these substances in fish tissue over time. Natural attenuation should eventually reduce organochlorine pollutant levels to concentrations that pose no threat to beneficial uses in San Diego Creek or Newport Bay. While natural degradation of these compounds is likely the principal cause of the observed decline in fish tissue concentrations, the implementation of erosion and sediment controls and other Best Management Practices to address compliance with the sediment and nutrient TMDLs for Newport Bay and its watershed (see

**Table NB-OCs-9. TMDLs and Allocations for San Diego Creek, Upper and Lower Newport Bay (expressed on a “daily” basis to be consistent with the recent D.C. Circuit Court of Appeals decision in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015 [D.C. Cir.2006]).<sup>a,b</sup>**

Type		Total DDT	Chlordane	Total PCBs	Toxaphene
		(average grams/day)			
<b>San Diego Creek</b>					
<b>WLA</b>	Urban Runoff – County MS4 (36%)	0.35			0.005
	Construction (28%)	0.27			0.004
	Commercial Nurseries (4%)	0.04			0.001
	Caltrans MS4 (11%)	0.11			0.002
	<b>Subtotal – WLA (79%)</b>	<b>0.77</b>			<b>0.01</b>
<b>LA</b>	Agriculture (5%) (excludes nurseries under WDRs)	0.05			0.001
	Open Space (9%)	0.09			0.001
	Streams & Channels (2%)	0.02			0.0003
	Undefined (5%)	0.05			0.001
	<b>Subtotal – LA (21%)</b>	<b>0.21</b>			<b>0.003</b>
<b>MOS (10% of total TMDL)</b>		<b>0.11</b>			<b>0.002</b>
<b>Total TMDL</b>		<b>1.00</b>			<b>0.02</b>
<b>Upper Newport Bay</b>					
<b>WLA</b>	Urban Runoff - County MS4 (36%)	0.14	0.08	0.08	
	Construction (28%)	0.09	0.06	0.06	
	Commercial Nurseries (4%)	0.01	0.01	0.01	
	Caltrans MS4 (11%)	0.04	0.03	0.02	
	<b>Subtotal – WLA (79%)</b>	<b>0.31</b>	<b>0.18</b>	<b>0.18</b>	
<b>LA</b>	Agriculture (5%) (excludes nurseries under WDRs)	0.02	0.01	0.01	
	Open Space (9%)	0.04	0.02	0.02	
	Streams & Channels (2%)	0.01	0.005	0.005	
	Undefined (5%)	0.02	0.01	0.01	
	<b>Subtotal – LA (21%)</b>	<b>0.08</b>	<b>0.05</b>	<b>0.05</b>	
<b>MOS (10% of Total TMDL)</b>		<b>0.04</b>	<b>0.03</b>	<b>0.03</b>	
<b>Total TMDL</b>		<b>0.44</b>	<b>0.25</b>	<b>0.25</b>	
<b>Lower Newport Bay</b>					
<b>WLA</b>	Urban Runoff – County MS4 (36%)	0.05	0.03	0.21	
	Construction (28%)	0.04	0.02	0.17	
	Commercial Nurseries (4%)	0.01	0.003	0.02	
	Caltrans MS4 (11%)	0.02	0.01	0.07	
	<b>Subtotal – WLA (79%)</b>	<b>0.11</b>	<b>0.07</b>	<b>0.47</b>	
<b>LA</b>	Agriculture (5%) (excludes nurseries under WDRs)	0.01	0.004	0.03	
	Open Space (9%)	0.01	0.01	0.05	
	Streams & Channels (2%)	0.003	0.002	0.01	
	Undefined (5%)	0.01	0.004	0.03	
	<b>Subtotal – LA (21%)</b>	<b>0.03</b>	<b>0.02</b>	<b>0.12</b>	
<b>MOS (10% of Total TMDL)</b>		<b>0.02</b>	<b>0.01</b>	<b>0.07</b>	
<b>Total TMDL</b>		<b>0.16</b>	<b>0.09</b>	<b>0.66</b>	

<sup>a</sup> Percentages for WLA (79%) and LA (21%) are applied to the TMDL, after subtracting the 10% MOS from the Total TMDL. Percent WLA and Percent LA add to 100%.

<sup>b</sup> Compliance to be achieved as soon as possible but no later than December 31, 2015.

**Table NB-OCs-10. TMDLs and Allocations for San Diego Creek, Upper and Lower Newport Bay (expressed on an "annual" basis for implementation purposes).<sup>a, b</sup>**

		Total DDT	Chlordane	Total PCBs	Toxaphene
Type		(grams per year)			
<b>San Diego Creek</b>					
WLA	Urban Runoff – County MS4 (36%)	128.3			1.9
	Construction (28%)	99.8			1.5
	Commercial Nurseries (4%)	14.3			0.2
	Caltrans MS4 (11%)	39.2			0.6
	<b>Subtotal – WLA (79%)</b>	<b>281.6</b>			<b>4.3</b>
LA	Agriculture (5%) (excludes nurseries under WDRs)	17.8			0.3
	Open Space (9%)	32.1			0.5
	Streams & Channels (2%)	7.1			0.1
	Undefined (5%)	17.8			0.3
	<b>Subtotal – LA (21%)</b>	<b>74.8</b>			<b>1.1</b>
MOS (10% of Total TMDL)		40			0.6
<b>Total TMDL</b>		<b>395</b>			<b>6</b>
<b>Upper Newport Bay</b>					
WLA	Urban Runoff – County MS4 (36%)	51.8	69.1	29.8	
	Construction (28%)	40.3	23.3	23.2	
	Commercial Nurseries (4%)	5.8	3.3	3.3	
	Caltrans MS4 (11%)	15.8	9.2	9.1	
	<b>Subtotal – WLA (79%)</b>	<b>113.7</b>	<b>68.1</b>	<b>65.4</b>	
LA	Agriculture (5%) (excludes nurseries under WDRs)		8	7	
	Open Space (9%)	3.0	7.6	7.5	
	Streams & Channels (2%)	2.9	1.7	1.7	
	Undefined (5%)		4.2	4.2	
	<b>Subtotal – LA (21%)</b>	<b>30.2</b>	<b>21.4</b>	<b>20.3</b>	
MOS (10% of Total TMDL)		16	9	9	
<b>Total TMDL</b>		<b>160</b>	<b>93</b>	<b>92</b>	
<b>Lower Newport Bay</b>					
WLA	Urban Runoff – County MS4 (36%)	19.1	11.0	78.1	
	Construction (28%)	14.9	8.6	60.7	
	Commercial Nurseries (4%)	2.1	1.2	8.7	
	Caltrans MS4 (11%)	5.8	3.4	23.9	
	<b>Subtotal – WLA (79%)</b>	<b>41.9</b>	<b>24.2</b>	<b>171.4</b>	
LA	Agriculture (5%) (excludes nurseries under WDRs)	2.7	1.5	10.8	
	Open Space (9%)	4.8	2.8	19.5	
	Streams & Channels (2%)	1.1	0.6	4.3	
	Undefined (5%)	2.7	1.5	10.8	
	<b>Subtotal – LA (21%)</b>	<b>11.2</b>	<b>6.4</b>	<b>45.5</b>	
MOS (10% of Total TMDL)		5.9	3.4	24	
<b>Total TMDL</b>		<b>59</b>	<b>34</b>	<b>241</b>	

<sup>a</sup> Percentages for WLA (79%) and LA (21%) are applied to the TMDL, after subtracting the 10% MOS from the total TMDL. Percent WLA and Percent LA add to 100%.

<sup>b</sup> Compliance to be achieved as soon as possible but no later than December 31, 2015.

**Table NB-OCs-11. Informational TMDLs and Allocations for San Diego Creek (expressed on a “daily” basis)<sup>a</sup>**

Category	Type	Chlordane	Total PCBs
		(average grams per day)	
<b>San Diego Creek</b>			
<b>WLA</b>	Urban Runoff – County MS4 (36%)	0.23	0.11
	Construction (28%)	0.18	0.09
	Commercial Nurseries (4%)	0.03	0.01
	Caltrans MS4 (11%)	0.07	0.03
	<b>Subtotal – WLA (79%)</b>	<b>0.50</b>	<b>0.24</b>
<b>LA</b>	Agriculture (5%) (excludes nurseries under WDRs)	0.03	0.02
	Open Space (9%)	0.03	0.03
	Streams & Channels (2%)	0.01	0.01
	Undefined (5%)	0.03	0.02
	<b>Subtotal – LA (21%)</b>	<b>0.13</b>	<b>0.08</b>
<b>MOS (10% of total TMDL)</b>		<b>0.07</b>	<b>0.03</b>
<b>Total TMDL</b>		<b>0.70</b>	<b>0.34</b>

<sup>a</sup> Percentages for WLA (79%) and LA (21%) are applied to the TMDL, after subtracting the 10% MOS from the Total TMDL. Percent WLA and Percent LA add to 100%.

**Table NB-OCs-12. Informational TMDLs and Allocations for San Diego Creek (expressed on an “annual” basis)<sup>a</sup>**

Category	Type	Chlordane	Total PCBs
		(grams per year)	
<b>San Diego Creek</b>			
WLA	Urban Runoff – County MS4 (36%)	82.6	40.5
	Construction (28%)	64.3	31.5
	Commercial Nurseries (4%)	9.2	4.5
	Caltrans MS4 (11%)	25.2	12.4
	<b>Subtotal – WLA (79%)</b>	<b>181.3</b>	<b>88.9</b>
LA	Agriculture (5%) (excludes nurseries under WDRs)	11.5	5.6
	Open Space (9%)	20.7	10.1
	Streams & Channels (2%)	4.6	2.3
	Undefined (5%)	11.5	5.6
	<b>Subtotal – LA (21%)</b>	<b>48.2</b>	<b>23.6</b>
<b>MOS (10% of total TMDL)</b>			<b>13</b>
<b>Total TMDL</b>		<b>255</b>	<b>125</b>

<sup>a</sup> Percentages for WLA (79%) and LA (21%) are applied to the TMDL, after subtracting the MOS from the total TMDL. Percent WLA and Percent LA add to 100%.

discussions of these TMDLs elsewhere in this Basin Plan) is a probable factor. In any case, the observed trends suggest that as monitoring continues in the watershed and pollutant levels decline, some or all of the organochlorine compounds may warrant delisting from the Clean Water Act Section 303(d) list of impaired waters. Again, these TMDLs would need to be revisited accordingly.

This implementation plan also reflects recommendations by regulated stakeholders in the Newport Bay watershed to convene a Working Group to develop and implement a comprehensive Work Plan to: address, as an early action item, the technical uncertainties in these TMDLs and make recommendations for revisions, as appropriate; identify and prioritize tasks necessary to implement the TMDLs; integrate TMDL implementation tasks with those already being conducted in response to other programs (e.g., permits, other TMDLs); and, investigate other pollutants of concern in the watershed.

Table NB-OCs-13 lists the tasks and schedules needed to implement the organochlorine TMDLs. This implementation plan is aimed at identifying actions to accelerate the decline in organochlorine compound concentrations in the watershed, and to augment their natural attenuation. The implementation plan is focused to a large extent on the monitoring and, where necessary, enhanced implementation of Best Management Practices (BMPs) to reduce the erosion and transport to surface waters of fine sediment to which the organochlorine compounds tend to adhere. Many of these BMPs are already in place as the result of existing permits issued by the Regional Board or State Water Resources Control Board for stormwater and construction activities, and/or in response to established TMDLs. The intent is to

assure that source control activities are implemented to reduce any active sources of the organochlorine compounds, and in other areas where such actions will be most effective in meeting the TMDL goals. Monitoring and special study requirements are included to provide for TMDL compliance assessment and refinement.

In response to the recommendation by watershed stakeholders, this implementation plan provides an opportunity for dischargers to participate in the development and implementation of a comprehensive Work Plan. The implementation tasks identified in Table NB-OCs-13 (except Tasks 1 and 4; see discussion of Task 7, below) will be considered in the development of the Work Plan and incorporated, as appropriate. Implementation of the Work Plan, which will be approved by the Regional Board at a public hearing, will obviate the need for individual actions on the tasks in Table NB-OCs-13 by members of the Working Group. Completion of the Work Plan will result, in part, in recommendations for revisions to these TMDLs based on review by an Independent Advisory Panel and the results of ongoing or requisite monitoring and investigations, and in the development of a comprehensive plan for BMPs and other actions needed to assure compliance with the TMDLs, wasteload allocations and load allocations as soon as possible after completion or execution of the Work Plan but no later than December 31, 2015<sup>1</sup>. Dischargers who elect not to participate in the Work Plan approach will be required to implement the tasks shown in Table NB-OCs-13, as appropriate.

Each of the tasks identified in Table NB-OCs-13 is described below.

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<sup>1</sup> This compliance schedule and/or the organochlorine compounds TMDLs may be modified, through the Basin Planning process, in response to information provided by implementation of the Work Plan tasks and/or other investigations.

**Table NB-OCs-13. Organochlorine Compounds TMDLs Implementation Tasks and Schedule**

<b>Task</b>	<b>Description</b>	<b>Compliance Date – As Soon As Possible But No Later Than <sup>b</sup></b>
<b>PHASE I IMPLEMENTATION</b>		
1	Revise existing WDRs and NPDES permits: <i>Commercial Nursery WDRs, MS4 Permit, Other NPDES Permits</i>	Upon OAL approval of BPA and permit renewal
2 <sup>a</sup>	a. Develop proposed agricultural BMP and monitoring program to assess and control OCs discharges. b. Implement program	a. (3 months after OAL approval of BPA) b. Upon Regional Board approval
3 <sup>a</sup>	a. Identify responsible parties for open space areas b. Develop proposed monitoring program to assess OCs inputs from open space areas c. Implement proposed monitoring program d. Develop plan to implement effective erosion and sediment control BMPs for management of fine particulates (if found necessary based on monitoring results) e. Implement BMP plan	a. (1 month after OAL approval of BPA) b. 2 months after notification of responsible parties c. Upon Regional Board approval d. Within 6 months of notification of need to develop plan e. Upon Regional Board approval
4 <sup>a</sup>	Implement effective sediment and erosion control BMPs for management of fine particulates on construction sites: Regional Board: a. Develop SWPPP Improvement Program MS4 permittees: b. Revise planning processes as necessary to assure proper communication of SWPPP requirements c. Evaluate/implement BMPs effective in reducing/eliminating organochlorine discharges: i. Submit proposed plan and schedule for BMP studies and implement plan ii. Submit studies report; including plan and schedule to implement BMPs/include in Guidance Manual iii. Implement BMPs/include in Guidance Manual	a. (Upon OAL approval of BPA) b. Within 3 months of appropriate revision of the MS4 permit c. i. Submit plan within 3 months of 13267 letter issuance/MS4 permit revision and implement upon Executive Officer approval; ii. Within 6 months of completion of studies plan; iii. Upon Executive Officer approval
5 <sup>a</sup>	Evaluate sources of OCs; develop and implement BMPs accordingly: a. Submit proposed plan and schedule for source	a. Submit plan within 3 months of 13267 letter issuance/appropriate revision of the MS4 permit

	<ul style="list-style-type: none"> <li>area investigations</li> <li>b. Implement investigation plan</li> <li>c. Submit report of investigation findings and plan/schedule for implementation of BMPs</li> <li>d. Implement BMP plan</li> </ul>	<ul style="list-style-type: none"> <li>b. Upon Executive Officer approval</li> <li>c. Within 6 months of completion of investigation plan</li> <li>d. Upon Executive Officer approval</li> </ul>
6 <sup>a</sup>	Evaluate feasibility and mechanisms to fund future dredging operations within San Diego Creek, Upper and Lower Newport Bay	Submit feasibility/funding report within <i>(3 years after OAL approval of BPA)</i>
7	<ul style="list-style-type: none"> <li>Develop comprehensive Work Plan to meet TMDL implementation requirements, consistent with an adaptive management approach</li> <li>a. Convene Working Group</li> <li>b. Submit proposed Work Plan</li> <li>c. Implement Work Plan</li> <li>d. Complete execution of Work Plan</li> </ul>	<ul style="list-style-type: none"> <li>a. <i>(one month of OAL approval of BPA)</i></li> <li>b. <i>(3 months after OAL approval of BPA)</i></li> <li>c. Upon Regional Board approval</li> <li>d. Within 5 years of Work Plan approval</li> </ul>
8 <sup>a</sup>	Revise regional monitoring program	<i>(3 months after OAL approval of BPA), Annual Reports due November 5</i>
9	Conduct <b>special studies</b>	As funding allows, and in order of priority identified in comprehensive Work Plan (Task 7), if applicable
<b>PHASE II IMPLEMENTATION</b>		
10	Review TMDLs, including numerical targets, WLAs and LAs; delist or revise TMDLs pursuant to established Segment Quality Objectives, new data, and results of special studies	No later than <i>(5 years from OAL approval of BPA)</i>

- a. The tasks and schedules identified in the Regional Board approved Work Plan developed by the Working Group shall govern implementation activities by members of the Working Group.
- b. Final compliance with the TMDLs to be achieved no later than December 31, 2015.

**Table NB-OCs-14. Existing NPDES Permits and WDRs Regulating Discharges in the Newport Bay Watershed**

No.	Permit Title	Order No.	NPDES No.
1	Waste Discharge Requirements for the United States Department of the Navy, Former Marine Corps Air Station Tustin, Discharge to Peters Canyon Wash in the San Diego Creek/Newport Bay Watershed	R8-2006-0017	CA8000404
2	Waste Discharge Requirements for the County of Orange, Orange County Flood Control District and the Incorporated Cities of Orange County within the Santa Ana Region - Areawide Urban Storm Water Runoff - Orange County (MS4 permit)	R8-2002-0010	CAS618030
3	National Pollutant Discharge Elimination System (NPDES) Permit Statewide Storm Water Permit and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans)	99-06-DWQ	CAS000003
4	General Waste Discharge Requirements for Discharges to Surface Waters that Pose an Insignificant (de minimus) Threat to Water Quality	R8-2003-0061 as amended by R8-2005-0041 and R8-2006-0004	CAG998001
5	General Waste Discharge Requirements for Short-term Groundwater-Related Discharges and De Minimus Wastewater Discharges to Surface Waters Within the San Diego Creek/Newport Bay Watershed	R8-2004-0021	CAG998002
6	General Groundwater Cleanup Permit for Discharges to Surface Waters of Extracted and Treated Groundwater Resulting from the Cleanup of Groundwater Polluted by Petroleum Hydrocarbons, Solvents and/or Petroleum Hydrocarbons mixed with Leachate and/or Solvents	R8-2002-0007, as amended by R8-2003-0085 and R8-2005-0110	CAG918001
7	Waste Discharge Requirements for City of Tustin's 17th Street Desalter	R8-2002-0005	CA8000305
8	Waste Discharge Requirements for City of Irvine, Groundwater Dewatering Facilities, Irvine, Orange County,	R8-2005-0079	CA8000406
9	Waste Discharge Requirements for Bordiers Nursery, Inc.	R8-2003-0028	
10	Waste Discharge Requirements Hines Nurseries, Inc.	R8-2004-0060	
11	Waste Discharge Requirements for El Modena Gardens, Inc., Orange County	R8-2005-0009	
12	Waste Discharge Requirements for Nakase Bros. Wholesale Nursery, Orange County	R8-2005-0006	

## **Phase I Implementation**

### **Task 1: WDRs and NPDES Permits**

The Regional Board shall review and revise, as necessary, existing NPDES permits and/or WDRs to incorporate the appropriate TMDL WLAs, compliance schedules, and monitoring program requirements. These permits are identified in Table NB-OCs-14. The appropriate TMDL WLAs, compliance schedules and monitoring program requirements shall be included in new NPDES permits/WDRs. The NPDES permits/WDRs shall specify TMDL-related provisions that apply provided that: (1) the dischargers are and remain members of the Working Group (see Task 7); and (2) the approved Work Plan developed by the Working Group is implemented in a timely and effective manner. The NPDES permit/WDRs shall also include TMDL-related provisions that apply if the discharger(s) do not participate or discontinue participation in the Working Group and/or if the approved Work Plan is not implemented effectively or in a timely manner.

Compliance with the TMDLs and wasteload allocations is to be achieved as soon as possible, but no later than December 31, 2015. The way that this deadline applies to a particular discharger differs depending on whether the discharger is participating in the Working Group:

1. Working Group Participants. Provisions in NPDES permits/WDRs issued during implementation of the Work Plan will specify the following for Working Group members:

(a) Interim effluent limitations. Participation in the Working Group and timely and effective implementation of the Regional Board-approved Work Plan will constitute interim, performance-based effluent limitations to implement the wasteload allocations. Adhering to these interim effluent limitations satisfies the requirement, during the Work Plan implementation period, to achieve compliance with the TMDLs and wasteload allocations "as soon as possible."

(b) Final effluent limitations. Final effluent limitations based on the wasteload allocations will also be specified, with a schedule requiring compliance as soon as possible but no later than December 31, 2015.<sup>2</sup> Compliance with the interim, performance-based limitations will fulfill the "as soon as possible" requirement. The NPDES permits/WDRs will specify further that the status of compliance with the final effluent limitations based on the wasteload allocations will be reviewed on an annual basis. Compliance with these limitations will be required prior to the completion of the Work Plan tasks, in accordance with a schedule approved by the Regional Board's Executive Officer, if it is demonstrated to the satisfaction of the Executive Officer that such earlier compliance is reasonably feasible.

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<sup>2</sup> It is recognized that this schedule may exceed the five year terms of NPDES permits. This schedule will be reflected in subsequent renewals of these NPDES permits.

Following the completion of the Work Plan tasks, NPDES permits/WDRs will require dischargers to comply with wasteload allocations in the shortest practicable time, but in no event later than December 31, 2015.

2. Non-Working Group Dischargers. For dischargers not participating in the Working Group, NPDES permit/WDR provisions will require compliance with the wasteload allocations as soon as possible after adoption of NPDES permits/WDRs that implement the TMDLs, but no later than December 31, 2015. In this case, the determination of what constitutes "as soon as possible" will be at the discretion of the Regional Board's Executive Officer.

Completion of the Work Plan and/or other investigations conducted by the Regional Board or others may result in modification of the TMDLs, wasteload allocations and the compliance schedule through the Basin Planning process. Subsequent issuance/revision of NPDES permit/WDRs will implement any such changes.

Ultimate compliance with permit limitations based on wasteload allocations is expected to be based upon iterative implementation of effective BMPs to manage the discharge of fine sediments containing organochlorine compounds, along with monitoring to measure BMP effectiveness.

Permit revisions shall be accomplished as soon as possible upon approval of these TMDLs. Given Regional Board resource constraints and the need to consider other program priorities, permit revisions are likely to be tied to renewal schedules.

For commercial nurseries covered under existing WDRs, revisions of these WDRs shall address the following identified needs:

- (1) Evaluation of sites to determine/verify potential storm water and nonstorm water discharge locations;
- (2) Evaluation of current monitoring programs and methods of sampling and analysis for consistency with other monitoring efforts in the watershed;
- (3) In cooperation with U.C. Cooperative Extension, evaluation of BMPs for adequacy and implementation of the most effective BMPs to reduce/eliminate the discharge of potentially-contaminated fine sediments in both storm water and non-storm water discharges;
- (4) Monitoring to better quantify nursery runoff as a potential source of organochlorine compounds and to assure that load reductions are achieved; and
- (5) Based on the results of the preceding tasks, development of a workplan to be submitted within one month of the effective date of these TMDLs that identifies: (a) the BMPs implemented to date and their effectiveness in reducing fine sediment and organochlorine compound discharges; (b) the adequacy and consistency of monitoring efforts, and proposed improvements; (c) a plan and schedule for implementation of revised BMPs and monitoring protocols, where appropriate. It is recognized that

most nursery operations are likely to be of very limited duration due to the expiration of land leases. The workplan shall identify recommendations for BMP and monitoring improvements that are effective, reasonable and practicable, taking this consideration into account. This workplan shall be implemented upon approval by the Regional Board Executive Officer.

Revisions to the Municipal Separate Storm Sewer System (MS4) permit (R8-2002-0010, NPDES No. CAS618030), including the monitoring program shall address the monitoring and BMP-related tasks identified below, as appropriate. The Regional Board will coordinate also with the State Water Resources Control Board regarding revision of the Caltrans permit to address these monitoring and BMP-related tasks. These include: oversight and implementation of construction BMPs (Task 4); organochlorine compound source evaluations (Task 5); assessment of dredging feasibility and identification of a funding mechanism (Task 6); and, revision of the regional monitoring program (Task 8).

NPDES permits that regulate discharges of ground water to San Diego Creek or its tributaries shall be reviewed and revised as necessary to require annual (at a minimum) monitoring, using the most sensitive analytical techniques practicable, to analyze for organochlorine compounds in the discharges. If organochlorine compounds are found to be present, the dischargers shall be required to evaluate whether and to what extent the discharges would cause or contribute to an exceedance of wasteload allocations and to implement appropriate measures to reduce or eliminate organochlorine compounds in the discharges. New NPDES permits issued for these types of discharges shall incorporate the same requirements.

These dischargers (nurseries, MS4 permittees, Caltrans, ground water dischargers) may address the specific requirements identified above through their participation in the development and implementation of an appropriate, Regional Board approved Work Plan (see Task 7).

### **Task 2: Develop and Implement an Agricultural BMP and Monitoring Program**

Apart from certain nurseries, agricultural operations in the watershed are not currently regulated pursuant to waste discharge requirements. The SWRCB's "Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program" (Nonpoint Source Policy) (2004) requires that all nonpoint source dischargers be regulated under WDRs, waivers of WDRs, Basin Plan prohibitions, or some combination of these three administrative tools. Board staff is developing recommendations for an appropriate regulatory approach to address agricultural discharges. It is expected that the Regional Board will be asked to consider these recommendations and to approve a regulatory approach in late 2007. Appropriate load allocations to implement these TMDLs will be included in WDRs or a waiver of

WDRs, if and when issued by the Regional Board to address discharges from agricultural operations.

In the interim, agricultural operators shall identify and implement a monitoring program to assess OCs discharges from their facilities, and identify and implement a BMP program designed to reduce or eliminate those discharges. The proposed monitoring and BMP program shall be submitted as soon as possible but no later than *(3 months from OAL approval of this Basin Plan Amendment (BPA))*. These monitoring and BMP programs will be components of the waste discharge requirements or conditional waiver of waste discharge requirements that Board staff will recommend to implement the Nonpoint Source Policy. Load allocations identified in these TMDLs will also be specified in the WDRs/waiver, with a schedule of compliance.

It is recognized that most agricultural operations are expected to be of very limited duration due to the expiration of land leases. The monitoring and BMP programs proposed by the agricultural operators should include recommendations that are effective, reasonable and practicable, taking this consideration into account. The BMP and monitoring programs shall be implemented upon approval by the Regional Board. The BMP and monitoring programs may be implemented individually or by a group or groups of agricultural operators.

In addition, responsible parties may address these BMP/monitoring program requirements through their participation in the development and implementation of an appropriate, Regional Board approved Work Plan (see Task 7). WDRs or conditional waivers of WDRs issued to agricultural operators pursuant to the Nonpoint Source Policy shall specify that for those operators who participate in the development and implementation of a Regional Board approved Work Plan, compliance with the TMDLs and load allocations is to be achieved as soon as possible, but no later than December 31, 2015. The way that this deadline applies to a particular agricultural operator differs depending on whether the operator is participating in the Working Group:

1. Working Group Participants. Provisions in WDRs or conditional waivers of WDRs issued during implementation of the Work Plan will specify the following for Working Group members:

(a) Interim limitations: Participation in the Working Group and timely and effective implementation of the Regional Board-approved Work Plan will constitute interim, performance-based limitations to implement the load allocations. Adherence to these interim limitations satisfies the requirement, during the Work Plan implementation period, to achieve compliance with the TMDLs and load allocations "as soon as possible."

(b) Final limitations: Final limitations based on the load allocations will also be specified in the WDRs/waivers, with a schedule requiring compliance as soon as

possible but no later than December 31, 2015. Compliance with the interim, performance-based limitations will fulfill the "as soon as possible" requirement. The WDRs/waivers will specify further that the status of compliance with the final limitations based on the load allocations will be reviewed on an annual basis. Compliance with these limitations will be required prior to the completion of the Work Plan tasks, in accordance with a schedule approved by the Regional Board's Executive Officer, if it is demonstrated to the satisfaction of the Executive Officer that such earlier compliance is reasonably feasible.

Following the completion of the Work Plan tasks, WDRs/waivers will require agricultural operators to comply with load allocations in the shortest practicable time, but in no event later than December 31, 2015.

2. Non-Working Group Dischargers. For agricultural operators not participating in the Working Group, provisions in WDR/waivers of WDRs will require compliance with the load allocations as soon as possible after adoption of WDRs/waivers of WDRs that implement the TMDLs, but no later than December 31, 2015. In this case, the determination of what constitutes "as soon as possible" will be at the discretion of the Regional Board's Executive Officer.

Completion of the Work Plan and/or other investigations conducted by the Regional Board or others may result in modification of the TMDLs, load allocations and the compliance schedule through the Basin Planning process. Subsequent issuance/revision of WDRs/conditional waivers of WDRs will implement any such changes.

**Task 3: Identify Parties Responsible for Open Space Areas; Develop and Implement an OCs Monitoring Program to Assess Open Space Discharges; Develop and Implement an OCs BMP Program, if Necessary**

Nonpoint source discharges from open space are also subject to State regulation. During Phase I of these TMDLs, sufficient data shall be collected by the responsible parties to determine whether discharges of OCs from designated open space, as well as discharges resulting from erosion in and adjacent to unmodified streams, are causing or contributing to exceedances of water quality objectives and/or impairment of beneficial uses of San Diego Creek and Newport Bay. With the assistance of the stakeholders, Regional Board staff will identify the responsible parties as soon as possible but no later than *(one month from OAL approval of this BPA)*. Board staff will notify the identified responsible parties of their obligation to propose an organochlorine compound monitoring program within two months of notification. The monitoring program shall be implemented upon Regional Board approval.

Based on the results of this monitoring program, the responsible parties shall develop a BMP implementation plan within 6 months of notification by the Regional

Board's Executive Officer of the need to do so. The responsible parties shall implement that plan upon Regional Board approval.

The responsible parties may address these monitoring and BMP implementation program requirements through their participation in the development and implementation of an appropriate, Regional Board approved Work Plan (see Task 7).

The Regional Board will consider whether WDRs or a WDR waiver is necessary and appropriate for responsible parties not currently regulated, based on the monitoring results. WDRs or a WDR waiver, if issued, will include appropriate load allocations to implement these TMDLs. For responsible parties compliance with the TMDLs and load allocations is to be achieved as soon as possible, but no later than December 31, 2015. The way that this deadline applies to a particular responsible party differs depending on whether that responsible party is participating in the Working Group:

1. Working Group Participants. Provisions in WDRs or conditional waivers of WDRs issued during implementation of the Work Plan will specify the following for Working Group members:

(a) Interim limitations: Participation in the Working Group and timely and effective implementation of the Regional Board-approved Work Plan will constitute interim, performance-based limitations to implement the load allocations. Adherence to the interim, performance-based limitations satisfies the requirement, during the Work Plan implementation period, to achieve compliance with the TMDLs and load allocations "as soon as possible."

(b) Final limitations: Final limitations based on the load allocations will also be specified in the WDRs/waivers, with a schedule requiring compliance as soon as possible but no later than December 31, 2015. Compliance with the interim, performance-based limitations will fulfill the "as soon as possible" requirement. The WDRs/waivers will specify further that the status of compliance with the final limitations based on the load allocations will be reviewed on an annual basis. Compliance with the final limitations will be required prior to the completion of the Work Plan tasks, in accordance with a schedule approved by the Regional Board's Executive Officer, if it is demonstrated to the satisfaction of the Executive Officer that such earlier compliance is reasonably feasible.

Following the completion of the Work Plan tasks, WDRs/waivers will require responsible parties to comply with load allocations in the shortest practicable time, but in no event later than December 31, 2015.

2. Non-Working Group Dischargers. For responsible parties not participating in the Working Group, compliance with the load allocations will be as soon as possible after TMDLs adoption and approval, but no later than December 31, 2015. In this

case, the determination of what constitutes "as soon as possible" will be at the discretion of the Regional Board's Executive Officer.

Completion of the Work Plan and/or other investigations conducted by the Regional Board or others may result in modification of the TMDLs, load allocations and the compliance schedule through the Basin Planning process. Subsequent issuance/revision of WDRs/conditional waivers of WDRs will implement any such changes.

#### **Task 4: Develop and Implement Appropriate BMPs for Construction Activities**

Currently, all construction activities in the watershed are regulated under the State Water Resource Control Board's (SWRCB) General Permit for Discharge of Storm Water Runoff Associated with Construction Activity (Order No. 99-08-DWQ, NPDES No. CAS000002; the "General Construction Permit"), SWRCB National Pollutant Discharge Elimination System (NPDES) Permit, Statewide Storm Water Permit and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans) (Order No. 99-06-DWC, NPDES No. CAS000003; the Caltrans MS4 permit), and/or the Orange County MS4 NPDES permit. The requirements of these permits and an iterative, adaptive management BMP approach, coupled with monitoring, are the foundation for meeting the TMDL WLAs for construction. The General Construction Permit, and the Orange County and Caltrans MS4 permits are expected to be revised over time. The specific tasks identified below may be addressed by revisions to one or more of these permits. In that case, the Regional Board will integrate requirements for implementation of this Task with the requirements of the Orange County and Caltrans MS4/General Construction permits so as to prevent conflict and/or duplication of effort.

To assure that effective construction BMPs are identified and implemented, program improvements are needed in the following areas: (a) Storm Water Pollution Prevention Plans (SWPPPs) prepared in response to the General Construction Permit must include supporting documentation and assumptions for selection of sediment and erosion control BMPs, and must state why the selected BMPs will meet the Construction WLAs for the organochlorine compounds; (b) SWPPP provisions must be rigorously implemented on construction sites; (c) sampling and analysis for the organochlorine pesticides and PCBs in storm and nonstorm discharges containing sediment from construction sites is necessary to determine the efficacy of BMPs, as well as compliance with the construction WLAs; sampling and analysis plans must be included in SWPPPs; (d) additional BMPs, including enhanced BMPs, must be evaluated to determine those that may be appropriate for reducing or eliminating organochlorine compound discharges from construction sites (e.g., BMPs effective in control of fine particulates) without significant adverse environmental effects (e.g., toxicity that might result from improper storage and/or application of polymers); (e) outreach is necessary to assure the effective implementation of these SWPPP requirements; and (e) enforcement of the SWPPP requirements is necessary.

To address these program improvements, Regional Board staff shall develop a SWPPP Improvement Program that identifies the Regional Board's expectations with respect to the content of SWPPPs, including documentation regarding the selection and implementation of BMPs, and a sampling and analysis plan. The Improvement Program shall include specific guidance regarding the development and implementation of monitoring plans, including the constituents to be monitored, sampling frequency and analytical protocols. The SWPPP Improvement Program shall be completed by *(the date of OAL approval of this BPA)*. No later than two months from completion of the Improvement Program, Board staff shall assure that the requirements of the Program are communicated to interested parties, including dischargers with existing authorizations under the General Construction Permit. Existing, authorized dischargers shall revise their project SWPPPs as needed to address the Program requirements as soon as possible but no later than *(three months of completion of the SWPPP Improvement Program)*. Applicable SWPPPs that do not adequately address the Program requirements shall be considered inadequate and enforcement by the Regional Board shall proceed accordingly. The Caltrans and Orange County MS4 permits shall be revised as needed to assure that the permittees communicate the Regional Board's SWPPP expectations, based on the SWPPP Improvement Program, with the Standard Conditions of Approval.

The MS4 permittees shall conduct studies to evaluate BMPs that are most appropriate for reducing or eliminating organochlorine compound discharges from construction sites (e.g., fine particulates), including advanced treatment BMPs. The evaluation shall consider the potential for adverse environmental effects associated with implementation of each of the BMPs identified. MS4 Permittees shall include these BMPs in the Orange County Stormwater Program Construction Runoff Guidance Manual and the Caltrans Storm Water Management Plan (SWMP). Implementation of these MS4 permittee requirements shall commence upon issuance of appropriate Water Code Section 13267 letters or renewal of the MS4 permits, whichever occurs first. The Section 13267 letters/revised permits shall require the permittees to: (a) submit a proposed plan and schedule for studies to evaluate appropriate BMPs, as described above, within three months of issuance of the 13267 letter or permit revision; (b) implement the plan and schedule upon approval by the Regional Board's Executive Officer; (c) submit a report of the BMP investigations within 6 months of approval of the study plan, provided that sufficient storms, as defined in the study plan, have occurred within that period. If the number of storms does not conform to the study plan, then the report shall be submitted in accordance with a schedule approved by the Executive Officer once the requisite number of storms has occurred. The report shall include a proposed plan and schedule for implementation of the BMPs, as appropriate, and inclusion of the BMPs in the Orange County Guidance Manual and in the Caltrans SWMP and related guidance documents; (d) implement the BMP plan upon approval by the Executive Officer.

The MS4 permittees may address these SWPPP and construction site BMP-related requirements through their participation in the development and implementation of an appropriate, Regional Board approved Work Plan (see Task 7).

**Task 5: Evaluate Sources of OCs to San Diego Creek and Newport Bay; Identify and Implement Effective BMPs to Reduce/Eliminate Sources**

Based on the regional monitoring program being implemented by the Orange County MS4 permittees and/or on the results of other monitoring and investigations, all MS4 permittees shall conduct source analyses in areas tributary to the MS4 system demonstrating elevated concentrations of OCs. Based on mass emissions monitoring (described below) and source analysis, the permittees shall implement additional/enhanced BMPs as necessary to ensure that organochlorine discharges from significant land use sources to surface waters are reduced or eliminated. As part of the investigation task, if the results indicate that additional OCs soil remediation is necessary on MCAS Tustin and MCAS El Toro, the responsible parties for such remediation will be identified. The responsible party will be tasked to implement those portions of the BMP plan identified for the responsible party for MCAS Tustin and MCAS El Toro.

The permittees shall develop and implement a collection program for all banned OC pesticides and PCBs. This type of program has had demonstrated success in other geographic areas in collecting and disposing of banned pesticides. Residents and businesses in the watershed may have stored legacy pesticides that could be collected through such a program; if this is the case, this task would prevent future use and improper disposal of these banned pesticides.

Implementation of these requirements shall commence upon issuance of appropriate Water Code Section 13267 letters of approval of an appropriately revised MS4 permits, whichever occurs first. Revisions to the Orange County MS4 permit and Caltrans SWMP shall implement requirements specified in applicable Section 13267 letters, if used to implement TMDL-related requirements. The 13267 letters/revised permit shall specify require the permittees to: (a) submit a proposed plan and schedule for source analyses of MS4 tributary areas with elevated OCs concentrations within 3 months of issuance of the 13267 letters or permit revision; (b) implement the proposed plan upon approval by the Regional Board's Executive Officer; (c) submit a report within 6 months of completion of the approved study plan. The report shall provide the study results and include a proposed plan and schedule for prioritized implementation of BMPs in OCs source areas; (d) implement the BMP plan upon Executive Officer approval.

The permittees may address these requirements through their participation in the development and implementation of an appropriate, Regional Board approved Work Plan (Task 7).

**Task 6: Evaluate Feasibility and Mechanisms to Fund Future Dredging Operations**

Because large-scale erosion and sedimentation primarily occurs during large storm events, traditional BMPs may have limited success in reducing/eliminating the discharge of potentially-contaminated sediments to receiving waters during wet weather. In such cases, dredging within Newport Bay and/or San Diego Creek may be the most feasible and appropriate method of reducing OCs loads in these waters. However, the feasibility and effectiveness of dredging projects in removing OCs would require careful consideration, since dredging may or may not expose sediments with higher concentrations of OCs. Financing of such projects is also a significant consideration.

Entities discharging potentially contaminated sediment in the watershed shall analyze the feasibility of dredging to achieve water quality standards, and shall identify funding mechanisms for ensuring that future dredging operations can be performed, as necessary, within San Diego Creek, Upper and Lower Newport Bay. A report that presents the results of this effort shall be submitted no later than (*three years from the date of OAL approval of this BPA*). It is recognized that dredging activities are likely to be an integral part of efforts to comply with other established TMDLs, particularly the sediment TMDL. Ideally, dredging feasibility and funding investigations would be integrated with implementation and review of the sediment TMDL through the comprehensive Work Plan (Task 7). The responsible parties may address this Task requirement through their participation in the development and implementation of an appropriate Regional Board approved Work Plan.

**Task 7: Develop a Comprehensive Work Plan to Meet TMDL Implementation Requirements, Consistent with the Adaptive Management Approach**

During the development of these organochlorine compounds TMDLs, regulated stakeholders in the Newport Bay watershed expressed concerns that the numeric targets used to develop the TMDLs, wasteload allocations and load allocations were flawed and that scientific review by an independent panel of experts was necessary. Further, these stakeholders suggested that pollutants other than the organochlorine compounds, such as metals, pyrethrins or other, emerging pollutants may pose the more real or significant threat to beneficial uses in the watershed. Finally, it was recommended that an integrated approach to TMDL implementation, and to the development of pending TMDLs and refinement of established TMDLs, would be a more effective and efficient approach.

Substantial efforts are already being made by many stakeholders in the watershed to address established permit and/or TMDL requirements for BMP implementation and monitoring and to conduct special investigations to understand and improve water quality conditions in the watershed. Thus, the framework exists to develop a

comprehensive watershed plan for addressing water quality, not only as it relates to the organochlorine compounds, but on a larger scale that encompasses all sources of water quality impairment.

This implementation plan provides the opportunity for regulated stakeholders to form a Working Group and to participate in the development and implementation of a comprehensive Work Plan to evaluate the scientific basis of these organochlorine TMDLs, to prioritize TMDL implementation tasks, to integrate implementation with other TMDL and/or permit requirements, and to investigate unknown sources of toxicity in the watershed. As noted in the previous Task descriptions, participation by responsible parties in the Working Group and the development and implementation of a Regional Board Work Plan would address the responsible parties' obligations pursuant to the Tasks in Table NB-OCs-13. Dischargers who elect not to participate in the Working Group/Work Plan will be required to implement these Tasks, as described above.

Dischargers interested in participating in a Working Group to develop and implement a comprehensive Work Plan must commit to do so by *(within one month of OAL approval of the BPA)*. Submittal of a draft Work Plan is required no later than *(three months of OAL approval of the BPA)*. The schedules for implementation of the tasks identified in the Work Plan must reflect the shortest practicable time necessary to complete the tasks. Implementation of the Work Plan will commence upon approval of the Work Plan by the Regional Board at a properly noticed public hearing. Execution of the Work Plan must be complete within five years of Regional Board approval. Substantive changes to the tasks and schedules included in the approved Work Plan are contingent on Regional Board approval at a subsequent, properly noticed public hearing(s). However, the Regional Board's Executive Officer is authorized to revise the approved tasks and schedules if no significant comments are received during the public notice period.

At a minimum, the expected result of the execution of the Work Plan is a comprehensive, watershed plan for BMP implementation, monitoring, special investigations and other actions that will assure compliance with the OCs TMDLs, as they may be amended, as soon as possible after completion of execution of the Work Plan but no later than December 31, 2015<sup>3</sup>.

The specific detailed Work Plan tasks and schedules will be determined as the Work Plan is developed. Regional Board staff will work with the Working Group to identify a suitable Work Plan. Key initial tasks are expected to include the following:

1. Convene an Independent Advisory Panel (IAP) of experts with relevant expertise. To avoid questions of objectivity, the panel shall be convened by a neutral third party organization such as the National Water Research Institute. The Working Group and Regional Board staff will work together to define the desired qualifications needed for IAP participants, define the scope and

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<sup>3</sup> This compliance date is subject to change through the Basin Planning process.

authority of the IAP, and identify and describe the primary issues that will require guidance, recommendations, or specific actions from the IAP.

## 2. Re-evaluate OCs TMDLs Numeric Targets and Loads

With input and recommendations from the IAP, and using data being generated through ongoing scientific investigations in the watershed, the Work Plan should assess the current OCs TMDLs numeric targets, evaluate potential alternative numeric targets, and determine if the current targets should be revised, or whether targets based on site-specific data can be developed. If site-specific targets can be developed, the process or methods that will be used to develop targets should be determined, such as risk assessments or re-calculation of targets using accepted, peer-reviewed scientific methodologies.

It is recognized that there is a need for flexibility to respond to unanticipated findings and events, and to changes that may be recommended by the Independent Advisory Panel (see below). However, at a minimum, each of the tasks identified in Table NB-OCs-13 (except Task 1, which requires action by the Regional Board, and Task 4, which requires action by the Regional Board and the MS4 permittees based on established MS4 permit requirements) must be considered in Work Plan development and implementation. If one or more of these tasks is not proposed for inclusion in the Work Plan, or where modifications of these tasks/schedules are recommended, a written description and justification must be provided with the draft Work Plan submittal. In addition, consideration shall be given to the following:

### Develop conceptual models

Data interpretation and monitoring must be organized around a systematic conceptual view of the sources of the different organochlorine compounds and their distribution and behavior in the watershed. Development of conceptual models for these compounds would significantly enhance our understanding of their sources and impacts and would help to structure hypothesis development, monitoring design, and data interpretation. Development of the conceptual models should be based on a review of available data and information about the OCs in the watershed, and the models should be updated as new information accumulates. Characterization of sources and of habitats at risk should be based on a review of available data, framed in terms of the conceptual models and supported with the collection of new data as needed. It is expected that the IAP would provide critical review and recommendations in this process.

### Develop Information Management System

Different types of data – water column, sediment, fish or bird egg tissue, infaunal surveys, hydrology, etc. – are being or will be collected throughout

the Newport Bay watershed through a variety of studies, monitoring programs, or other projects. Since these data are often collected for different purposes (e.g., in response to various TMDLs and/or permits), at different times and in different areas, much of the data may be in non-comparable formats, redundant, or not spatially or temporally compatible. In order to determine what data are useful or significant, where data gaps may still occur, or where current data needs are sufficient, a comprehensive information management system should be developed that (1) establishes clear procedures for assessing data quality for data acquisition and transfer and for control of evolving versions of datasets; (2) is a relational database that can manage the variety of data types and has appropriate mechanisms for ensuring and maintaining data quality; (3) can conduct quality control checks and needed reformatting to ensure needed consistency across all data types and sources as data from other sources are obtained; (4) provides for straightforward query and data sub-setting routines to streamline access to the data; and (5) ensures that GIS capability is available for analysis, modeling, and presentation purposes. Development of a comprehensive information management system will allow for the identification of significant data gaps that need to be addressed and will provide a vehicle for establishing monitoring guidelines and preventing redundant or superfluous data collection.

To the extent that there are any conflicts between the individual tasks and schedules identified in Table NB-OCs-13, and the prioritized plan and schedule identified in the Work Plan, the Work Plan would govern implementation activities with respect to the stakeholders responsible for Work Plan development and implementation as part of the Working Group.

#### **Task 8: Revise Regional Monitoring Program**

The County of Orange, as Principal Permittee under the County's MS4 permit, oversees the countywide monitoring program. Implementation of the monitoring program is supported by funds shared proportionally by each of the Permittees named in the Orange County MS4 permit. Some monitoring requirements identified in this implementation plan are already reflected in the current program.

By (3 months from OAL approval of BPA), the Orange County MS4 permittees shall: (1) document each of the current monitoring program elements that addresses the monitoring requirements identified in the preceding tasks; and, (2) revise the monitoring program as necessary to assure compliance with these monitoring requirements.

Review of/revisions to the monitoring program shall address:

- (1) Estimation of mass emissions of chlordane, DDT, PCBs and toxaphene.

- (2) Determination of compliance with MS4 wasteload allocations for Upper and Lower Newport Bay, and of status of achievement with the informational wasteload allocations for San Diego Creek for chlordane and PCBs.
- (3) Assessment of temporal and spatial trends in organochlorine compound concentrations in water, sediment and tissue samples.
- (4) Semi-annual sediment monitoring in San Diego Creek and Newport Bay. Measurements of sediment chemistry in these waters should be evaluated with respect to evidence of biological effects, such as toxicity and benthic community degradation.
- (5) Evaluation of organochlorine bioaccumulation and food web biomagnification
- (6) Assessment of the degree to which natural attenuation is occurring in the watershed.

Accurately quantifying the very small mass loads that are allowable under these TMDLs will be very challenging; analytical strategies for quantifying loads of the organochlorine compounds must be carefully explored.

Revisions to the monitoring program shall take into consideration the following recommendations provided by members of the Organochlorine Compounds TMDL Technical Advisory Committee (TAC):

- (1) The analytical parameters measured need to be established for each matrix of interest (e.g., sediment, tissue, ambient water). The representative list of compounds to be measured needs to be identified (e.g., what chlordane compounds will be measured and summed to represent "total chlordane;" will PCB congeners be measured and summed or will Aroclors).
- (2) Data quality will need to be consistent with the State's Surface Water Ambient Monitoring Program (SWAMP). Detection limits, accuracy and precision of analytical methods should be adequate to assure the goals of the monitoring efforts can be achieved.
- (3) Bioaccumulation/biomagnification in high trophic level predators may not immediately respond to load reductions; appropriate time scales and schedules for monitoring that are supported by empirical data and/or modeling should be established.
- (4) Sentinel fish and wildlife species should be selected for monitoring based on home range, life history, size and age.

MS4 permittees may address the requirements specified herein by participation in the Working Group and development and implementation of an appropriate, Regional Board approved Work Plan (see Task 7).

**Task 9: Conduct Special Studies**

The following special studies should be conducted, in addition to the studies already underway in the watershed. This list is based, in part, on recommendations of the technical advisory committee for the organochlorine compounds TMDLs. These studies will be implemented as resources become available, and the results will be used to review and revise these TMDLs. Stakeholder contributions to these investigations are encouraged and would facilitate review of the TMDLs.

- (1) Evaluation of sediment toxicity in San Diego Creek and tributaries, and Upper and Lower Newport Bay.

Previous studies have included Toxicity Identification Evaluations (TIEs) that have yielded inconclusive results as to the cause of toxicity in Newport Bay. Sediment toxicity within San Diego Creek is not well-documented or well-understood. There is evidence that pyrethroid compounds may be a significant contributor. In determining the extent to which nonpolar organic compounds are causing or contributing to sediment toxicity, the differential contribution of both the organochlorine compounds and pyrethroids should be determined to assure that control actions are properly identified and implemented. Monitoring should be performed year-round at multiple locations within San Diego Creek and Newport Bay (to encompass spatial and temporal variability), and should include various land use types in order to quantify the relative contributions from various sources.

- (2) Refinement of sediment and tissue targets.

A study is being conducted by the San Francisco Estuary Institute to develop indicators and a framework for assessing the indirect effects of sediment contaminants. The objective is to provide methodology that will assist in evaluating indirect adverse biological effects for bioaccumulative pollutants (e.g. due to food web biomagnification), as part of the overall goal of developing statewide sediment quality objectives. Newport Bay is being used as a case study to show how the proposed methodology could be implemented on a screening level. Multiple lines of evidence will be evaluated to determine impacts of organochlorine pesticides and PCBs to humans and wildlife. A conceptual foodweb model will be developed, and sensitive wildlife receptors will be identified. Empirical field data and a steady-state food web model will be used to calculate bioaccumulation factors for the organochlorine compounds. The bioaccumulation factors will be combined with effects thresholds to identify sediment concentrations that are protective of target wildlife and humans.

Once completed by SFEI, a thorough evaluation of the Newport Bay case study needs to be initiated, and any additional analyses required for a more in-depth risk analysis should be identified and completed. Protective sediment and tissue targets for indirect effects to humans and wildlife should be developed by the time the TMDLs are re-opened. Furthermore, once TIEs have identified the likely toxicant(s)

responsible for sediment toxicity in San Diego Creek and Newport Bay (direct effects), field and laboratory studies should be conducted in order to determine bioavailability and the dose-response relationship between sediment concentrations and biologic effects.

- (3) Evaluation of regional BMPs (e.g., constructed wetlands and sediment detention basins) for mitigating potential adverse water quality impacts of sediment-associated pollutants (e.g., OCs, pyrethroids).

Large-scale, centralized BMPs such as constructed wetlands and storm water retention basins may be more effective than project-level BMPs in reducing adverse environmental impacts of sediment-borne pollutants. Regional BMPs are either being planned or are in place within the watershed (e.g., IRWD NTS). Their potential effectiveness for capturing the organochlorine compounds and mitigating impacts needs to be evaluated.

- (4) Improvement in linkage between toxaphene measured in fish tissue and toxaphene in bed sediments.

The toxaphene impairment listing for San Diego Creek is based on fish tissue exceedances that have no measured linkage with toxaphene in sediments. While sediment is the primary TMDL target for these TMDLs, toxaphene is usually not detected in sediment. Because of its chemical complexity, there is a large degree of analytical uncertainty with measurements of toxaphene in environmental samples that use standard methods (e.g., EPA Method 8081a), especially at low levels. Confirmations of toxaphene in fish and sediment samples in San Diego Creek (and possibly Newport Bay) using other techniques (e.g., GC-ECNI-MS or MS/MS) is recommended.

- (5) Evaluation of relative importance of continuing OCs discharges to receiving waters through erosion and sedimentation processes, versus recirculation of existing contaminated bed sediments, in causing beneficial use impairment in San Diego Creek and Newport Bay.

This study should allow for determination of the most effective implementation strategies to reduce organochlorine compounds in the MS4 and other receiving waters.

## **Phase II Implementation**

### **Task 10: TMDL Reopener**

These TMDLs will be reopened no later than *(five (5) years following OAL approval of this BPA)* in order to evaluate the effectiveness of Phase I implementation. At that time, all new data will be evaluated and used to reassess impairment, BMP

effectiveness, and whether modifications to the TMDLs are warranted. If BMPs implemented during Phase I have been shown to be ineffective in reducing levels of organochlorine compounds, then more stringent BMPs may be necessary during Phase II implementation.

Implementation of these TMDLs and the schedule for implementation are very closely tied with other TMDLs that are currently being implemented in the watershed. The sediment TMDL allowable load for San Diego Creek was the basis for calculating organochlorine compound loading capacities. The sediment TMDL is scheduled for revision in 2007; changes to the sediment TMDLs will likely necessitate changes to these organochlorine compounds TMDLs as well.

Draft

SALESMEN'S MANUAL

AROCLOR

DESCRIPTION AND PROPERTIES

The Aroclors are a series of chlorinated hydrocarbons based on biphenyl and terphenyl. They are not pure compounds but are mixtures of closely related chlorine substitution products manufactured essentially to a set of specifications based on physical properties rather than chemical composition.

The approximate chlorine content is indicated by the last two figures of the Aroclor number. The chemical composition closely approaches the average for the indicated chloro-derivatives as follows, but should not be represented as simple chemical compositions according to the formula shown:

Approximate Equivalent Chemical Compound

1219+1	Monochlorobiphenyl
1232	Dichlorobiphenyl
1242	Trichlorobiphenyl
1248	Tetrachlorobiphenyl
1254	Pentachlorobiphenyl
1260	Hexachlorobiphenyl
1262	Heptachlorobiphenyl
1268	Nonachlorobiphenyl
1271	Decachlorobiphenyl
5460	Nonachloroterphenyl

Reference should be made to technical bulletin P-115 for tables and graphs of physical properties. This manual contains only that information which is not designed for general public distribution or has been made more recently available than permitted incorporation in the printed bulletin.

The following Aroclors not in commercial production (but available) have been proposed:

Aroclor No.	5448	5454
Fixed Chlorine	47.9%	54.83%
Color (Lovibond)	6.0	20.0
Four Point	60°0	81°0
Softening Point	63°0	85°0



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10-1-44

Aroclor No.	5448	5454
Viscosity 98.9°C (210°F)	395.0*	-
Flash Point	250°C	-
Burn Point	400°C	-
Chlorides	None	None
Acidity - mg. KOH/g.	0.008	0.004
Evaporation	0.006	0.007
Resistivity	--	--
Ageing	--	--
Dielectric Constant	4.65	4.17

\*SUS

ELECTRICAL PROPERTIES

	<i>4.65</i> Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 5442
*Dielectric Constant @ 100°C	4.63	4.15-4.35	3.6-3.8	4.92
**Resistivity @ 100°C. OHMS/cm <sup>3</sup>	500x10 <sup>9</sup>	Above 500x10 <sup>9</sup>	Above 500x10 <sup>9</sup>	1469x10 <sup>9</sup>
***Dielectric Strength		36 KV Min.		
Power Factor (100°C, 1000 ks)	Less than 0.1%			Less than 0.1%

- \* IRS Method H-3955871
- \*\* Resistivity @ 100° under 500 Volts DC
- \*\*\* ASTM D-177-11

<u>Refractive Index</u>	<u>Range</u>	<u>Midpoint</u>
Aroclor 1270	1.691-1.74	1.712
Aroclor 1271	1.691-1.74	1.712
Tetradecachlorometaterphenyl	1.712-1.718	--
Tetradecachloroperaterphenyl	1.691-1.74	1.712

<u>Heat of Vaporisation</u>	<u>B.I.U./lb.</u>
Aroclor 1260 (3 mm. pressure)	104
Aroclor 1262 (760 mm. pressure)	72.4
Aroclor 1169 (0.151 atm. @ 350°C)	69.2
(0.079 atm. @ 325°C)	70.6

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10-1-44

SOLUBILITY

<u>Solvent</u>	<u>Aroclor 1268</u>	
	<u>Cold</u>	<u>Hot</u>
Acetone	I	I
Alcohol, Formula J-A	I	I
Amyl Acetate	S	S
Amyl Alcohol	FS	S
Benzene	S	S
Butyl Acetate	S	S
N. Butyl Alcohol	I	FS
Carbitol	I	S
Carbon Disulfide	S	S
Cellosolve <i>Carbon tetrachloride</i>	I	S 70°C
Chloroform	S	S
Di Butyl Phthalate	S	S
Ether	S	S
Ethyl Acetate	FS	FS
Ethyl Lactate	I	S
Ethylene Dichloride	S	S
40% Formaldehyde	I	I
Furfural	FS	FS
High Test Gasoline		
Glycerin	I	I
Kerosene	FS	S
Linseed Oil	I	S
Methyl Acetate	FS	FS
Mineral Spirits	FS	S 110°C
Paraffin		
Phenol 90%	FS	S
Pine Oil	S	S
Pyridine	S	S
Toluene	S	S
Tri Cresyl Phosphate	S	S
Tung Oil	I	S
Turpentine	FS	S 120°C
Xylene	FS	S 120°C

I = Insoluble  
 FS = Partially Soluble  
 S = Soluble

<u>Solvent</u>	<u>Gms. Aroclor 1270 per 100 cc. Solvent</u>	<u>Approx. Temp. at which soln. complete</u>
Furfural	2.0	105-110°C
Furfural	4.0	120-125°C
Secondary Amyl Acetate	4.0	110-115°C
Secondary Amyl Alcohols	4.0	Not completely soluble at boil
Carbitol	4.0	Above 125°C
Heavy White Mineral Oil	4.0	110-115°C

MONS 092645

STABILITYToward Heat

Aroclor 1248 was heated to 650°F in stainless steel autoclave with the resulting changes indicated in the following tabulation:

	Time of Heating (Hours)	Temperature	Acidity mg. NaOH/gm. Aroclor 1248
Original Sample	0	--	.0021
Autoclave #1	331	34300. 6500F.	.0392
Autoclave #2	500	34300. 6500F.	.0809
Autoclave #3	669	34300. 6500F.	.0800

These results are interpreted as indicating very excellent stability for Aroclors under the conditions of test.

Toward Oxidation

When Aroclor 1254 is heated for 50 or 60 days at 1500C in the presence of oxygen and copper, there is likely to be some attack on the copper. Examination of Aroclor 1254 after that period of time will usually show the presence of soluble copper. This also occurs with mineral oil and other insulating liquids.

In general, even after severe oxidation conditions no evidence of chlorine splitting from the parent hydrocarbon has been found.

Toward Acids

Aroclors 1242 and 1254 were stirred with an equal volume of concentrated Sulfuric Acid (98%), dilute Sulfuric Acid (10%), Nitric Acid (70%), and dilute Nitric Acid (5%), at room temperature (2500) for 150-250 hours. The Aroclor was then washed until neutral, dehydrated with Sodium Sulfate, then analyzed in comparison with a control sample for the various properties which are regularly considered, without causing these properties to depart from specification limits.

Aroclor 1262 was treated for 160 hours suspended in the same acids as above at 50 to 5500. The concentrated Nitric Acid caused an increase in color, otherwise no significant change in characteristics.

The acid layer from the treatment of Aroclor 1254 was concentrated Sulfuric Acid at room temperature for 150 hours and was tested for chloride content. The quantity of HCl found was so small that it was not possible by ordinary methods to obtain a quantitative figure. Thus it appears that practically no hydrogen chloride is evolved under these conditions.

CORROSION

Additional corrosion data not included in bulletin P-115 (Pl 4-43-R) is as follows:

<u>Metal</u>	<u>Temperature</u>	<u>Time of Exposure</u>	<u>Penetration in/yr.</u>
Monel	342°C	360 hrs.	.008
Dow Metal	150°C	40 days	.001
Yellow Brass	325°C	2,960 hrs. in steel bomb	.003
Al alloy 178T	120°C	21	.00035*
Al alloy 525H	120°C	21	.00035*
Al alloy 538T	120°C	21	.00038*

\*The weight loss occurred in the first seven days of the test. Negligible loss was encountered in the last 14 days.

The vapor condenser and the product receiver of the plant distillation unit for producing Aroclor 1254 is constructed of Monel and no failure in the system nor any noticeable reaction between the Aroclor and the Monel has been discovered after three years of operation.

SOLUBILITY OF WATER IN AROCLOR 1242

The water content of a sample of Aroclor 1242 saturated with water at approximately 30°C was determined, using the Karl Fischer reagent, to be about 0.00%.

Aroclor 1242, as regularly produced, contains by the same test less than 0.001% water.

SURFACE TENSION

The surface tension of Aroclor 1254 is as follows:

<u>Temperature</u>	<u>Dynes per Centimeter</u>
25°C	50.3
80°C	44.0
100°C	42.0

TOXICITY

All chlorinated hydrocarbons have measurable degrees of toxicity to the animal organism. Aroclors are no exception. The symptoms of Aroclor poisoning are:

1. Pore acne (chlor-acne) nodular eruptions of the hair follicles or sebaceous glands as a result of insufficient cleansing of the skin.

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2. Acute yellow atrophy of the liver in which the liver cells show swelling, hypergranulation, hyaline inclusions and vacuolation as a result of extensive exposure over long periods of time.

These symptoms may also result from exposure to other chlorinated hydrocarbons of commerce, such as: carbon tetrachloride, dichloroethylene, trichloroethylene, chlorinated naphthalene (Halowax). The best known (at present) measure of the degree of toxicity of the Aroclors is presented below:

Permissible Limits (in mg./cu.m.) of Concentration in Air of Work Rooms: (Journal of Industrial Hygiene & Toxicology 21: 155, 1939)

Tested on Rats by Inhalation

	Chlorine Content %	Permissible Limit mg./cu.m.
Aroclor 1268	68	10.0
Aroclor 4465	65	0.5 *
Aroclor 5460	60	0.5
Aroclor 1254	54	0.5
Trichloronaphthalene plus trace Tetrachloronaphthalene	49.9	10.0 *
Tetra and Pentachloronaphthalenes	56.4	1.0 *
Penta and Hexachloronaphthalenes	62.6	0.5 *
Tetra and Pentachloronaphthalenes plus Refined Chlorinated Diphenyl	45.5	0.5 *
5% Penta and Hexachloronaphthalenes / Aroclor 4465	63.0	0.5 *
Chlorinated Diphenyl Oxide	54.0	0.5
Chlorinated Diphenyl Oxide	57.0	0.5
Hexachlor Diphenyl Oxide / 5% Trichloronaphthalene	50-55	0.5
Hexachloronaphthalene and Crude Chlorinated Diphenyl	--	0.5
Special Chlorinated Naphthalene	50-56	0.5

\*Tested also by feeding.

Summary of Gross Feeding Experiments

Of the various materials fed rats in large doses, Trichloronaphthalene plus traces of Tetrachloronaphthalene was quite innocuous. Tetra and Pentachloronaphthalene showed definite liver damage. Penta and Hexachloronaphthalenes caused a similar grade of injury. The addition of chlorinated diphenyl to Penta and Hexachloronaphthalenes increased the toxicity. Chlorinated Diphenyl alone produced liver lesions but in the dosage used was less effective than when mixed with highly chlorinated naphthalenes. In no case did the compounds

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used produce acute yellow atrophy but the lesions observed indicate this might be possible if one found a dosage which could act for the proper period of time.

Feeding Precise Doses by Stomach Tube: The compounds employed were suspended in gum acacia. In figuring the dosage the total amount a man of 50 kg. would inhale in an 8-hour day, assuming an air concentration of 20 mgm. per cu.m., was first calculated and reduced to milligrams per kilogram. The rats and rabbits received this dose each day. The compounds used were those employed in the gross feeding experiments and the results were essentially similar though the lesions were less severe.

Subcutaneous Injections: The same gum acacia suspensions were injected subcutaneously into rats and rabbits, the dosage being calculated on the basis of 2 mgm. per cu.m. of air. Again similar results were obtained. In all such experiments there must of necessity be differences in the degree of effect but invariably the liver was the sole organ affected and the lesions were those already described many times.

Recommendations for Industrial Practice: Unless there is a very good reason for using the hot method of impregnation, all new installations should use the cold or solvent method of impregnation with chlorinated naphthalenes and diphenyls. Where the hot method is now being used it should be changed over to cold, if possible, or surrounded with every known protective measure. 7 A

General hygienic measures should be followed, but in no case should these be allowed to supersede engineering control of the primary source of the exposure, the operations in the plant.

The following hygienic measures may be considered good practice where these compounds are handled:

- (A) Two lockers for each worker exposed to chlorinated waxes (one for working and one for street clothes).
- (b) All work clothes above the underwear should be provided and laundered at least twice a week by the management.
- (c) The workers should change to clean underwear at the end of each shift before getting into his street clothes.
- (d) Supervised cleaning: (1) At noon the workers should remove outer clothing and scrub hands and face under supervision; (2) at the end of the shift they should be required to take a supervised shower before changing back to street clothes.

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- (e) Protective skin creams or protective clothing should be provided by the management at the discretion of the foreman, nurse, medical, or plant superintendent.
- (f) All departments handling chlorinated synthetic waxes should be thoroughly cleaned according to a prearranged schedule. This should include the removal of all deposits of waxy material from the machines, floors and surrounding objects. Workers doing the cleaning should be provided with protective clothing and supplied air or organic vapor masks where exhaust ventilation is inadequate or not possible.

The foremen of all departments where this material is handled should be apprised of the toxic nature of the material and instructed in safe handling procedures. These men should make it their duty to check up on the workers in their departments and instruct them in safe practice.

Pre-employment and periodic physical examinations should be made of all exposed workers. These should include the taking of a full clinical history, with special emphasis on gastro-intestinal disturbances and dermatitis. In addition, the skin should be carefully examined periodically and the more reliable liver function tests performed. Gastro-intestinal complaints developing in a worker at any time should be a signal for an immediate medical check-up. A history of liver disease, jaundice, or anti-syphilitic treatment should automatically exclude a worker from jobs involving a possible toxic exposure. Pregnant women should not be employed where there is a possible exposure to the synthetic chlorinated waxes.

Engineering control of plant operations cannot be over-emphasized but specific recommendations are not applicable to all cases. It would be wise for a plant using this class of materials to check their control measures with the state industrial hygiene agency, the insurance carrier and some competent consultant before occupational disease occurs.

APPLICATIONS OF AROCLORS

ADHESIVES

Adhesives of good electrical characteristics can be prepared containing Aroclors. The following are typical examples:

		<u>Typical Values</u>
#103	Aroclor 4465 (Code 3140-0144)	47.0%
(IV)	Paraffin 50.800	1.0
	Mineral Oil (Extra Heavy White)	2.0
	Barytes - Nephaw's #2	50.0

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		<u>Typical Values</u>
#103B	Aroclor 2565 (B.P. 77.5°C) (Code 3140-0114)	46.50%
(XB)	Paraffin 50.8°C	1.17
	Mineral Oil (Extra Heavy White - Sonneborn's)	2.33
	Barytes - Mepham's #2	50.00
#131	Aroclor 4465 (Code 3140-0144)	16.10%
E-11	Ester Gum - HICO #1202XXXX Pale	14.35
65B	Paraffin 50.8°C	4.55
	Barytes - Mepham's #2	65.00
#135	Aroclor 4465 (Code 3140-0144)	20.70%
	Ester Gum - HICO #1202XXXX Pale	18.45
	Mineral Oil (Extra Heavy White - Sonneborn's)	5.85
	Barytes - Mepham's #2	55.00
#H	Aroclor 4465 (Code 3140-0144)	46.0%
50B	Mineral Oil (Extra Heavy White - Sonneborn's)	4.0
	Barytes - Mepham's #2	50.0
#"M"	Aroclor 4465	89.5%
	Mineral Oil (Extra Heavy White - Sonneborn's)	10.5
#"M"	Aroclor 4465	58.2%
	Mineral Oil (Extra Heavy White - Sonneborn's)	6.8
	Silica (Schults, Champlain & Bibbo)	35.0

For the preparation of thermo-plastic adhesives Purdue University found that the harder Aroclors are better than anything else discovered to date, primarily because of their high compatibility with other resins and their thermo-stability.

ELECTRICAL

Dielectrics and Electrical Insulators

The Aroclors have excellent dielectric properties, that is, low dielectric constant and resistivity and low power factor. Aroclor 1242 has the highest dielectric constant of the whole series which we are manufacturing commercially, while higher chlorine Aroclors have higher resistivity.

The Aroclors have found usefulness as a dielectric in condensers and as a dielectric and cooling medium in transformers; and a number of miscellaneous similar uses where the characteristics above named are of importance.

AROCLORS AS SATURANTS

Saturation may be defined as that operation by which liquids or gases are caused to penetrate relatively porous materials. The penetrating medium is known as the saturant and is generally in

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the liquid state. Saturation may be assisted or accelerated by means of increased temperature and pressure or by the use of a vacuum.

Various classes of products are saturated for the purpose of giving them a wide variety of properties. Some of the properties attained by saturation are: water and flame resistance; resistance to chemicals; abrasion; moisture; light and weather changes; increased strength; and increased weight.

Among the articles that are treated to obtain some one or all of the above mentioned properties are included the various fibres and fabrics: animal; vegetable and mineral; woods, both hard and soft; ceramic ware and cement; and certain kinds of electrical apparatus, such as carbon resistors.

The saturants, or, as they are sometimes called, the impregnants, are usually made up of waxes, oils, resins, or water solutions of certain inorganic salts.

Applications

At present the saturating applications that are of chief interest are insulated wire, low voltage cable commonly called network cable, and carbon resistor fields. These proposed uses are described more fully under the separate headings which follow.

Network Cable

Attempts are being made to develop a use for Aroclor as a saturant for secondary network or low voltage cable. Cable of this kind is used in electrical network distribution systems. Generally, it consists of the copper conductor or conductors, the paper insulation, and the lead sheath. The paper is saturated with an oil, usually a good grade of oil such as the General Electric Company's Transil Oil. This form of construction is objectionable because under the conditions imposed by a short circuit, combustible gases are generated which flow through the conduits to the manholes, at which point they may form explosive mixtures with the air and, in turn, cause explosions in the manholes. Both the paper and the oil are sources of combustible gases. It is therefore desirable to replace them -- the paper with an inert form of insulation, if possible, and the oil with a non-inflammable saturant such as Aroclor. Thus far, Aroclor 1254 appears to meet the requirements of this use.

The more important cable manufacturers in the country are already at work on the development of a flame resistant cable and also one in which the explosion hazard will be lessened or eliminated.

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## **Exhibit 5**

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SALESMEN'S MANUAL

AROCLOR

DESCRIPTION AND PROPERTIES

The Aroclors are a series of chlorinated hydrocarbons based on biphenyl and terphenyl. They are not pure compounds but are mixtures of closely related chlorine substitution products manufactured essentially to a set of specifications based on physical properties rather than chemical composition.

The approximate chlorine content is indicated by the last two figures of the Aroclor number. The chemical composition closely approaches the average for the indicated chloro-derivatives as follows, but should not be represented as simple chemical compositions according to the formula shown:

Approximate Equivalent Chemical Compound

1239+	Monochlorobiphenyl
1232	Dichlorobiphenyl
1242	Trichlorobiphenyl
1248	Tetrachlorobiphenyl
1254	Pentachlorobiphenyl
1260	Hexachlorobiphenyl
1262	Heptachlorobiphenyl
1268	Nonachlorobiphenyl
1271	Decachlorobiphenyl
5460	Nonachloroterphenyl

Reference should be made to technical bulletin P-115 for tables and graphs of physical properties. This manual contains only that information which is not designed for general public distribution or has been made more recently available than permitted incorporation in the printed bulletin.

The following Aroclors not in commercial production (but available) have been proposed:

Aroclor No.	<u>5448</u>	<u>5454</u>
Fixed Chlorine	47.9%	54.83%
Color (Lovibond)	6.0	20.0
Four Point	60°C	84°C
Softening Point	63°C	85°C



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Aroclor No.	5448	5454
Viscosity 98.9°C (210°F)	395.0*	-
Flash Point	250°C	-
Burn Point	400°C	-
Chlorides	None	None
Acidity - mg. KOH/g.	0.008	0.004
Evaporation	0.006	0.007
Resistivity	--	--
Ageing	--	--
Dielectric Constant	4.65	4.17

\*SUS

ELECTRICAL PROPERTIES

	<i>After final test</i> Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 5442
*Dielectric Constant @ 100°C	4.63	4.15-4.35	3.6-3.8	4.92
**Resistivity @ 100°C. OHMS/CM <sup>3</sup> <i>at 100°C.</i>	500x10 <sup>9</sup>	Above 500x10 <sup>9</sup>	Above 500x10 <sup>9</sup>	1469x10 <sup>9</sup>
***Dielectric Strength	35 KV Min.			
Power Factor (100°C, 1000 kc)	Less than 0.1%		Less than 0.1%	

- \* IRS Method H-3955871
- \*\* Resistivity @ 100° under 500 Volts DC
- \*\*\* ASTM D-177-11

<u>Refractive Index</u>	<u>Range</u>	<u>Midpoint</u>
Aroclor 1270	1.691-1.74	1.712
Aroclor 1271	1.691-1.74	1.712
Tetradecachlorometaterphenyl	1.712-1.718	--
Tetradecachloroparaterphenyl	1.691-1.74	1.712

<u>Heat of Vaporization</u>	<u>B.I.U./lb.</u>
Aroclor 1260 (3 mm. pressure)	104
Aroclor 1262 (760 mm. pressure)	72.4
Aroclor 1169 (0.151 atm. @ 350°C)	69.2
(0.079 atm. @ 325°C)	70.6

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SOLUBILITY

<u>Solvent</u>	<u>Aroclor 1268</u>	
	<u>Cold</u>	<u>Hot</u>
Acetone	I	I
Alcohol, Formula 3-A	I	I
Amyl Acetate	S	S
Amyl Alcohol	PS	S
Benzene	S	S
Butyl Acetate	S	S
N. Butyl Alcohol	I	PS
Carbitol	I	S
Carbon Disulfide <i>Carbon tetrachloride</i>	S	S <i>70-80°C</i>
Cellcosolve	I	S
Chloroform	S	S
Di Butyl Phthalate	S	S
Ether	S	S
Ethyl Acetate	PS	PS
Ethyl Lactate	I	S
Ethylene Dichloride	S	S
40% Formaldehyde	I	I
Furfural	PS	PS
High Test Gasoline		
Glycerin	I	I
Kerosene	PS	S
Linseed Oil	I	S
Methyl Acetate	PS	PS
Mineral Spirits	PS	PS <i>110-120°C</i>
Paraffin		
Phenol 90%	PS	S
Pine Oil	S	S
Pyridine	S	S
Toluene	S	S
Tri Cresyl Phosphate	S	S
Tung Oil	I	S
Turpentine	PS	PS <i>120-130°C</i>
Xylene	PS	PS <i>120-130°C</i>

I = Insoluble  
 PS = Partially Soluble  
 S = Soluble

<u>Solvent</u>	<u>Gms. Aroclor 1270 per 100 cc. Solvent</u>	<u>Approx. Temp. at which soln. complete</u>
Furfural	2.0	105-110°C
Furfural	4.0	120-125°C
Secondary Amyl Acetate	4.0	110-115°C
Secondary Amyl Alcohols	4.0	Not completely soluble at boil
Carbitol	4.0	Above 125°C
Heavy White Mineral Oil	4.0	110-115°C

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STABILITYToward Heat

Aroclor 1248 was heated to 650°F in stainless steel autoclave with the resulting changes indicated in the following tabulation:

	Time of Heating (Hours)	Temperature	Acidity mg. NaOH/gm. Aroclor 1248
Original Sample	0	--	.0021
Autoclave #1	331	343°C. 650°F.	.0392
Autoclave #2	500	343°C. 650°F.	.0809
Autoclave #3	669	343°C. 650°F.	.0800

These results are interpreted as indicating very excellent stability for Aroclors under the conditions of test.

Toward Oxidation

When Aroclor 1254 is heated for 50 or 60 days at 150°C in the presence of oxygen and copper, there is likely to be some attack on the copper. Examination of Aroclor 1254 after that period of time will usually show the presence of soluble copper. This also occurs with mineral oil and other insulating liquids.

In general, even after severe oxidation conditions no evidence of chlorine splitting from the parent hydrocarbon has been found.

Toward Acids

Aroclors 1242 and 1254 were stirred with an equal volume of concentrated Sulfuric Acid (98%), dilute Sulfuric Acid (10%), Nitric Acid (70%), and dilute Nitric Acid (5%), at room temperature (25°C) for 150-250 hours. The Aroclor was then washed until neutral, dehydrated with Sodium Sulfate, then analyzed in comparison with a control sample for the various properties which are regularly considered, without causing these properties to depart from specification limits.

Aroclor 1262 was treated for 160 hours suspended in the same acids as above at 50 to 55°C. The concentrated Nitric Acid caused an increase in color, otherwise no significant change in characteristics.

The acid layer from the treatment of Aroclor 1254 was concentrated Sulfuric Acid at room temperature for 150 hours and was tested for chloride content. The quantity of HCl found was so small that it was not possible by ordinary methods to obtain a quantitative figure. Thus it appears that practically no hydrogen chloride is evolved under these conditions.

CORROSION

Additional corrosion data not included in bulletin P-115 (Pl 4-43-R) is as follows:

<u>Metal</u>	<u>Temperature</u>	<u>Time of Exposure</u>	<u>Penetration in/yr.</u>
Monel	342°C	360 hrs.	.006
Dow Metal	150°C	40 days	.001
Yellow Brass	325°C	2,960 hrs. in steel bomb	.003
Al alloy 178T	120°C	21	.00035*
Al alloy 528H	120°C	21	.00035*
Al alloy 538T	120°C	21	.00038*

\*The weight loss occurred in the first seven days of the test. Negligible loss was encountered in the last 14 days.

The vapor condenser and the product receiver of the plant distillation unit for producing Aroclor 1254 is constructed of Monel and no failure in the system nor any noticeable reaction between the Aroclor and the Monel has been discovered after three years of operation.

SOLUBILITY OF WATER IN AROCLOR 1242

The water content of a sample of Aroclor 1242 saturated with water at approximately 30°C was determined, using the Karl Fischer reagent, to be about 0.00%.

Aroclor 1242, as regularly produced, contains by the same test less than 0.001% water.

SURFACE TENSION

The surface tension of Aroclor 1254 is as follows:

<u>Temperature</u>	<u>Dynes per Centimeter</u>
25°C	50.3
80°C	44.0
100°C	42.0

TOXICITY

All chlorinated hydrocarbons have measurable degrees of toxicity to the animal organism. Aroclors are no exception. The symptoms of Aroclor poisoning are:

1. Pore acne (chlor-acne) nodular eruptions of the hair follicles or sebaceous glands as a result of insufficient cleansing of the skin.

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2. Acute yellow atrophy of the liver in which the liver cells show swelling, hypergranulation, hyaline inclusions and vacuolation as a result of extensive exposure over long periods of time.

These symptoms may also result from exposure to other chlorinated hydrocarbons of commerce, such as: carbon tetrachloride, dichloroethylene, trichloroethylene, chlorinated naphthalene (Halovax). The best known (at present) measure of the degree of toxicity of the Aroclors is presented below:

Permissible Limits (in mg./cu.m.) of Concentration in Air of Work Rooms: (Journal of Industrial Hygiene & Toxicology 21: 155, 1939)

Tested on Rats by Inhalation

	<u>Chlorine Content %</u>	<u>Permissible Limit mg./cu.m.</u>
Aroclor 1268	68	10.0
Aroclor 4465	65	0.5 *
Aroclor 5460	60	0.5
Aroclor 1254	54	0.5
Trichloronaphthalene plus trace Tetrachloronaphthalene	49.9	10.0 *
Tetra and Pentachloronaphthalenes	56.4	1.0 *
Penta and Hexachloronaphthalenes	62.6	0.5 *
Tetra and Pentachloronaphthalenes plus Refined Chlorinated Diphenyl	43.5	0.5 *
5% Penta and Hexachloronaphthalenes / Aroclor 4465	63.0	0.5 *
Chlorinated Diphenyl Oxide	54.0	0.5
Chlorinated Diphenyl Oxide	57.0	0.5
Hexachlor Diphenyl Oxide / 5% Trichloronaphthalene	50-55	0.5
Hexachloronaphthalene and Crude Chlorinated Diphenyl	--	0.5
Special Chlorinated Naphthalene	50-56	0.5

\*Tested also by feeding.

Summary of Gross Feeding Experiments

Of the various materials fed rats in large doses, Trichloronaphthalene plus traces of Tetrachloronaphthalene was quite innocuous. Tetra and Pentachloronaphthalene showed definite liver damage. Penta and Hexachloronaphthalenes caused a similar grade of injury. The addition of chlorinated diphenyl to Penta and Hexachloronaphthalenes increased the toxicity. Chlorinated Diphenyl alone produced liver lesions but in the dosage used was less effective than when mixed with highly chlorinated naphthalenes. In no case did the compounds

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used produce acute yellow atrophy but the lesions observed indicate this might be possible if one found a dosage which could act for the proper period of time.

Feeding Precise Doses by Stomach Tubes: The compounds employed were suspended in gum acacia. In figuring the dosage the total amount a man of 50 kg. would inhale in an 8-hour day, assuming an air concentration of 20 mgm. per cu.m., was first calculated and reduced to milligrams per kilogram. The rats and rabbits received this dose each day. The compounds used were those employed in the gross feeding experiments and the results were essentially similar though the lesions were less severe.

Subcutaneous Injections: The same gum acacia suspensions were injected subcutaneously into rats and rabbits, the dosage being calculated on the basis of 4 mgm. per cu.m. of air. Again similar results were obtained. In all such experiments there must of necessity be differences in the degree of effect but invariably the liver was the sole organ affected and the lesions were those already described many times.

Recommendations for Industrial Practice: Unless there is a very good reason for using the hot method of impregnation, all new installations should use the cold or solvent method of impregnation with chlorinated naphthalenes and diphenyls. Where the hot method is now being used it should be changed over to cold, if possible, or surrounded with every known protective measure. 7 A

General hygienic measures should be followed, but in no case should these be allowed to supersede engineering control of the primary source of the exposure, the operations in the plant.

The following hygienic measures may be considered good practice where these compounds are handled:

- (a) Two lockers for each worker exposed to chlorinated waxes (one for working and one for street clothes).
- (b) All work clothes above the underwear should be provided and laundered at least twice a week by the management.
- (c) The workers should change to clean underwear at the end of each shift before getting into his street clothes.
- (d) Supervised cleaning: (1) At noon the workers should remove outer clothing and scrub hands and face under supervision; (2) at the end of the shift they should be required to take a supervised shower before changing back to street clothes.

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- (e) Protective skin creams or protective clothing should be provided by the management at the discretion of the foreman, nurse, medical, or plant superintendent.
- (f) All departments handling chlorinated synthetic waxes should be thoroughly cleaned according to a prearranged schedule. This should include the removal of all deposits of waxy material from the machines, floors and surrounding objects. Workers doing the cleaning should be provided with protective clothing and supplied air or organic vapor masks where exhaust ventilation is inadequate or not possible.

The foremen of all departments where this material is handled should be apprised of the toxic nature of the material and instructed in safe handling procedures. These men should make it their duty to check up on the workers in their departments and instruct them in safe practice.

Pre-employment and periodic physical examinations should be made of all exposed workers. These should include the taking of a full clinical history, with special emphasis on gastro-intestinal disturbances and dermatitis. In addition, the skin should be carefully examined periodically and the more reliable liver function tests performed. Gastro-intestinal complaints developing in a worker at any time should be a signal for an immediate medical check-up. A history of liver disease, jaundice, or anti-syphilitic treatment should automatically exclude a worker from jobs involving a possible toxic exposure. Pregnant women should not be employed where there is a possible exposure to the synthetic chlorinated waxes.

Engineering control of plant operations cannot be over-emphasized but specific recommendations are not applicable to all cases. It would be wise for a plant using this class of materials to check their control measures with the state industrial hygiene agency, the insurance carrier and some competent consultant before occupational disease occurs.

APPLICATIONS OF AROCLORS

ADHESIVES

Adhesives of good electrical characteristics can be prepared containing Aroclors. The following are typical examples:

	<u>Typical Values</u>
#103 Aroclor 4465 (Code 3140-0144)	47.0%
(XV) Paraffin 50.800	1.0
Mineral Oil (Extra Heavy White)	2.0
Barytes - Mephan's #2	50.0

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		<u>Typical Values</u>
#103B	Aroclor 2565 (S.P. 77.5°C) (Code 3140-0114)	46.50%
(XB)	Paraffin 50.8°C	1.17
	Mineral Oil (Extra Heavy White - Sonneborn's)	2.33
	Barytes - Mepham's #2	50.00
#131	Aroclor 4465 (Code 3140-0144)	16.10%
E-11	Ester Gum - BKEG #1202XXXX Pale	14.35
65B	Paraffin 50.8°C	4.55
	Barytes - Mepham's #2	65.00
#135	Aroclor 4465 (Code 3140-0144)	20.70%
	Ester Gum - BKEG #1202XXXX Pale	18.45
	Mineral Oil (Extra Heavy White - Sonneborn's)	5.85
	Barytes - Mepham's #2	55.00
#R	Aroclor 4465 (Code 3140-0144)	46.0%
50B	Mineral Oil (Extra Heavy White - Sonneborn's)	4.0
	Barytes - Mepham's #2	50.0
#"M"	Aroclor 4465	89.5%
	Mineral Oil (Extra Heavy White - Sonneborn's)	10.5
#"M"	Aroclor 4465	58.2%
	Mineral Oil (Extra Heavy White - Sonneborn's)	6.8
	Silica (Schultz, Champlain & Bibbo)	35.0

For the preparation of thermo-plastic adhesives Purdue University found that the harder Aroclors are better than anything else discovered to date, primarily because of their high compatibility with other resins and their thermo-stability.

ELECTRICAL

Dielectrics and Electrical Insulators

The Aroclors have excellent dielectric properties, that is, low dielectric constant and resistivity and low power factor. Aroclor 1242 has the highest dielectric constant of the whole series which we are manufacturing commercially, while higher chlorine Aroclors have higher resistivity.

The Aroclors have found usefulness as a dielectric in condensers and as a dielectric and cooling medium in transformers, and a number of miscellaneous similar uses where the characteristics above named are of importance.

AROCLORS AS SATURANTS

Saturation may be defined as that operation by which liquids or gases are caused to penetrate relatively porous materials. The penetrating medium is known as the saturant and is generally in

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the liquid state. Saturation may be assisted or accelerated by means of increased temperature and pressure or by the use of a vacuum.

Various classes of products are saturated for the purpose of giving them a wide variety of properties. Some of the properties attained by saturation are: water and flame resistance; resistance to chemicals; abrasion; moisture; light and weather changes; increased strength; and increased weight.

Among the articles that are treated to obtain some one or all of the above mentioned properties are included the various fibres and fabrics: animal; vegetable and mineral; woods, both hard and soft; ceramics ware and cement; and certain kinds of electrical apparatus, such as carbon resistors.

The saturants, or, as they are sometimes called, the impregnants, are usually made up of waxes, oils, resins, or water solutions of certain inorganic salts.

Applications

At present the saturating applications that are of chief interest are insulated wire, low voltage cable commonly called network cable, and carbon resistor fields. These proposed uses are described more fully under the separate headings which follow.

Network Cable

Attempts are being made to develop a use for Aroclor as a saturant for secondary network or low voltage cable. Cable of this kind is used in electrical network distribution systems. Generally, it consists of the copper conductor or conductors, the paper insulation, and the lead sheath. The paper is saturated with an oil, usually a good grade of oil such as the General Electric Company's Transil Oil. This form of construction is objectionable because under the conditions imposed by a short circuit, combustible gases are generated which flow through the conduits to the manholes, at which point they may form explosive mixtures with the air and, in turn, cause explosions in the manholes. Both the paper and the oil are sources of combustible gases. It is therefore desirable to replace them -- the paper with an inert form of insulation, if possible, and the oil with a non-inflammable saturant such as Aroclor. Thus far, Aroclor 1254 appears to meet the requirements of this use.

The more important cable manufacturers in the country are already at work on the development of a flame resistant cable and also one in which the explosion hazard will be lessened or eliminated.

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### Carbon Resistors

Carbon resistors are small molded rods of a mixture of carbon black and sand with a resinous binder. They are porous and their electrical resistance is seriously affected by the entrance of moisture.

To prevent moisture getting into the units they are usually impregnated with some material to fill up the voids and to coat the surface of the resistor. A wax is generally used for this purpose and serves very well as far as moisture-proofing is concerned. However, after completion, the resistor must be lacquered for identification. Lacquer does not adhere well to the waxed surfaces.

Aroclor 465 Moisture-proofing Compounds give moisture proofness (Humidity test) equal to that of wax and, in addition, give a surface to which lacquer will adhere.

The Aroclor Compound is non-crystalline and therefore does not have a definite melting point and does not become extremely fluid at the melting point of most waxes that are used in this application, but it gradually softens under increased temperature.

In extensive tests to find the most effective medium for impregnating radio resistors to stabilize the electrical resistivity under exaggerated and extreme humidity tests, Aroclor 5460 gave by far the best results when compared with Santovax and various petroleum waxes and compounds.

This excellent Aroclor success was accomplished by grinding off or sanding the surface of the carbon resistor prior to impregnating, thus exposing the inner pores of the resistor, permitting excellent penetration. Penetration has always been a problem in the impregnation of resistors with resinous materials such as Aroclor.

### Cable Insulation

Electrical conductors and cables insulated with asbestos are frequently lacking in waterproofness. Impregnation with wax compositions gives an insulating medium resistant to atmospheric moisture and sometimes even to immersion in water for a short time, but hitherto no composition having the required characteristics of heat resistance and flameproofness has given sufficient water resistance to withstand immersion for prolonged periods.

An improved method of impregnating asbestos is described in U. S. Patent 2,162,953, assigned to Rockbestos Products Corporation, which depends on the use of a phenolic resin in conjunction with a chlorinated diphenyl. It has already been proposed to use each of these substances separately for a similar purpose, but alone the first lacks flameproofness and the second resistance to water.

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The phenolic resin used for this purpose should be thermoplastic, solid and rather brittle at ordinary temperatures, with a flow point of 105°C. Bakelite XR 8430 is suggested as a suitable type. The best chlorinated diphenyl for this process is stated to be one having a viscosity of 95 sec. Saybolt at 100°C, and, of course, it must mix readily with the phenolic resin. One containing about 62 per cent chlorine is said to be satisfactory, for example, Aroclor 1262.

The two ingredients are mixed in equal parts by weight at 160°C, preferably with the addition of 5 per cent by weight of a plasticizer such as Tricresyl Phosphate. The resulting mixture is stable and can be stored.

In manufacturing the cable the individual conductors are insulated, twisted and covered with the layers of impregnated asbestos and varnished cambric (or the like) in the manner well understood in the art. A layer of loosely felted dry asbestos of suitable thickness is then applied around the thus assembled cable, and a dry asbestos braid is applied over the felted layer of asbestos. The so-covered cable is then passed through the impregnating compound (mixture of resinous phenolic condensation product and chlorinated diphenyl) while maintaining the compound at a temperature of about 155°C. The time required to impregnate the layer of felted asbestos and asbestos braid will depend on the thickness of the layer. As the cable emerges from the heated bath of impregnating compound, it is passed through suitable snubbing devices to remove the excess compound from its outer surface.

In order to prevent migration of the outer surface compound when the finished wire or cable is subjected to high temperatures in service, it has been found advantageous in some instances to apply to the impregnated layer of asbestos a second coat of the impregnating compound to which has been added about 15 to 20% of ground mica or other finely divided inert solid material. The impregnating compound on the outer surface of the impregnated asbestos then contains dispersed finely divided particles of the inert solid material which act to thicken the compound and render it less susceptible to flow. The admixture of mica or the like is not required or desirable in the compound used to impregnate the asbestos layer, since the asbestos fibres themselves satisfactorily perform the function of retaining the compound within the mass by capillary attraction.

The insulated conductor or cable of the invention possesses all the necessary characteristics of heat resistance, flameproofness, pliability, dielectric strength and resistance to water. The outer insulating layer of asbestos impregnated with a mixture of resinous phenolic condensation product and chlorinated diphenyl is substantially waterproof, even when submerged in water for extended periods of time or subjected to hydrostatic pressure as high as 25 pounds per square inch. In general, the use of asbestos

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as an electrical insulating material has heretofore been limited to locations where high temperatures or the hazard of inflammable material made the use of ordinary forms of insulation (such as rubber, varnished cambric, paper, etc.) undesirable or prohibitive. It will, therefore, be evident that the invention widely extends the usefulness of asbestos insulated wires and cables.

Condensers

A rapidly growing use of Aroclor is in the manufacture of the small condensers employed in fluorescent lighting fixtures for offices, business houses and factories.

AROCLOR EMULSION FORMULA

16 pounds of Aroclor - liquid  
8 pounds of Water  
16 ounces of Stearic Acid  
4 ounces of Triethanolamine

The Aroclor is heated to a workable viscosity above 82°C (180°F) and the Stearic Acid is added and completely stirred in. The water is heated to 97°C (207°F) and the Triethanolamine added and thoroughly stirred in. After both of these operations have been carried out, the Aroclor-Stearic Acid combination is poured into the water mixture while the latter is well agitated and then the whole mixture is processed through a colloid mill. Good results may even be obtained without the use of a colloid mill, provided the mixture is agitated with a high-speed emulsifying stirrer.

FLAMEPROOFERS

The Aroclors are not inflammable and when mixed in sufficiently large proportion with many other materials have rendered the complete compound non-inflammable. For instance, a mixture of about equal parts of Aroclor 2565 and asphalt gives a resulting compound that will not permit the spread of flame. Wood may be impregnated sufficiently with one of the higher chlorine Aroclors, such as 4465, that it will pass the most rigid tests now applied to wood which has been treated for flameproofness, such as the tests used by the Forest Products Laboratory and by the Building Department of the City of New York.

We have not yet found a market for Aroclor in the field of flameproofing wood because in most cases where the wood is treated for flameproofness it is used indoors where it is not exposed to leaching by rain, so that one of the phosphate salts is generally used. However, there may be special uses where these materials are not acceptable and where the price of Aroclor is justified.

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There is throughout the country a tremendous market for compounded waxes for all manner of uses. It is very likely that in some of the applications of these materials it would be desirable to have them non-inflammable. It is also likely that the incorporation of Aroclor with some other resinous or waxy materials would give other desirable properties. These applications could probably be worked out in conjunction with companies who are now in the business of compounding and selling such materials. There are some of these companies in each of our sales territories.

Aroclors 4465 and 5460 are the most likely ones in this application.

Tests are under way to determine the suitability of the substitution of Aroclor 1260 for chlorinated paraffin in the treatment of paulins and tentage for use by the Army. This is for the purpose of producing non-inflammability, improving moisture resistance, and mildew proofing.

The Aroclors are remarkably stable and their superiority in this respect to chlorinated paraffin customarily employed for this purpose is demonstrated in the following results reported by our laboratory.

Light Stability Tests

In order to be certain that the tests were comparable in every respect, they were conducted by personnel of the A. French Textile School, Georgia School of Technology, Atlanta, Georgia.

The samples used in these tests had been prepared at Anniston prior to this visit. They consisted of sections of kierboiled cotton sheeting impregnated with compositions as shown in the tabulation below. Approximately 10% of chlorinated hydrocarbon was applied to each of the impregnated samples. The chlorinated paraffin used had the following characteristics:

\$Cl_2	43.15
Sp.Gr. @ 25/2500	1.183
Viscosity @ 2100P	175 308
Four Point	-807

As will be noted, several pigments, namely,  $Fe_2O_3$ ,  $Sb_2O_3$ , and  $CaCO_3$ , were also applied to the fabric. These pigments were used in the following proportions:

$Fe_2O_3$  - 10 parts  $Fe_2O_3$  to 8 parts chlorine in the chlorinated hydrocarbon.

$Sb_2O_3$  - 10 parts  $Sb_2O_3$  to 8 parts chlorine.

$CaCO_3$  - 7½ parts  $CaCO_3$  to 10 parts chlorine.

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In the tests with the pigmented mixtures, the pigment adhered to the surface of the cloth and was not very evenly distributed.

The actual tests made at Georgia Tech. involved exposure for two hours in a Cooper-Hewitt lamp cabinet, then conditioning at 70°F and 65% R.H. for four hours or longer, and finally testing for warpwise tensile strength by the grab method with a Scott tester. The Cooper-Hewitt cabinet had a Uviarc (fused quartz mercury arc) lamp as the source of ultra-violet light. On the basis of dye fading tests conducted at Georgia Tech. over an extensive period several years ago, two hours' exposure in the Cooper-Hewitt cabinet is roughly equivalent to 20 days' average outdoor weathering. This relation does not necessarily apply to tensile strength deterioration tests. Judging by the deterioration of the tensile strength of unimpregnated samples, it would appear that 2 hours' exposure in the Cooper-Hewitt was equivalent to much more than 20 days' outside exposure.

Summarized data for the tensile strength tests were as shown in the following tabulation:

Impregnation Mixture	Tensile Strength (X)	
	Unexposed	Exposed
None (Plain cloth only)	53.75	27.9
Chlorinated Paraffin	57.75	15.1
" " & Fe2O3	60.9	17.75
" " & Sb2O3	57.0	17.9
" " & CaCO3	57.9	18.25
Aroclor 1254	54.5	24.0
" " & Fe2O3	60.1	27.1
" " & Sb2O3	56.2	24.5
" " & CaCO3	58.75	25.9
Aroclor 1260	59.4	25.75
" " & Fe2O3	58.0	30.1
" " & Sb2O3	62.4	34.9
" " & CaCO3	59.25	30.9
Aroclor 5442	60.1	33.5
" " & Fe2O3	65.5	34.1
" " & Sb2O3	63.9	40.6
" " & CaCO3	62.4	40.9

(X) Units are in-pounds and, except for three instances, the values shown are averages of 4 tests.

The conclusion from these tests was that the Aroclors contributed little, if any, to the deterioration of tensile strength of the cloth upon exposure to ultra-violet light, whereas chlorinated paraffin did appreciably accelerate deterioration under the same

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conditions. Also, under the conditions of these tests, all of the pigments tried decreased to some extent the tendering effect of the ultra-violet light. This is probably not abnormal, since the pigments should have reflected a portion of the light rays.

It has been reported that certain pigments decrease the heat stability of chlorinated paraffin, thus accelerating tendering of treated cotton goods upon exposure in hot climates. Heat stability tests on all of the impregnation mixtures tried as outlined above are now being run in the laboratory at Anniston.

Compared with plain cloth unexposed (100%) the hydrocarbon treatments alone effected the following improvement in tensile strengths:

Chlorinated Paraffin	7.5%
Aroclor 1254	1.7%
Aroclor 1260	10.5%
Aroclor 5442	11.8%

This increase in tensile strength through impregnation is compensated for in the following calculation.

When the "Exposed Tensile Strength" is expressed as per cent of "Unexposed Tensile Strength" the following relationship is evident:

	Per cent Resistance to Deterioration on Exposure to Ultra-violet Light
Untreated Cloth	51.9
Chlorinated Paraffin	28.10
" " & Fe2O3	29.15
" " & Sb2O3	31.40
" " & CaCO3	31.52
Aroclor 1254	44.05
" " & Fe2O3	45.10
" " & Sb2O3	43.62
" " & CaCO3	44.19
Aroclor 1260	43.36
" " & Fe2O3	51.86
" " & Sb2O3	56.00
" " & CaCO3	52.10
Aroclor 5442	55.70
" " & Fe2O3	52.05
" " & Sb2O3	63.53
" " & CaCO3	65.53

The advantage of the Aroclors in comparison with Chlorinated Paraffin as a non-inflammable, waterproof impregnant for cotton fabric as measured by resistance to loss of tensile strength on

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exposure to ultra-violet light is expressed in the following relationship, basis equivalent Chlorinated Paraffin treatment as 100%:

		<u>Per cent Improvement in Resistance to Deterioration over Comparable Treatment with Chlorinated Paraffin</u>	
Aroclor 1254		56.7	
" "	& Fe2O3	54.7	
" "	& Sb2O3	42.1	
" "	& CaCO3	40.1	
	Average		48.4
Aroclor 1260		54.3	
" "	& Fe2O3	77.9	
" "	& Sb2O3	78.3	
" "	& CaCO3	65.3	
	Average		68.9
Aroclor 5442		98.2	
" "	& Fe2O3	78.6	
" "	& Sb2O3	102.2	
" "	& CaCO3	107.9	
	Average		96.7

Heat Stability Tests

These tests were made by absorbing and titrating the HCl evolved from 20 grams of chlorinated hydrocarbon when held at 175°C and blown with air at the rate of 0.01 cubic foot per minute for four hours. This is the method outlined on pages 375-378 of the August 30, 1943, issue of the American Dyestuff Reporter, Vol. 32, No. 18. James R. Redmond, Textile Technologist, Jeffersonville, Q.M. Depot, was the author of the article.

Data for the tests that have been completed were as follows:

<u>Chlorinated Hydrocarbon Composition</u>	<u>% HCl Evolved in 4 hrs. at 175°C</u>
20 gms. Chlorinated Paraffin	0.41
20 gms. " " 2.0 gms. Fe2O3	20.00
20 gms. " " 10.5 gms. Sb2O3	0.29
20 gms. " " 6.3 gms. CaCO3	0.29
20 gms. Aroclor 1254	0.00
20 gms. " " 2 gms. Fe2O3	0.01
20 gms. " " 2 gms. Sb2O3	0.01
20 gms. " " 2 gms. CaCO3	0.02

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Chlorinated Hydrocarbon Composition	% HCl Evolved in 4 hrs. at 175°C
20 gms. Aroclor 1260	0.002
20 gms. " " / 2 gms. Fe <sub>2</sub> O <sub>3</sub>	0.02
20 gms. " " / 2 gms. Sb <sub>2</sub> O <sub>3</sub>	0.005
20 gms. " " / 2 gms. CaCO <sub>3</sub>	0.01
20 gms. Aroclor 5442	0.00
20 gms. " " / 2 gms. Fe <sub>2</sub> O <sub>3</sub>	0.00
20 gms. " " / 2 gms. Sb <sub>2</sub> O <sub>3</sub>	0.02
20 gms. " " / 2 gms. CaCO <sub>3</sub>	0.02

These data clearly demonstrate the markedly superior heat stability of the Aroclors as compared to chlorinated paraffin. Particularly significant is the accelerating action of Fe<sub>2</sub>O<sub>3</sub> on the decomposition rate of chlorinated paraffin. No such accelerating action was noted with the Aroclors.

While in most of the tests with the Aroclors our titrations indicated the evolution of HCl ranging up to 0.02%, the titrations were so small as to possibly be within the range of experimental error. At any rate, we are quite sure that 0.02% HCl evolution represents the maximum HCl loss under the conditions of the tests.

Chlorinated Hydrocarbon Mixture	% HCl Evolved in 4 hrs. at 175°C
20 gms. Chlorinated Paraffin and 2 gms. Zinc Borate #3167	15.6
20 gms. Aroclor 1254 and 2 gms. Zinc Borate #3167	0.01
12 gms. Aroclor 5442 and 8 gms. Tricresyl Phosphate	0.02
12 gms. Aroclor 5442 and 8 gms. Tricresyl Phosphate and 2 gms. Fe <sub>2</sub> O <sub>3</sub>	0.00
12 gms. Aroclor 5442 and 8 gms. Tricresyl Phosphate and 2 gms. Sb <sub>2</sub> O <sub>3</sub>	0.01
12 gms. Aroclor 5442 and 8 gms. Tricresyl Phosphate and 2 gms. CaCO <sub>3</sub>	0.00
12 gms. Aroclor 5442 and 8 gms. Tricresyl Phosphate and 2 gms. Zinc Borate #3167	0.01

Again it will be noted that the Aroclors are far more stable than Chlorinated Paraffin in the presence of Zinc Borate.

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HEAT TRANSFER MEDIUM

Aroclor has been used for a number of years at Anniston as a heat transfer medium. It is now employed as such in the HB-40 plant.

Company (075050) used Aroclor as a heat transfer medium in maintaining a molten lead bath in which they soaked 14 inch armour piercing projectiles. They operated one unit using Aroclor and another using Dowtherm. Both of these units were used for several years. They then discontinued the use of Aroclor after discovering corrosion in the Aroclor system, which did not occur in the Dowtherm system.

A company developed some equipment for heating pyrites in which they intended using Aroclor as the heat transfer medium. Since the equipment was never sold commercially, none of these units involving Aroclor are now in operation.

Many people considering Aroclor as a heat transfer medium gave it up either because it would not stand the temperature they required, or on account of fumes coming from the Aroclor, or because it cost more than oil normally used for this purpose.

Favorable features to the use of Aroclor for this purpose are:

1. Liquid at room temperature.
2. Does not oxidize.
3. Has nearly twice the specific heat of petroleum oils generally used for this purpose.
4. Non-inflammable.

HYDRAULIC FLUID

Company (576,450) operating a high pressure steam-electric generating plant use Aroclor 1248 as an hydraulic medium in their governor system. They do not use it as a lubricant. The Aroclor is used instead of oil, merely because of its non-inflammability. When oil is used in the governor system, it is customary to use the same oil reservoir, both for the lubricating and governor systems. When Aroclor is used in the governor system and petroleum oil in the lubricating system, it is necessary to segregate the two systems and use separate pumps for the lubricating and governor systems.

Westinghouse have been the principal promoters of the use of Aroclor in the governor system as a result of having the oil in a governor system catch fire in one of the Jersey Central Light and Power Company's stations while Westinghouse engineers were working with the unit.

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ENAMELS

Company (104460) has obtained some interesting results with baked-on enamels containing Aroclor 1254, Acryloid Resin and Tricresyl Phosphate, pigmented with Titanium Dioxide and Zinc Oxide. The enamel is baked on at 135°C (275°F). They have found that Tricresyl Phosphate aids the Aroclor on baking, giving a hard surface.

This same company has found that mixes of Aroclor and Vistanex (No. 6 B-80 and B-100) or Aroclor and Vixtac (No. 1 and No. 2) give interesting properties somewhat like shellac. They state that these products have good adhesion.

LACQUERS

We have a very good general line-up on the use of Aroclor in lacquers in the booklet P-115 which we have published for distribution. This booklet gives the limits of compatibility of Aroclors 1254 and 1262 in Nitrocellulose lacquers. Since this booklet has been published, a number of companies have started using Aroclor 1242 in special flexible lacquers, such as are used on high tension cables, etc. The compatibility limits of Aroclor 1242 are higher than those of the higher chlorine Aroclors so that it is possible to incorporate enough of the Aroclor to give it extreme flexibility. You have the formula for Aroclor Lacquer No. 34 which gives the details of the use of this Aroclor in cable lacquer.

The work done in our laboratory using Aroclor in lacquers indicates that we get somewhat less chalking with the Aroclor lacquers than with those made up by other formulas. We get practical freedom from checking and cracking and, we believe, better color retention in the white and light colored lacquers. These are important considerations in lacquer manufacture, and Aroclor should be given much more consideration from now on for general use such as an automobile lacquer, etc., than it has received in the past because of the rising prices of other resins which are generally used.

We have a number of customers who use Aroclors 1242, 1254 and 1262 in the manufacture of lacquer.

Lacquer Formulation Chart

Non-Volatile Constituents

1. A resin
2. Nitrocellulose (cellulose nitrate)
3. A plasticizer or softener

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Volatile Constituents

1. The alcohol constituent
2. The ester constituent
3. The hydrocarbon constituent

Finished Lacquer

X per cent of the non-volatile  
(100 - X) per cent of the volatile

The percentage X, of the non-volatile or film-forming constituents, may vary between 20% and 30% of the weight of the finished lacquer

Non-Volatile Constituents

As has been shown by the table, the non-volatile components of a lacquer consist of a resin, cellulose nitrate and a plasticizer or softener. For the resin, some one of those of synthetic origin may be employed, or a natural resin such as Gum Dammar may be used. Gum Dammar is a generally used resin in lacquer formulation, and it can be taken as the number one component. The number two component is the cellulose nitrate itself. It is also known as Nitrocellulose, Pyroxylin and "PX." To the industry in general it is "cotton." It can be purchased in two kinds, the AS and RS grades. The latter grade is the one that is chiefly used by lacquer manufacturers.

The initials indicate a difference in the method of manufacture, AS meaning that the cotton is alcohol-soluble, and RS meaning that it is regularly soluble.

Both grades are usually bought wet with denatured alcohol. The viscosity of the cotton is another determining factor with regard to its use. The cotton that is commonly employed by the industry has a viscosity of one-half second and is known as "half-second cotton." For the third component dibutyl phthalate, tricresyl phosphate or castor oil may be used.

At this point an explanation of the terms "plasticizer" and "softener" becomes necessary. The average lacquer technologist uses these terms synonymously, and for this reason they have come to mean almost one and the same thing in this industry. Strictly speaking, a true plasticizer should be a solvent for the "cotton" and the resin. In addition, it should have a low vaporization loss and should confer such properties as flexibility, pliability, and durability on the lacquer film. Both dibutyl phthalate and tricresyl phosphate meet these requirements. Castor oil, on the other hand, does not, in that it is only a partial solvent for "cotton." It does, however, give to the film the qualities already mentioned, in short, it exerts a softening effect - hence the name "softener." The difference, then, between a plasticizer and a "softener" is that the former is a true solvent for the

non-volatile constituents of a lacquer, while the latter is a non-solvent, or, at best, only a partial solvent. Castor oil is typical of this latter class and is widely used as a lacquer "softener."

Volatile Constituents

The volatile constituents form what is known as a balanced solvent mixture, the purpose of which is to be used as a solvent or thinner for the non-volatile constituents. The components of this mixture must be in such a proportion to each other so as to insure a uniform evaporation rate when the lacquer film dries, and also to make sure that no precipitation of the "cotton" will occur at the time of thinning.

The number one, or the alcohol, component is generally composed of ethyl alcohol - 95% and butyl alcohol. The ester component is made up in general of ethyl acetate and butyl acetate, while the hydrocarbon component usually consists of some compound such as toluol or, for special lacquers such as cable dopes, benzol.

Finished Lacquer

The finished lacquer is prepared by taking a given weight of the non-volatile constituents and dissolving them in a given weight of the volatile constituents.

Competition

The question of competition will have to be viewed from two angles: first with regard to the Aroclors as resins, and second with regard to them as softeners. Since the Aroclors have more the properties of softeners than of resins, the softeners are nearly competitive with the Aroclors than are the resins.

Competing Resins - Synthetic

Name	Number	Manufacturer
Amberol	801	The Resinous Products & Chemicals Co. Philadelphia, Pennsylvania
Bakelite	IN-302	Bakelite Corporation New York, New York
Beckacite	{1110} {1114}	Beck, Koller & Company, Inc. Detroit, Michigan
Glyptal	1202	General Electric Company Schenectady, New York
Levisol	{2} {3}	John D. Lewis, Inc. Providence, Rhode Island

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Competing Resins - Synthetic

<u>Name</u>	<u>Number</u>	<u>Manufacturer</u>
Paraplex*	(5-B) (RG-2)	The Resinous Products & Chemicals Co. Philadelphia, Pennsylvania
Rezyl	(12) (19)	American Cyanamid & Chemical Corp. New York, New York
Rezyl Balsams	-	American Cyanamid & Chemical Corp. New York, New York
Taglacs	-	American Cyanamid & Chemical Corp. New York, New York

\*Paraplex can probably be considered a softener as well as a resin.

Competing Resins - Semi-Synthetic

<u>Name</u>	<u>Number</u>	<u>Manufacturer</u>
Ester Gum	None (One of the most generally used resins.)	There are many manufacturers

Natural Resins

Gum Dammar	(Batavia) (Singapore)	Imported - obtained through brokers
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Competing Plasticizers or Softeners

<u>Name</u>	<u>Grade</u>	<u>Trade Name</u>	<u>Manufacturer</u>
Dibutyl Phthalate*	-	-	Monsanto Chemical Co. St. Louis, Missouri
Tricresyl Phosphate*	-	-	Monsanto Chemical Co. St. Louis, Missouri
		Kronitex	Kavalco Products, Inc. Nitro, West Virginia
		Lindol	Celluloid Corporation Newark, New Jersey
Abalyn	(A rosin product recommended for lacquer formulation)		Hercules Powder Company Wilmington, Delaware

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Competing Plasticizers or Softeners

<u>Name</u>	<u>Grade</u>	<u>Trade Name</u>	<u>Manufacturer</u>
ADM-100	(A modified linseed oil for lacquer formulation)		Archer-Daniels Midland Co Milwaukee, Wisconsin
Castor Oil (Baker's)*	Number 4	Blown	The Baker Castor Oil Co.
	Number 15	Blown	Jersey City New Jersey
	Number 16	Blown	
	AA	Unblown	
Spencer-Kellogg Oil	(A modified castor oil for lacquer formulation)	Spencer-Kellogg & Sons Buffalo, New York	

\*There are other manufacturers of these products - this list is by no means complete.

In listing these products, only those that are in more or less general use have been included. There are some notable exceptions, however, in the cases of such materials as Abalyn, ADM-100 Oil, and Spencer-Kellogg Oil.

The materials listed in these tables must not be thought of entirely as competing products because they may be more important as aids or auxiliaries in co-development work with the Aroclors. In fact, it is believed preferable to regard them more in this light than as competitors.

Advantages

In thinking of any advantages the Aroclors may have, the statements made in the final paragraph under "Competition" must be borne in mind. It is preferable to confine oneself to a discussion of the outstanding properties of the Aroclors, for it is believed that it is only through the development of some specific property that progress is going to be made.

The properties of the Aroclors that should be emphasized are:

1. Low vaporization loss
2. Pale color
3. Adhesion
4. Chemical Stability
  - a. to light
  - b. to water, acids and alkalies
  - c. to heat
  - d. to oxidation
  - e. to chemical action in general

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5. Non-inflammability
6. Non-corrosiveness
7. Solubility in commonly used lacquer solvents

A resume of the properties that Aroclors impart to lacquers and the types of lacquers for which they are recommended may be given briefly as follows:

In a Dammar-type lacquer the plasticizer-softener combination, such as the usual dibutyl phthalate-castor oil combination, may be advantageously replaced by an Aroclor alone. The resulting lacquer is less subject to checking and cracking on outside exposure and retains its gloss.

Aroclor 1262 may also be substituted entirely for the resin in certain types of lacquer. The clear lacquer, so produced, is practically colorless and provides an excellent base for white enamels. Such enamels, however, do not withstand weathering as well as those containing Dammar in addition to the Aroclor.

The advantageous properties of the Aroclors in imparting added weather resistance to properly formulated lacquers may be traced to their resistance to the action of sunlight, to their permanency in the film, and to their extreme chemical stability. The Aroclors do not oxidize, "dry," or harden. The Aroclors are unaffected by dilute acids and even by hot caustic solutions. They are not subject to polymerization, rancidity or other change, as far as is known.

When added to a nitrocellulose solution, the Aroclors reduce the viscosity slightly. This change in viscosity takes place at once and no further change due to the presence of the Aroclor occurs on several months' aging in closed containers.

By virtue of their high refractive index, they impart apparent depth to the lacquer film. Aroclor 1262 has adhesive properties and the lacquers containing it have good adhesion. Lacquers containing the Aroclors dry normally and give a hard, non-tacky, durable film of excellent gloss.

Certain lacquer technologists have found that a lacquer containing Aroclor can be polished with a minimum of rubbing and, furthermore, that the Aroclor seems to impart a harder finish to a lacquer film than oils, tricresyl phosphate, or dibutyl phthalate. It has also been reported that properly formulated lacquers containing Aroclor show no tendency to "spew" or "sweat out" when buffed.

In addition to the properties of general interest, other properties of the Aroclors are of value in formulating lacquers to fit special requirements. Aroclors 1254, 4465, 5460 and 1262 do not support combustion, and when present in nitrocellulose films they

retard the rate of burning. The Aroclors retard the rate of transfer of moisture and of gases through a nitrocellulose film, and by virtue of this fact have already found extensive use in protective lacquers for application over those types of electrical insulating materials, such as rubber, that deteriorate rapidly in contact with oxygen, ozone, moisture or other vapors.

#### Procedure

Upon visiting a lacquer company, every effort should be made to see the chemist in charge of formulation or production. In large companies the director of research should always be seen. As a general rule, a great deal will not be accomplished until these respective individuals are seen.

A complete discussion of the properties of the Aroclors should be given, emphasis being placed upon the possible formulation of a new lacquer with some one of these properties as the background.

When discussing the use of Aroclors in lacquers, the salesman should remember that the Aroclors are not solvents for nitrocellulose and that for this reason an excessive amount of Aroclor must never be used in the formulation of a lacquer. The limiting percentages that can be used for successful results have been carefully worked out by a large number of experiments. The few simple rules that must be followed in formulating lacquers with the Aroclors are embodied in a booklet entitled "The Properties of Two Aroclors of Special Interest to Manufacturers of Lacquers." Copies of this booklet may be had on application to our sales offices. It is recommended that the salesman offer copies of this booklet and the bulletin "Plasticizers & Resins - Organic Division" to interested lacquer manufacturers.

Attempts should be made to determine what particular lacquers a manufacturer specializes in and what problems he is studying at the time of the call.

Aroclors have fair or good compatibility with nitrocellulose, Formvar, Butvar, vinyl copolymers, polyvinyl acetate, poly-styrene, chlorinated rubber and ethyl cellulose. In general, the liquid or semi-solid Aroclors act like true resins. One principal value is their chemical inertness. Where great flexibility is to be obtained, it may be necessary to employ auxiliary plasticizers. Some of the exceptions are in chlorinated rubber and in ethyl cellulose where flexibility or hardness may be varied simply by selecting an Aroclor of the proper physical characteristics.

The liquid Aroclors such as 1242, 1248 or 1254 will greatly increase flexibility but will cause softness. The semi-solids such as 1260 or 5442 will impart some flexibility without the marked softening effect. The brittle, resinous Aroclors such as 4465 or 5460 produce very hard compositions with excellent adhesion and

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weathering qualities. If a single Aroclor does not impart the desired combination of properties, usually some mixture of Aroclors will do so. It would seem that in polystyrene molding compositions, the resinous Aroclors could be used as a flux or flow promoter at molding temperatures without causing softness and flow at normal temperatures. Some mixture of Aroclors or a combination of an Aroclor with another plasticizer either solid or liquid might be required for this purpose.

Of course, it is well known that for alkali resistant coatings, combinations of Aroclors (1254-1260 and 5460) with chlorinated rubber have been used for a long time. At the present time, the use of equal parts of Aroclor 5460 and ethyl cellulose is being pushed by Company (331850) as a weather resistant coating. Similar coatings of low viscosity polystyrene and Aroclors would probably be of value.

ARMY-NAVY AERONAUTICAL SPECIFICATION

LACQUER - CAMOUFLAGE

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TABLE IV  
Control Formula - Clear Vehicle

Ingredients	Percent	Weight	Volume
		lbs. per 100 gal.	gal. per 100 gal.
Paraplex RG-2	(100%)	11.1	90
Amberlac B-94	(80% in xylene)	5.6	45
Aroclor 5460	(100%)	4.3	35
Ethyl Cellulose (3 to 4 sec)	(100%)	4.3	35
Cellulose-Nitrate (1/4 sec. R.S.) (65% in ethyl alcohol)		9.4	75
Ethyl Alcohol		3.5	4
Ethyl Acetate		4.5	5
Butyl Alcohol		12.4	15
Ethyl Acetate		22.4	25
Aromatic Petroleum Naphtha Type 1, Grade B		22.5	25

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It is also of value in other resins where a highly alkali resistant plasticizer is required. Papers by Bovran, Paint Technology (reference for December 1936, dated January 1937) indicate many possible applications for the Aroclors. Sales to lacquer trade at present are confined to specialty manufacturers.

The compatibility of Aroclor 4465 in 1/4 second nitrocellulose is indicated as:

1. Between 24.2% and 26.5% by inspections for blush in thin aged films.
2. Between 13.7% and 16.6% by inspection for loss of gloss in thin aged films.

The presence of a mutual solvent such as dibutyl phthalate raises the compatibility.

The formulation of a flexible lacquer designed for oven drying is given as follows:

Non-Volatile 25%	(15-20 Sec. R.S. Nitrocellulose	32%
	(Tricresyl Phosphate	40%
	(Aroclor 1242	28%
Volatile 75%	(Benzol	62%
	(Alcohol	22%
	(Ethyl Acetate	16%

This formula is intended for application followed by oven drying. Air drying at atmospheric temperature causes blushing. A modification of the volatile portion is suggested when air drying is used.

Volatile	(Alcohol	6.4%
	(Ethyl Acetate	6.4%
	(Butanol	6.4%
	(Butyl Acetate	30.8%
	(Toluol	50.0%

Experiments on flock insulation and lacquers for aircraft indicated Tricresyl Phosphate as a choice over Aroclors in Ethyl Cellulose lacquers, especially since there is no tendency to settle out when Tricresyl Phosphate is used. Aroclor is more effective in flame retarding, however.

Stop-Off Lacquers

Rather detailed information is given in the Monsanto (Organic Products Division) Plasticizers and Resins Booklet on the preparation of Nitrocellulose lacquers containing Aroclors. A

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suggested formulation is as follows:

1/2 second Nitrocellulose, Dry	100
Aroclor 1260	80-70
Tricresyl Phosphate	39-70
Santicizer B-16 may be substituted for Tricresyl Phosphate	

If the Nitrocellulose itself does not have sufficient resistance, a composition of Aroclor with a chlorinated rubber, Ethyl Cellulose or a Vinyl Resin again using Aroclor is suggested, and if the flexibility is not sufficient, it can be improved by the addition of a small amount of one of the liquid Aroclors such as 1242 or 1254, although again Tricresyl Phosphate or Santicizer B-16 could be used.

In coatings, as a general rule, the hard resinous Aroclors will produce very hard and very resistant compositions, but these will be brittle. The liquid Aroclors will tend to produce flexibility but may be lacking somewhat in adhesion. It is for that reason that we have suggested Aroclor 1260, which is about half-way between and will produce a combination of flexibility and adhesion. It will be obvious that hardness can then be increased by the addition of a harder Aroclor such as 5460 or the flexibility can be increased by the use of a liquid Aroclor. The Aroclors themselves are unaffected by acid and alkali.

Stop-Off Waxes

The characteristics of a stop-off wax should be as follows:

- a. Tightly adherent to metal surfaces.
- b. Should not be removed at a bath temperature of 160°F.
- c. Should not be affected by the acids or alkalies of electrolytic baths.
- d. Should prevent electrolytic activity on the surface covered.
- e. Should be capable of removal by solvent vapor phase cleansing baths, by melting in boiling water, or ordinary cleaning solutions.

Suggested compositions are as follows:

		Softening Point
Methide (Monsanto Merrimac)	40%	118°C.
Aroclor 5442	60%	
Methide (Monsanto Merrimac)	20%	108°C.
Aroclor 4465	80%	

An attempt was made to use these compositions in solution form by dissolving them in turpentine. This was not particularly

successful since at room temperature the degree of solubility was less than 12%. It might be possible to use a 25% concentration of wax in turpentine at 50-75°C, painting the metal surface with the hot solution.

#### PAINTS

Paints containing Aroclor have shown remarkable durability, far better than any other paints against which they were tested.

One serious drawback, however, is that paints containing Aroclor do not brush as readily as the normal house paints. Paint manufacturers interested in quick drying paints should be encouraged to try Aroclor. Under war conditions there is great interest in the manufacture of fire-proof painting for the interior of ships. Aroclors should be a definite contribution to their formulation.

Aroclor 5460 is successfully used in camouflage paint where it imparts flameproofness.

#### VARNISHES

There has been only a limited amount of work done in our laboratory on the subject of Aroclor in varnishes and from that work it has been concluded that the most likely field for Aroclor in varnishes is in conjunction with some other resin such as Ester Gum or Dammar, or one of the other commonly used gums, since the use of Aroclor alone has, in our experience at least, given a tackiness to the film.

Aroclor 1262 mixed with East India Gum and cut with naphtha furnishes a varnish base.

The Aroclors may be used in alkali-proof varnishes by incorporating them as a cold cut or as a chill back -- and for the purpose we recommend Aroclor 1262. The Aroclor may be said to function either as a resin or as an oil. In other words, by the addition of the Aroclor, a short oil varnish takes on many of the physical characteristics of a long oil varnish. Our work along this line has indicated that the best procedure is to cook (in the usual manner) using as a resin base a pure phenolic resin but using only half the usual amount of china-wood oil. When the varnish attains proper body, the Aroclor may be added directly as a chill back and the varnish then thinned in the usual manner.

Since Aroclor 1262 is a semi-solid resin, it is best heated until liquid before introducing as the chill back.

An optional method is to dissolve it in the thinner and add in the usual thinning operation. This was worked out as a possible means of extending the supplies of china-wood oil. In other words, it acts as an oil substitute more than as a resin substitute.

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In regard to the alkali resistance, we have found that provided the other materials have, of themselves, considerable alkali resistance, then the Aroclor will add to that resistance. It is not possible, however, to use a resin such as lined rosin or ester gum having poor alkali resistance and impart high alkali resistance by the addition of the Aroclor.

Aroclor 1262 can be used to replace up to 50% of the china-wood oil in varnishes.

1. If ester gum, rosin, or other cheap resin is used, the varnish will be suitable only for interior work.
2. If a good 100% phenolic resin is used, the varnish will be satisfactory for exterior purposes.

Varnishes containing Aroclor 1262 are not superior in quality to similar varnishes made with tung oil alone, with the possible exception of a very slight improvement in alkali resistance, flexibility and adhesion in some formulations.

Varnishes containing Aroclor 1262 soften at lower temperatures than do varnishes employing only tung oil, and so are more subject to "printing" and marring when warm.

The advantage of increased flexibility of Aroclor varnishes is lost at low temperatures due to embrittlement of the Aroclor.

Because Aroclors weigh more per gallon than china-wood oil, they increase the cost of varnishes (which are sold by the gallon) even if put at the same price per pound as the oil.

LUBRICANTS

An outstanding service is performed by Aroclor 1254 as a lubricant for high pressure air compressors operating at 4400 pounds per square inch pressure. Besides avoiding flammability, it is claimed that the lubricant is superior to oil, no corrosion deposits result, and there is no excessive wear on the equipment (Company 15850).

Company (233950) is using Aroclor in a special drawing compound. Company (541370) tested Aroclor 1248 in one of their pumps operating at 2500 pounds pressure with the following results:

Compressibility change is 0.3% compared to 0.5% for petroleum oil. The wear rate of the pump was measured by observing the slip of the pump at intervals during the endurance run. Inspection of the pump showed the wear to have occurred on the piston hole walls in the cylinder and on the hardened surface of the pintle, the surface of the pintle felt wavy - not smooth. A wear rate of 22% per 1000 hours was found to exist. The viscosity slope of Aroclor 1248 was poor.

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The conclusion of these tests is reported as follows: Aroclor 1248 is not a very satisfactory fluid for general use in oil gear pumps at 2500 pounds per square inch. It is expensive as the pump requires special paint on the outside and inside; the operating range is narrow and the wear rate on the pump tests was 22% per 1000 hours at 100°F and 25 pounds pressure.

Our experimental work in using Aroclor as a lubricant in steam turbines was not successful, due principally to the fact that the Aroclor is of such high density that it picks up any bit of grit that may be in the system and floats it up in the bearing.

Petroleum oil having so much lower density allows most of these particles to settle in the bottom of the reservoir.

United States Patent #2,245,649, assigned to Celluloid Corporation, describes a steam turbine lubricant consisting of 50 parts of chlorinated diphenyl and 50 parts of triaryl phosphate.

E. P. Lubricants

Much attention is being given by lubricating men to the matter of increasing the film strength or load carrying capacity of lubricants, particularly so as to be able to use smaller gears for a given load.

There are a great many such lubricating compounds now on the market. As a class they are called "Extreme Pressure" or E. P. Lubricants.

It is well accepted in the lubricating industry that by the addition of certain elements as Chlorine, Sulphur and others in the proper form to a lubricating oil, a certain chemical combination takes place with the iron or steel metal bearing surfaces. These surface compositions tend to prevent seizure of the rubbing surfaces under extreme loads and under which loads, if the sole lubricant was a pure mineral oil, seizure or scoring would result at once through film failure.

In attempting to discuss Aroclor as an extreme pressure base, it is very difficult to evaluate its comparative load-carrying capacities with other extreme pressure bases, such as lead soap, active sulphur, saponifiable oils, sulphur chloride, etc., without actual results from exhaustive tests not only of the various E. P. testing machines, but also from actual service under normal operating conditions. It is recognized by the lubricating industry that results obtained on testing machines, such as Almen machine, Timken machine and others, mean very little unless the results are correlated and proved by service conditions. It is true that in the past Aroclor has been tested as an E. P. base on the Timken machine at Timken Roller Bearing and on the General

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Motors machine at General Motors Research, and in each case the Aroclor addition has shown a marked increase in load carrying capacity.

Several companies are purchasing Aroclor today for use in E. F. Lubricants, but indications are that they sometime add other elements along with the Aroclor to achieve commercial results at a lower price. Since we have never run service tests on the Aroclor ourselves and the few companies purchasing Aroclor are naturally very reluctant to divulge their experience along with what other chemicals, if any, they are using in conjunction with the Aroclor, the best that can be done is to offer comments by several of the companies who have tested the Aroclor and possibly give a general interpretation or suggestions as to where it might find more general present day application.

Top Cylinder Lubricant

Recently the practice of putting a lubricant in motor gasoline has become quite general. This is, of course, to lubricate the top section of the cylinder.

We have two customers who purchase Aroclor regularly for use in the top cylinder lubricant, which they make and sell.

We do not know the function of the Aroclor in this use other than that these customers tell us that it prevents the deposit of carbon on the valves. We understand that they use a relatively small percentage of Aroclor in the lubricant.

One of these customers uses Aroclor 1248 and the other uses Aroclor 1154.

We have done very little work with the Aroclor as a top cylinder lubricant but would suggest that Aroclor 1248 be used in small percentages. This Aroclor will be found completely soluble in low viscosity oil and should not cause any appreciable difference in its cold test. This is often added to the gasoline to achieve top-cylinder lubrication.

Company (735900) obtained excellent results using Aroclor 1254 on a bearing test, operating in straight Aroclor at 255-260°F (124-129°C) for two weeks. Much less carbonization and decomposition than with the usual spindle oil under the same conditions.

PLASTICS

Compatibility of Aroclors with Cellulose Acetate

Experimental Work. The compatibility limits of Aroclor 1262 were determined with five grades of cellulose acetate. For these

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cellulose acetates the limits were as follows:

<u>Eastman Cellulose Acetate Number</u>	<u>Compatibility Limit of Aroclor 1262 (per cent)</u>
7025	Between 10.0 and 13.6
7026	Between 16.2 and 17.9
7027	Between 13.1 and 16.6
7028	Between 17.8 and 19.7
10246	Between 16.4 and 18.1

These figures, as well as all the compatibility limits given in this report, refer to the limits as determined on thin films dried slowly in dry air and deposited from solutions containing, as is customary, 0.1 gram of "solids" per cubic centimeter of solution. The solvent was a mixture of 80% by weight of ethylene dichloride and 20% of alcohol (denatured, Formula 3A).

Another solvent mixture comprising 33.3% acetone, 33.3% ethyl lactate, 16.7% alcohol and 16.7% ethyl acetate (all percentages by weight) was less suitable than the solvent given above, and gave lower compatibility limits in the cases tried.

The compatibility limits of several Aroclors with one cellulose acetate (#10246) were determined. The observed limits were as follows:

<u>Aroclor No.</u>	<u>Limit (Per cent)</u>
1242	From 25.9 to 28.7
1254	From 25.7 to 29.1
1262	From 16.4 to 18.1
4465	From 14.2 to 16.8
5465	From 10.1 to 13.0

The ternary systems, comprising a cellulose acetate, Aroclor 1254, and a common plasticizer, were investigated.

The constants of the cellulose acetates, as given by Eastman Kodak Company, are as follows:

<u>Cellulose Acetate No.</u>	<u>Acetyl (Per cent)</u>	<u>Viscosity (Seconds)</u>
7025	39.3	5
7026	40.4	7
7027	40.8	30
7028	36.4	34
10246	41.4	6

Corresponds in viscosity characteristics approx. to 0.5-second (Lacquer grade) Nitrocellulose.

Conclusions

The compatibility limits of various Aroclors in a specific cellulose acetate and of one Aroclor in various cellulose acetates are comparatively low. The type of solvent employed affects the observed limits, the solvent which gives the more favorable results being the mixture of ethylene dichloride and alcohol. The compatibility limits of the Aroclors in cellulose acetate are, in general, more difficult to determine and less readily checked than the limits in nitrocellulose. The actual observed limit apparently depends upon the rate of drying, the thickness of the deposited film, the humidity of the air, and the solvent employed.

In the tests of compatibility made by Eastman Kodak Company, the limits were found to be 5% to 10% (Rittenhouse). Their low results were probably due to their method of detecting incompatibility, in which delicate optical methods were employed to detect haze in the film.

The work on the effect of Aroclors upon the rate of burning of cellulose acetate films, as given in the table, leads to the following conclusions:

1. Cellulose Acetate alone burns slowly.
2. The rate of burning, where burning takes place at all, is accelerated by each of the substances tried.
3. While the Aroclors increase the rate of burning, they at the same time give a flickering uncertain flame which tends to go out, that is, they tend to quench the flame.
4. Triphenyl Phosphate is an effective flameproofing agent, it being impossible to ignite the film containing 25% of it.
5. If flexibility and lack of tendency of the film to wrinkle or curl on drying is taken as a criterion of plasticizing power, the Aroclors are more effective plasticizers than either dibutyl phthalate or Tricresyl Phosphate.
6. The thick film containing 25% Aroclor 1254 (slightly below the compatibility limit for thin films) was blushed. This is in accord with the earlier observations of the effect of film thickness on the compatibility limit.

Company (756593) has found that mixtures of decachlorodiphenyl and styrene are non-inflammable and have a heat distortion point 20°F higher than polystyrene.

United States Patent No. 2,227,637, assigned to Leverkusen-I.G. Werk, describes a composition of matter comprising a resin-like chlorinated diphenyl of an average chlorine content of about 62%

and about 7.5% of polyvinyl carbazole.

### RUBBER

Company (297400) have found that Aroclor 1262 is the best plasticizer for rubber hydrochloride. It is compatible up to 100% rubber hydrochloride, although the usual working range is 5 to 10% of Aroclor 1262 based on the weight of the chlorinated rubber. Below 50% Aroclor no difficulty is encountered with brittleness. Aroclor tends to increase the gloss of rubber hydrochloride films, e.g., Pliofilm, Pliofilm, Pliolite. Five per cent rubber hydrochloride added to Aroclor reduces the tack.

On the other hand, Company (331850) recommends the use of Aroclor 1254 with chlorinated rubber, e.g., Parlon.

A rubber composition of reduced flammability comprises:

Rubber	100 parts
Chlorinated rubber	35 parts
Aroclors	65 parts
Sulfur	2.8 parts
Zinc Oxide	5 parts
Vulcanising Accelerator	1 part
Ammonium Borate	40 parts

This composition shows a flame resistance and a notable absence of melting around the burning material.

Aroclor 1268 is used in the manufacture of Cellulax rubber of low flammability for the aircraft industry.

Company (284144) has found that 15% of Aroclor 1242 added to Vistinex (polybutene) makes a de-icing coating for airplane propellers that looks promising. By the addition of plasticizer C-24 or plasticizer SC, low temperature characteristics can be obtained.

It is indicated that Aroclor 1242 may act as a solvent for one of the materials which is producing tack in Buna S.

The characteristics of Type E Neoprene compositions are said to be improved by the addition of Aroclor 1254 increasing water resistance. (Company 16947)

The use of Aroclor 5160 is under investigation as an extender for Hycar OR.

There are several different applications for Aroclor in rubber as follows:

As a plasticizer for hard rubber

Aroclor 1262 has been used as a plasticizer for hard rubber in dental plates, etc., for a couple of years. It should be equally useful in plasticizing hard rubber for other purposes where brittleness is undesirable.

To render rubber permanently tacky

Aroclors 1262 and 1254 are milled into rubber so as to make a homogeneous compound which has permanent tackiness or adhesion.

To flameproof rubber, Neoprene, and other synthetic rubbers

Aroclor 1269 is a hard crystalline material of high melting point. It may be ground very fine. This finely ground Aroclor is milled into the rubber just as any inert filler would be. The milling temperature is not high enough to melt this Aroclor and so there is no solvent action. It has been found that the incorporation of sufficient Aroclor 1269 in rubber prevents the spread of flame. This is suggested especially for flameproofing rubber for use on insulated wire.

THERMOSTATS

Aroclor 1248 is being used by several manufacturers of thermostats as the expanding medium in the bulb. Aroclor has been used in this service by one manufacturer for the last ten years. Aroclor has proved entirely satisfactory. Every precaution must be taken to eliminate the possibility of moisture or other foreign matter getting into the Aroclor. The thermostat equipment must be thoroughly cleaned before filling.

We do not recommend the use of Aroclor at temperatures above 600°F (315°C).

TEXTILES

Company (645300) reports that Aroclors, although more expensive, exert better fire retardant effect than chlorinated paraffins and smaller amounts are required.

Company (049900) claimed that Aroclors 1262 and 5460 showed a 10% increase in tensile strength when substituted for the standard Jeffersonville Quartermaster Depot specified impregnant for rope, which is the following formula:

41% Copper Naphthenate 800-S 98%  
14% Asphalt  
30% Paraffin Wax  
15% Mineral Seal Oil

Aroclor 1260 is proposed as a flameproofing, waterproofing, mildewproofing agent in the production of J.Q.D.'s specification 242 paulins and tentage for army use. Exact formulation and approval of the Quartermaster Corps has not yet been worked out.

WOOD

Aroclor as an Introdier for Sulfur in Wood Impregnation

It has been found desirable for some purposes to impregnate wood and other fibrous materials with sulfur. However, sulfur does not go into these materials without difficulty. The use of 10% of Aroclor 4465 mixed with the sulfur acts as an introdier, causing thorough penetration.

The impregnation is performed as follows:

A mixture of 90% sulfur and 10% Aroclor 4465 is melted and mixed and placed in an autoclave or pressure tank with the wood or other material to be impregnated and held at a temperature of 125°C to 140°C and a pressure of 100 pounds per square inch. The time necessary depends upon the kind of wood or other material being treated. The initial freezing point of this mixture is 107.5°C. The viscosity at 125°C is reported as 27 Seconds Saybolt Universal.

A typical impregnation of a yellow pine 2" x 8" plank gave an increase in weight of 127% and about 100% in tensile strength.

The valuable qualities contributed by this treatment are added strength, rigidity, resistance to moisture, to acids and to splintering. The electrical insulating properties are increased. The wood is made practically free from the effect of weather and resists attack by insects. The treated wood is practically free from shrinkage and swelling.

Possible uses of wood treated in this way are:

Transmission line crossarms.

Tanks to resist acids, etc.

Equipment in which swelling or splintering is objectionable.

Timbers likely to be attacked by termites, etc.

Perhaps many other applications where the qualities described above are desirable.

The requirement is that the wood so treated should stand being used 15 or 20 times in concrete forms, that it must remain smooth, and not show annular ring or grain structure on the concrete.

MORIANTO CHEMICAL COMPANY

10-1-44

where the forms are used. Plywood impregnated with a mixture of Aroclor 2565 and 10-20% hard paraffin (melting point 60-68°C) would be suitable for the construction of concrete forms. Addition of sulfur up to 20% of the mixture may be beneficial in reducing the cost of impregnating material and in making the treated wood harder.

The recommended procedure consists of keeping the plywood submerged for 30 minutes in the Aroclor-Paraffin mixture (or Aroclor, Paraffin, Sulfur mixture) at 80-90°C, then letting the boards drain at about 50°C and passing them between rollers to wipe off the excess of the wax.

Plywood treated in this manner increases in weight from 37 to 66% and gains only 3.1 to 5.7% in weight when immersed in water for six hours. Untreated wood gains 29% in weight when kept in water for an equal length of time.

Standard maple wood blocks used by the shoe last industry from (Company 769520) were treated with various compounds to prevent dimensional change from water absorption. The most effective composition was found to consist of:

70% Aroclor 2565  
20% Paraffin (hard or soft)  
10% Sulfur

When this composition was applied under the conditions shown below the results indicated were obtained:

	Weight of Treatment mg./sq.in.Surface	Effect of Soaking in Water 24 hrs.	
		Gain in Wt. g./sq.Meter	% Per- imeter change
1. 60 min. at 100°C.; 30 min. cooling	45.36	340	0.349
2. 60 min. at 100°C.; 30 min. cooling	42.96	375	0.349
3. 60 min. at 100°C.; 30 min. cooling	49.26	351	0.349
4. 60 min. at 100°C.; 30 min. cooling	49.50	367	0.525
5. Vac. 30 min. at 90°C. 5 min., released 10 min.	36.49	487	0.175
Maximum tolerable limit			0.556

MONS 092681

MONSANTO CHEMICAL COMPANY

10-1-44

From another series of tests conducted on hickory fishing pole handles it is concluded that the best results will be obtained using the following conditions:

Temperature	90-100°C
Vacuum	16-100 mm. for 25 min.
Atmospheric pressure	5 min.

Remove, drain and dry

MISCELLANEOUS

Purdue University found that Aroclor 1242 was very useful as a base upon which to flow gelatin solutions for the production of films, thus making it possible to eliminate mercury for this purpose.

As a result of interest aroused in the Aroclors, several suggestions have been made regarding uses which may prove of value.

1. Aroclor 1260 as an adhesive in a joint compound for glass building blocks.
2. A water emulsion of Aroclor 1262 for use in leather, paper, textiles, rubber and casein paints.
3. As a protective coating on certain pigments to prevent "livering" of paints containing resins of a high acid number. Specifically, zinc oxide pigment in water emulsion of "Aquadplex," a water emulsifiable alkyd resin.
4. A waterproofing for concrete.
5. Aroclor 1262 or 5460 as an ingredient of molding compositions made with such materials as ethyl cellulose, benzyl cellulose, soy bean meal and corn protein.

MONS 092682

SUGGESTED FORMULAE FOR MOISTUREPROOFING  
COMPOUNDS

Compound A	96.0% Aroclor 5460 4.0% Hard Paraffin
Compound B	96.0% Aroclor 4465 4.0% Hard Paraffin
Compound C	96.0% Aroclor 5060 4.0% Hard Paraffin
Compound D	96.0% Aroclor 4065 4.0% Hard Paraffin

When a relatively low softening point material is desired, we suggest these compounds using Aroclor 4465. When a higher softening point is required, we suggest the compounds using Aroclor 5460.

Compounds C and D are black materials and are useful where color is of no importance.

We do not prepare these compounds.



DRAFT LETTER

AROCLOR 1342

Aroclor 1342, Monsanto's modified capacitor fluid is replacing Aroclor 1242 in the manufacture of capacitors.

This new chlorinated biphenyl product is identical to Aroclor 1242, functionally, but has been modified to reduce the content of highly chlorinated components. The reason for this change is that environmental studies suggest that the more highly chlorinated components, especially those containing five and six chlorine atoms per molecule, are more persistent and therefore more likely to accumulate in the environment.

Aroclor 1342 will comply with new recommendations by CIGRE that capacitor askarels should not contain more than 3.5% pentachlor and more highly chlorinated biphenyls. To ensure that Aroclor 1342 complies with this specification sophisticated analytical methods will be employed to monitor the product.

Since the Aroclor 1342 retains the functional characteristics of Aroclor 1242 it is unlikely that any changes will be necessary in capacitor impregnation processes, nor will the performance characteristics of finished capacitors be changed.

Therefore Aroclor 1342 will be supplied against your orders for Aroclor 1242 received on or after July 1st 1974 when production of Aroclor 1342 is expected to commence.

It is not our intention to charge a premium for Aroclor 1342.

## **Exhibit 6**

EPA 560/6-76-005

PB252012



# PCBs IN THE UNITED STATES INDUSTRIAL USE AND ENVIRONMENTAL DISTRIBUTION

## TASK I

FEBRUARY 25, 1976

FINAL REPORT



REPRODUCED BY  
NATIONAL TECHNICAL  
INFORMATION SERVICE  
U. S. DEPARTMENT OF COMMERCE  
SPRINGFIELD, VA. 22161

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
OFFICE OF TOXIC SUBSTANCES  
WASHINGTON, D.C. 20460**

BIBLIOGRAPHIC DATA SHEET	1. Report No. <i>EPA 560/76-005</i>	2.	3. Recipient's Accession No. <i>PC-252,012</i>
	4. Title and Subtitle <i>A</i> PCBs In the United States Industrial Use and Environmental Distributions		5. Report Date February 25, 1976
7. Author(s) Robert L. Durfee, Gayaneh Contos, Frank C. Whitmore, James D. Barden, E.E. Hackman, III, and Robert A. Westin		8. Performing Organization Rept. No. 474.1	
9. Performing Organization Name and Address Versar Inc. 6621 Electronic Drive Springfield, Virginia 22151		10. Project/Task/Work Unit No.	
		11. Contract/Grant No. EPA No. 68-01-3259	
12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency Office of Toxic Substances Washington, D.C. 20460		13. Type of Report & Period Covered Final	
		14.	
15. Supplementary Notes EPA Project Officer - Tom Kopp			
16. Abstracts This document presents the current state of knowledge about the production, usage, and distribution of polychlorinated biphenyls (PCBs) in the United States. The information presented is derived from detailed studies on the production and first tier user industries, the past and present generation and disposition of PCB-containing wastes, environmental transport and cumulative loads, potential alternatives to PCBs usage, inadvertent losses to and potential formation in the environment, and current regulatory authorities for PCBs control. These results indicated that, although PCBs content of industrial wastes can be reduced through various approaches (treatment, substitution, etc.), there exists a potentially severe future hazard in the form of large amounts of PCBs currently contained in land disposal sites. Further definition of this and other aspects of the PCBs problem, and determination of ways to minimize the hazard, are recommended.			
17. Key Words and Document Analysis. 17a. Descriptors PCBs Properties Polychlorinated Biphenyls (PCBs) PCBs Manufacture Polychlorinated Terphenyls (PCTs) PCBs Users PCBs Wastewater Treatment PCBs Production & Distribution PCBs Substitutes PCBs Environmental Loads PCBs Environmental Transport Model Regulatory Actions on PCBs			
17b. Identifiers/Open-Ended Terms			
17c. COSATI Field Group			
18. Availability Statement		19. Security Class (This Report) UNCLASSIFIED	
		20. Security Class (This Page) UNCLASSIFIED	

#### ABSTRACT

This document presents the current state of knowledge about the production, usage, and distribution of polychlorinated biphenyls (PCBs) in the United States. The information presented is derived from detailed studies on the production and first tier user industries, the past and present generation and disposition of PCB-containing wastes, environmental transport and cumulative loads, potential alternatives to PCBs usage, inadvertent losses to and potential formation in the environment, and current regulatory authorities for PCBs control. These results indicated that, although PCBs content of industrial wastes can be reduced through various approaches (treatment, substitution, etc.), there exists a potentially severe future hazard in the form of large amounts of PCBs currently contained in land disposal sites. Further definition of this and other aspects of the PCBs problem, and determination of ways to minimize the hazard, are recommended.

TABLE 1.1-1  
 PCB & PCT MANUFACTURE AND PCB SALES  
 MONSANTO INDUSTRIAL CHEMICALS COMPANY  
 1957 thru 1964  
 (Thousands of Pounds)

	<u>1957</u>	<u>1958</u>	<u>1959</u>	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>
U.S. PRODUCTION OF PCBs	(1)	(1)	(1)	37919	36515	38353	44734	50833
DOMESTIC SALES OF PCBs	32299	26061	31310	35214	37538	38043	38132	44869
U.S. EXPORT SALES OF PCBs	(2)	(2)	(2)	(2)	(2)	(2)	3647	4096
U.S. PRODUCTION OF PCTs	-	-	2996	3850	2322	4468	4920	5288
<u>DOMESTIC SALES OF PCBs BY CATEGORY</u>								
Heat Transfer	-	-	-	-	-	157	582	929
Hydraulics/Lubricants	1612	1549	2685	2523	4110	3915	3945	4374
Misc. Industrial	704	755	1569	1559	2114	1681	1528	1692
Transformer	12955	5719	5984	7921	6281	7984	7290	7997
Capacitor	17028	14099	16499	16967	15935	15382	15606	19540
Plasticizer Applications	(1)	3939	4573	6244	9098	8924	9181	10337
Petroleum Additives	-	-	-	-	-	-	-	-
<u>DOMESTIC SALES BY PCB GRADE</u>								
Aroclor 1221	23	16	254	103	94	140	361	596
Aroclor 1232	196	113	240	155	241	224	13	13
Aroclor 1242	18222	10444	13598	18196	19827	20654	18510	23571
Aroclor 1248	1779	2559	3384	2827	4023	3463	5017	5238
Aroclor 1254	4461	6691	6754	6088	6294	6325	5911	6280
Aroclor 1260	7587	5982	6619	7330	6540	6595	7626	8535
Aroclor 1262	31	184	359	326	361	432	414	446
Aroclor 1268	-	72	102	189	158	210	284	190
Aroclor 1016	-	-	-	-	-	-	-	-

(1) Production figures and Plasticizer Applications figures unavailable during year indicated.  
 (2) U.S. Export Sales figures unavailable during year indicated.

TABLE 1.1-2  
 PCB & PCT MANUFACTURE AND PCB SALES  
 MONSANTO INDUSTRIAL CHEMICALS COMPANY  
 1965 thru 1974  
 (Thousands of Pounds)

	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>
U.S. PRODUCTION OF PCBs	60480	65849	75309	82854	76389	85054	34994	38600	42178	40466
DOMESTIC SALES OF PCBs	51796	59078	62466	65116	67194	73061	34301	26408	37742	34406
U.S. EXPORT SALES OF PCBs	4234	6852	8124	11231	10624	13651	-	6388	8346	5395
U.S. PRODUCTION OF PCTs	6470	8190	9450	8870	11600	17768	20212	8134	-	-
<u>DOMESTIC SALES OF PCBs BY CATEGORY</u>										
Heat Transfer	1237	1766	2262	2529	3050	3958	3060	752		
Hydraulics/Lubricants	4616	4258	4643	5765	8039	7403	1552	0		
Misc. Industrial	1841	1779	1426	1283	1079	1627	1155	0		
Transformer	8657	8910	11071	11585	12105	13828	11134	25656	37742	34406
Capacitor	23749	28884	29703	29550	25022	26708	14141			
Plasticizer										
Applications	11696	13481	13361	14404	16460	19537	3259	0		
Petroleum										
Additives	-	-	-	-	1439	-	-	0		
<u>DOMESTIC SALES BY PCB GRADE</u>										
Aroclor 1221	369	528	442	136	507	1476	2215	171	35	57
Aroclor 1232	7	16	25	90	273	260	171	0	0	0
Aroclor 1242	31533	39557	43055	44853	45491	48588	21981	728	6200	6207
Aroclor 1248	5565	5015	4704	4894	5650	4073	213	807	0	0
Aroclor 1254	7737	7035	6696	8891	9822	12421	4661	3495	7976	6185
Aroclor 1260	5831	5875	6417	5252	4439	4890	1725	305	0	0
Aroclor 1262	558	768	840	720	712	1023	1	0	0	0
Aroclor 1268	196	284	287	280	300	330	0	0	0	0
Aroclor 1016	0	0	0	0	0	0	3334	20902	23531	21955

TABLE 1.1-3

PCB MANUFACTURE AND SALES  
 MONSANTO INDUSTRIAL CHEMICALS COMPANY  
 First Quarter - 1975

	(Thousands of Pounds)
U.S. PRODUCTION	8532
DOMESTIC SALES	7986
U.S. EXPORT SALES	1538
<u>DOMESTIC SALES</u>	
Transformer and Capacitor	7986
<u>DOMESTIC SALES BY PCB GRADE</u>	
Aroclor 1221	10
Aroclor 1242	2201
Aroclor 1254	2115
Aroclor 1016	3660
<u>PREDOMINANT UTILIZATION OF AROCLORS</u>	
Aroclor 1221 }	Capacitors
Aroclor 1016 }	
Aroclor 1242 }	Transformers
Aroclor 1254 }	

TABLE 1.1-4  
END-USES OF PCTs AND PCBs BY TYPE

<u>End-Use</u>	<u>1016</u>	<u>1221</u>	<u>1232</u>	<u>1242</u>	<u>1248</u>	<u>1254</u>	<u>1260</u>	<u>1262</u>	<u>1268</u>	<u>PCTs</u>
<u>Existing Sales</u>										
Capacitors	XX	X		XX		X				
				through 1971						
Transformers				X		XX	X			
							through 1971			
<u>Sales Phased-Out</u>										
Heat transfer				X						
Hydraulics/ lubricants										
. hydraulic fluids			X	X	X	X	X			
. vacuum pumps					X	X				
. gas-transmission turbines		X		X						
Plasticizers										
. rubbers		X	X	XX	X	X			X	
. synthetic resins					X	X	X	X	X	XX
. carbonless paper				XX						
<u>Miscellaneous Industrial</u>										
. adhesives		X	X	XX	X	X				XX
. wax extenders				XX		X			X	XX
. dedusting agents						X	X			
. inks						X				XX
. cutting oils						X				
. pesticide extenders						X				
. sealants & caulking compounds										XX

Notes: (1) X denotes use of a given Aroclor in a specific end-use, while XX denotes principal use  
(2) PCTs denote series 25,44 & 54 Aroclors

Source: Monsanto Industrial Chemical Co.



ENVIRONMENT DIRECTORATE

OECD REPORT ON PROTECTION OF THE ENVIRONMENT  
BY CONTROL OF POLYCHLORINATED BIPHENYLS

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

PARIS 1979

Table 1

PRODUCTION

COUNTRY/PAYS	1973	1974	1975	1976	1977	1978	1979	1980
FRANCE	9 674	9 541	7 182	7 190**				
GERMANY ALLEMAGNE	6 949	8 374	7 328	6 610				
ITALY ITALIE	2 519	N.R.	1 868	1 933				
SPAIN ESPAGNE	N.R.	2 386*	N.R.	N.R.				
UNITED KINGDOM ROYAUME-UNI	4 067	4 818	3 274	3 013				
U.S.A. ETATS-UNIS	19 131.9	18 393.64	14 207.2	13 423				

(\*) Includes 2 250 tons of Pyralène T-I which is 40 % trichloro-benzine.

(\*) Y compris 2 250 tonnes de Pyralène T-I (40% de trichloro-benzine).

(\*\*) Includes T 60 which is 100% triphenyl

(\*\*) Y compris T 60 qui est 100% triphenyle

0,67

TABLE 2

1976 PRODUCTION BREAKDOWN / PRODUCTION VENTILEE-1976

Type	Mean WT % chlorine c/o moyen en ch(poids)	1976 Amount Quantités 1976 (in metric tons)
FRANCE <sup>(1)</sup>		
Di	32	362
Tri	41 to 42.5	4 166
Tetra	48 to 48.5	64
Penta	54 to 54.5	102
Hexa + $\frac{1}{2}$	60 to 62	2 496
T 60	60	546
GERMANY ALLEMAGNE		
Clophen:		
C	42.5	1 443
C Stab.	42.5	247
A 40	48.5	472
T 64 (70% PCB content)	58.0	1 483
T 241 (55% PCB content)	59.0	2 451
Elaol VI	42.0	514
ITALY ITALIE		
Fenchlor 42	39.0	295
Fenchlor 64	60.0	1 638
SPAIN <sup>(2)</sup> ESPAGNE		
DP-3 (100% Trichloro-biphénile)		
Pyralène 3000 (100% Trichloro-biphénile)		
DP-4 (100% Tetrachloro-biphénile)		
DP-5 (100% Pentachloro-biphénile)	N.R.	N.R.
Pyralène 5000 (100% Pentachloro-biphénile)		
DP-6,5 (100% Chlorobiphénile)		
Pyralène T-1 (60% Chlorobiphénile) (40% Trichloro benzène)		
UNITED KINGDOM <sup>(3)</sup> ROYAUME-UNI		
Aroclor 1342	42	2 420
Aroclor 1254	54	309
Aroclor 1260	60	284
UNITED STATES ETATS-UNIS		
Aroclor 1221	21.0	0
Aroclor 1016	41.3	9 629
Aroclor 1242	42	1 965
Aroclor 1254	54	1 829

(1) Figures include recuperated PCBs

(1) Y compris PCB récupérés

(2) 1974 figures (no figures submitted for '75). Production has remained fairly constant since 1969.

(2) Chiffres pour 1974 (pas d'informations pour 1975). La production est demeurée constante depuis 1969.

(3) The United Kingdom produced no Aroclor 1248 in 1975. Aroclor 1342 contains 3.5% maximum of the more persistent Penta and higher homologue.

(3) Le Royaume-Uni n'a pas produit d'Aroclor 1248 en 1975. L'Aroclor 1342 contient 3,5% maximum des homologues persistants à partir du Penta.

---

Halogenated biphenyls, terphenyls,  
naphthalenes, dibenzodioxins  
and related products

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*Editor*

RENATE D. KIMBROUGH

*Center for Disease Control,  
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1980

ELSEVIER/NORTH-HOLLAND BIOMEDICAL PRESS  
AMSTERDAM · NEW YORK · OXFORD



TABLE 1.13

U.S. sales (in 10<sup>6</sup> lbs) of PCBs by Aroclor grade and use category.

Year	Aroclor						Use category	
	1016	1242	1248	1254	1260	Others <sup>a</sup>	Closed systems <sup>b</sup>	Other uses
1957	0	18.2	1.8	4.5	7.6	0.3	30.0	2.3
1958	0	10.4	2.6	6.7	6.0	0.4	19.8	6.2
1959	0	13.6	3.4	6.8	6.6	1.0	22.4	8.9
1960	0	18.2	2.8	6.1	7.3	0.8	24.9	10.3
1961	0	19.8	4.0	6.3	6.5	0.9	22.2	15.3
1962	0	20.7	3.5	6.3	6.6	1.0	23.3	14.7
1963	0	18.5	5.0	5.9	7.6	1.1	22.9	15.2
1964	0	23.6	5.2	6.3	8.5	1.2	27.5	17.4
1965	0	31.5	5.6	7.7	5.8	1.1	32.4	19.4
1966	0	39.6	5.0	7.0	5.9	1.6	37.8	21.3
1967	0	43.1	4.7	6.7	6.4	1.6	40.8	21.7
1968	0	44.9	4.9	8.9	5.3	1.2	41.1	24.0
1969	0	45.5	5.7	9.8	4.4	1.8	37.1	30.1
1970	0	48.6	4.1	12.4	4.9	3.1	40.5	32.6
1971	3.3	22.0	0.2	4.7	1.7	2.4	25.2	9.1
1972	20.9	0.7	0.8	3.5	0.3	0.2	25.7	0.7
1973	23.5	6.2	0	8.0	0	<0.1	37.7	0
1974	22.0	6.2	0	6.2	0	<0.1	34.4	0
1975 <sup>c</sup>	14.6	8.8	0	8.5	0	<0.1	31.9	0

a. Aroclor 1221 + 1232 + 1260 + 1268.

b. Transformers and capacitors.

c. Estimates based on first-quarter figures.

cumulative PCB production in the U.S. was approx. 1400 million pounds, the cumulative sales data by use category (in millions of pounds) are: capacitors, 650; transformers, 335; plasticizer uses plus carbonless copy paper, 115 + 45; hydraulics and lubricants, 80; heat transfer, 20; miscellaneous, 25. In 1976, probably 60% — or, according to another source, in 1977 some 50% — of all PCBs purchased by U.S. industries were still in service, almost all in capacitors and transformers.

1.2.5.2. *Japan* (Tatsukawa, 1976). The total volume of PCBs used domestically during the period 1954–1972 was 120 million pounds. An estimated 82 million pounds were used by the electrical industry for such items as capacitors and transformers, 19 million pounds were used as heat-transfer agents and 12 million pounds for carbonless copy paper. PCB consumption for miscellaneous applications, such as in paints and lubricants, was 7 million pounds.

The main fields of use of the several Kanechlors were as follows: KC-300 (50), in capacitors and carbonless copy paper; KC-400 (20), as heat-transfer agent; KC-500 (34), in transformers; KC-600 (4.5), in paints. The values within brackets denote the total volume (in millions of pounds) produced between 1962 and 1971.

EJEM  
QD  
412  
.C5  
H85  
1974



# The Chemistry of PCB's

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202-260-3944

Recat. 10-13-94; OCLC #1055287

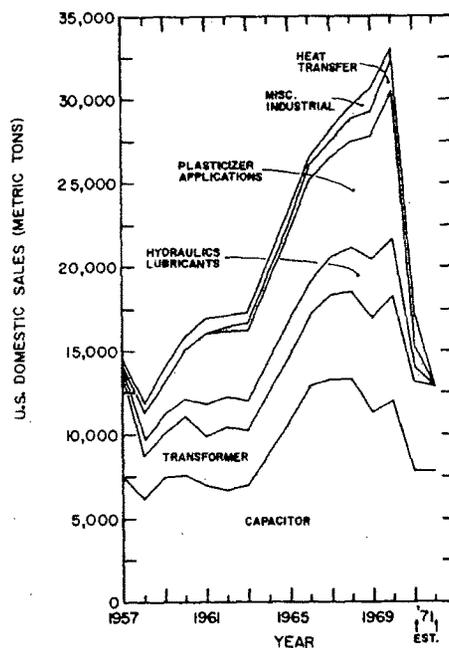


FIGURE 1. Domestic sales of Monsanto's Polychlorinated Biphenyls in the U.S. (by use). (Courtesy of Monsanto Company.)

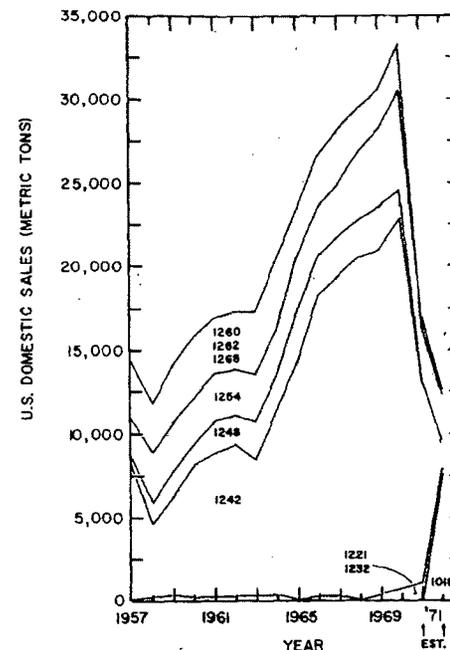


FIGURE 2. Domestic sales of Monsanto's Polychlorinated Biphenyls in the U.S. (specific Aroclors). (Courtesy of Monsanto Company.)

cated mixture of chlorobiphenyls with different numbers of chlorine atoms per molecule and their isomers.<sup>18,24</sup> This fact is responsible for the physical state of PCB preparations; most individual chlorobiphenyls are solids at room temperature whereas commercial mixtures are mobile oils (e.g., Aroclor 1221, 1232, 1242, and 1248); viscous liquids (e.g., Aroclor 1254) or sticky resins (e.g., Aroclor 1260 and 1262) due to the mutual depression of melting points of their components.

With the exception of Aroclor 1221 and 1268, PCB's do not crystallize but show a "pour point" below which the material changes into a resinous state. Some chemical and physical properties of Aroclor products are summarized in Table 4.<sup>25</sup> Electrical properties of some Aroclors are given in Table 5.<sup>18</sup>

The most important physical properties of PCB's from an environmental point of view, are solubility and vapor pressure. Solubilities of various Aroclors in a number of solvents are shown in Table 6.

The solubility of PCB's in water is low and

decreases with increasing chlorine content. Values given by Monsanto<sup>30</sup> are 200 ppb for 1242, 100 ppb for 1248, 40 ppb for 1254 and about 25 ppb for 1260. Freed<sup>12</sup> found a solubility of 43 ppb for Aroclor 1248 at 26°. These results are biased in each case by selective solution of components of lower chlorine content. Evidence for this comes from solubilization experiments of Zitko<sup>49,50</sup> and Freed.<sup>12</sup> Table 7 shows the relative peak height of saturated aqueous solutions of Aroclor 1254. The first few peaks which generally correspond to PCB components of lower chlorine content are significantly higher than in standard Aroclor 1254.

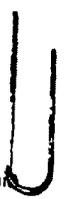
This variation of solubility between individual PCB components is also evident from studies on the water solubility of individual chlorobiphenyls<sup>16,44</sup> (Table 8).

Studies on the solubility of PCB in water are complicated by the fact that these compounds are strongly adsorbed onto various surfaces. PCB was shown to adsorb relatively rapidly onto wood-burn,<sup>12</sup> plastic,<sup>49</sup> glass,<sup>14,44</sup> and container and/or silt.<sup>10</sup>

5004441



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**1986 APTA RAPID TRANSIT  
CONFERENCE  
JUNE 1986  
COMMUTER CAR EQUIPMENT**

**AN ENVIRONMENTALLY ACCEPTABLE  
M U CAR TRANSFORMER**

**SUBMITTED BY:**

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## General Electric

The original G.E. askarel was a type B (ASTM-D2283) trade name Pyranol A13B3B with a composition of 45% Hexachlorobiphenyl (Aroclor 1260 - Monsanto trade name for 60% chloro/biphenyl) and 55% tri tetra chlorobenzene (a mixture of isomers and homologs of tetra and tri chlorobenzenes manufactured by Hooker Chemicals of Niagara Falls, New York). In 1965, G.E. began to switch away from the Aroclor 1260 because of mechanical problems resulting from evaporation TTCB and leaving a very thick "molasses type" residue and started using Aroclor 1254 (54% chloro/biphenyl). This continued until 1974-75 era. Also, in 1971, Monsanto stopped providing Aroclor 1260 (60% chlorinated biphenyl) as a control measure to contain PCB's.

## Westinghouse

Westinghouse originally used a type A (ASTM-D2282) askarel trade name Inerteen PPO which contained 60% hexachlorobiphenyl and 40% trichlorobenzene homologs and isomers. This differed from the G.E. mix in the absence of tetra chlorobenzene. Early in 1965, Westinghouse changed its formulation to a type D (ASTM-D2283) askarel consisting of 70% pentachlorobiphenyl (54% chlorinated biphenyl designated as Aroclor 1254-Monsanto trade mark) and 30% trichlorobenzenes. The mix was trade marked as Westinghouse Inerteen 54201KA. Westinghouse remained on this mix in railroad transformers until the phase out of manufacture in 1977.

### RAILROAD TRANSFORMER FLUID REQUIREMENTS

The railroad transformers required a fluid with fire resistance, electrical performance, physical characteristics, and environmental acceptability. The requirements did not change although the priorities shifted. More specifically, those requirements were as follows:

1. Fire resistance - should not support combustion - arc formed gases should be non-flammable.
2. Electrical performance - high impulse strength, good dielectric strength, and a dielectric constant - close to paper to even stress forces.
3. Physical characteristics - must be a good heat transfer material, must be fluid at temperature extremes, resistant to oxidation and moisture and a high aromatic content for gas absorption.
4. Environmental - must be non accumulative in the environment, biodegradable and non carcinogenic.
5. Non-toxic or exhibit a low level of toxicity.