PROGRESS REPORT
TECHNICAL SERVICES DEPT. - W. G. KRUMMRICH PLANT

JOB NO.	REPORT NO.	DATE
1716:246	93 (Final)	2, 21, 68

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TITLE: AROCLOR AND AROCLOR BLENDS: PROCESS IMPROVEMENT PLAN

PERSONNEL: R. M. McCutchan (T. E. Greenman)

PROBLEM: The objective of this report is to present the Dept. 246 (Aroclors, Pyranols and Pydrauls) Process Improvement Plan.

SUMMARY

Savings of $14,000 and new earnings of $45,000 (B.T.) will be realized during 1968 as a result of increased capacity.

Ready for 1969 production will be a new continuous chlorination plant with accompanying stills, earth treatment columns, storage tanks, and increased blend capacity at a cost of $1.5M. Benefits of the expansion will be:

1. Provide a total WGK Aroclor capacity of 70.0M lbs/yr which will be sufficient to meet sales needs through 1972 with a 25% excess domestically. Maximum capacity will be needed by 1976-77.
2. Protect market by achieving corporate quality goals.
3. Ability to supply all customers with Aroclor from either Anniston or WGK.
4. Lower maintenance costs.
5. Increased profits will begin in 1970 with payout occurring in 1974. (See "Appendix H" for manufacturing cost details.)

An estimated 3/4 man-years of TSD process time and 3-1/2 man-years of PR & D time will be needed during 1968.

ACKNOWLEDGMENTS: Thanks to D. C. Armstrong, V. Brawley, D. Fitzgerald, J. A. Gloeckner, and H. F. Ray for their assistance and cooperation in the gathering of data and writing of this report.

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DETAILS

I. Synopsis of Process

The Aroclor process consists of the following steps:

Chlorination - Batch chlorination of biphenyl (BiØ) with sniff gas (approximately 86 mole % Cl_2) at 150°C produces Aroclor. The by-product is hydrogen chloride (HCl) gas.

Blowing - Crude Aroclor from the chlorinators is blown with air to remove excess HCl before distillation.

Distillation - Crude Aroclor which has been air blown is continuously fed to the stills. These stills are straight-take-over type with no fractionation.

Earth Treatment and Filtration - The distilled Aroclor is earth (attapulgus) treated, filtered, and transferred to storage.

Blending and Loading - The finished product from the storage tanks is loaded into cans, drums, tank trailers, and tank cars, or used for making blends (electrical and non-electrical).

The principal Aroclors produced at WGK are 1242, 1248, 1254, and 1260. The last two digits indicate the % chlorine (weight) contained in the chlorinated biphenyl mixture (Aroclor).

II. Scope of Report

This report pertains to both the existing batch chlorination plant and the proposed continuous chlorination plant which is expected to be on-stream by January, 1969.

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III. TSD Process Job List

Priority	Job	Capital	Savings/Benefits	EDC
1	Install heat exchanger on Project 5334 (approved). Follow startup.	$8,000	Meet 1968 sales needs, insure $25,000 rate savings in 1968.	4/1/68
2	Coordinate quality tests in conjunction with PR&D effort.	0	Protect $5 M market	3/1/68
3	Make nitrogen blanket system operable.	$1,000	Quality	4/1/68
4	Determine biphenyl losses under various chlorinator conditions. Recommend conditions for 1968.	0	Quality, minimize losses	5/1/68
5	Design and install fume removal system.	$7,000	Safety	6/1/68
6	Investigate possible blend specification changes.	0	Increase blend capacity $1,000/yr in lab costs Raw material savings	5/1/68
7	Check still operation at pressure lower than 40 mm.	0	Quality	4/1/68
8	Evaluate level recorder for still #2, install if justified.	$1,500	Process control	6/1/68
9	Evaluate liquid nitrogen supply system for Dept. 246/254.	TBD	Lower nitrogen costs	4/1/68
10	Evaluate automatic drum flushing and drumming installation with new building.	$200-300 M	$20,000/yr labor savings and quality improvement.	
11	Evaluate equipping #1 still with horizontal pump and boildown facilities	$15,000	Increase distillation capacity by 5 M lbs/year	1/1/70

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IV. Capacity

A. Aroclor

1. Current Capacity

Department 246 is rated at 2.5 M lbs Aroclors/month, or 29.9 M lbs Aroclors/year. The department averaged 2.5 M lbs/month during 1967. Presently the bottleneck is chlorine availability and distillation rate.

2. Sales Forecast - WGK (H. J. Day, 9/7/67)

TABLE I (M Lbs)

Aroclor	Made In 1967	1968	1969	1970	1971	1972
1232	22					
1242	12576	16107	19037	21484	23772	25572
1248	5593	5049	4596	4571	4447	4861
1254	6615	4831	5039	5462	5957	6257
1260	4813	6638	6953	7345	8140	8485
1262	154	125	135	145	155	165
TOTAL	29773	32750	35760	39007	42471	45340
Dept.Cap.	37200*	---New 40 M lbs/yr Plant ---				

*Based on installation of still preheater and increased Cl_2 rate.

3. Capacity to Meet 1968 Sales

Current department capacity is not sufficient to meet 1968 sales needs. Capacity increases are planned in both the chlorination and distillation steps to an overall capacity of 37.2 M lbs Aroclors/year, or 3.1 M lbs/month.

a) Chlorination

1. Project 3824 installs a 6" chlorine feed line to Dept. 246 (EDC 3/1/68).

2. Project 4864 increases chlorine revaporization capacity (EDC 3/1/68).

3. The Brink's mist eliminator elements will be replaced to reduce yield losses in the off-gas.

4. In-line specific gravity instruments are needed, and will be installed in the continuous chlorination plant.

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IV. Capacity (Continued)

A. Aroclor (Cont'd)

b. Distillation

Project 5334 installs a spiral heat exchanger to preheat the still feed (EDC 3/1/68). This gives a 10% surge capability and insures needed production until the expansion is complete.

4. Storage Capacity, M Gal.

TABLE II

Product	Present Capacity, After Blending Project Complete	1968 Add 5 Tanks & Remove Un'gd	1971 Add Three Tanks	Minimum 1971 Storage Recom. By H. J. Day, 6/67
1242	55	80	140	132.0
1248	20	40	40	25.2
1254	20	40	40	34.4
1260	30	20	20	20.2
TOTAL	125	180	240	211.8

All new tanks will be 20,000 gallon aluminum tanks with nitrogen blanket facilities.

B. Aroclor Blends

1. Current Capacity

Dept. A-246 is rated at 1.2 $\bar{M}$ lbs/month Pyranols (14.4 $\bar{M}$ lbs/year) and B-246 at 0.575 $\bar{M}$ lbs/month Pydrauls (6.9 $\bar{M}$ lbs/year). However, the Pyranol capacity can not be achieved because of lack of mix tank capacity. During 1967 these blends were produced while operating at near capacity:

		1967
Pyranols:	1260 PPO	4,958,639
	1254 PPO	3,099,362
	A13B3B	1,199,190
		9,237,191
Pydrauls:	A-200	2,454,315
	280	191,772
TOTAL BLENDS		11,883,278

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IV. Capacity (Continued)

B. Aroclor Blends (Cont'd)

2. Future Capacity and Sales Forecast

Project 2844 (EDC 7/1/68) provides for changes and additions to loading and transfer lines, metering facilities, and the conversion of No. 8 storage tank to No. 3 mix tank. This will increase mix tank capacity from 27.5 M gal. to 47.5 M gallons, and should make possible capacities of 24.0 M lbs/year Pyranols and 6.9 M lbs/year Pydrauls.

Aroclor Blend Sales Forecast, M Lbs.
(H. J. Day, 9/26/67)

TABLE III

	Expanded Capacity	1968	1969	1970	1971	1972
Pyranols:						
Inerteen PPO (1260)		7200	7500	8000	8700	9200
Inerteen 54201 KA		2000	1800	1950	2100	2100
Pyranol A13B3B		1736	1800	1900	2200	2200
TOTAL PYRANOLS	24000	10936	11100	11850	13000	13500
Pydrauls:						
Pydraul A-200		2340	1700	1600	1100	1100
Pydraul 280		197	240	280	320	350
TOTAL PYDRAULS	6900	2537	1940	1880	1420	1450
TOTAL BLENDS	30900	13473	13040	13730	14420	14950

C. Drumming

1. Current Capacity

Drumming is done on two shifts, one standard operator per shift, 5 days per week. The standard operator also helps load trailers and tank cars (25% of time). During the 12 month period, June 1, 1966 - May 31, 1967, the following drums and cans were filled: (see Appendix A for detailed drumming report.)

TABLE IV

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Size	55 Gal.	30 Gal.	5 Gal.	Total
Aroclors	7221	0	569	7790
Blends	8249	540	2148	10937

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IV. Capacity (Continued)

C. Drumming (Cont'd)

1. Current Capacity (Cont'd)

Grand Total: 18,727 drums and cans
Average Output: 36 drums and cans/man/shift

2. Future Drumming Needs

TABLE V

Total Production, M Lbs

	1967	1972 (Sales Forecast)	5 Year % Increase
Aroclor	29.8	45.3	52%
Blends	11.9	14.9	25%

On the assumption that drumming requirements increase proportionally in 1972 with total production, 26,600 drums and cans will be needed. By adding one man on third shift drumming, these needs can be met with an average output of 34 drums and cans/man/shift. After 1972, a seven-day operation may be needed.

If drumming requirements increase sharply, a more automated drumming facility might be considered. (A rough estimate of such an installation including building is $200-300 M) Another source of justification for an automated system is the possible need of a drum flushing system for improved "as packaged" quality. Anniston TSD has the assignment of determining total company needs for maintaining Aroclor quality while packaged. Results of their studies will dictate drumming needs for future quality requirements.

D. Tank Car and Trailer Loading

The following table shows the number of tank cars and trailers loaded during June 1, 1966 - May 31, 1967, and the projected loadings for 1972:

TABLE VI 0190728

Number of Trailers or Cars

	6/66-5/67	1972
Tank Cars:		
Aroclors	72	111
Pyranols	95	125
Total	167	236
Trailers:		
95% Aroclors	197	300
5% Pydrauls		

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IV. Capacity (Continued)

D. Tank Car and Trailer Loading (Cont'd)

The existing loading facilities plus the two unloading docks included in the proposed plant expansion (CEA 1800) will be adequate through 1972.

E. Raw Materials

The following raw materials will be needed based on sales forecast.

TABLE VII

(M lbs)

	1968	1972
Biphenyl	18.0 M lbs	25.2 M lbs
Chlorine	34.1	46.6
TCB	3.5	4.3
TTCB	0.9	1.2

F. Expansion - Continuous Chlorination (CEA - 1800)

1. Scope

a) Five new 22,000 gallon aluminum storage tanks (EDC 7-1-68).
b) Railroad spur and two unloading docks
c) One 100,000 gallon biphenyl storage tank
d) Three existing 15,000 gallon underground tanks will be dismantled
e) Separate transfer lines for each product from day tanks to tank farm, and from tank farm to loading or drumming areas.
f) Chain of four chlorinators with external cooling and continuous feed tank (EDC 12-1-68)
g) Continuous blow tank and intermediate storage tank
h) Two semi-continuous distillation systems
i) Four continuous porocel column treatment systems
j) A complete therminol heating system
k) Additions to the existing control room including instrumentation
l) Electrical substation changes to supply power
m) Motor control center
n) Foreman's office

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IV. Capacity (Continued)

F. Expansion - Continuous Chlorination (Cont'd)

2. Justification for Expansion

a) Provide a total WGK Aroclor capacity of 65.0 M lbs/year which will be sufficient to meet sales needs through 1972 with a 40% excess at WGK.

b) Protect market by achieving corporate quality goals as follows:

	1242	1254
Resistivity, x 10^9 ohm-cm	10,000	15,000
Power Factor, %	0.6%	0.3%
Thermal Chemical Chlorides, ppm	<0.1	<0.1

c) Ability to supply all customers with Aroclor from either Anniston or WGK.

d) Lower maintenance costs.

e) Increased profits will begin in 1970 with payout occurring during 1974. At maximum capacity in the new plant, profits (B.T.) will be approximately $2.0 M/year over profits at maximum capacity in the old plant. If the Aroclor sales growth pattern continues, and with only a small increase in Anniston Aroclor capacity, maximum WGK capacity of 70 M lbs/year will be needed by 1976-77. If a 25% surge capacity is required, further expansion should be anticipated in 1972-73.

3. Capacity

After the continuous chlorination plant is on stream, all biphenyl will be chlorinated to the 1142 level in the new plant. It will then be chlorinated to the 1148, 1154, and 1160 levels in the batch plant. In 1972, based on H. J. Day's forecast of 9/1/67, the capacities and requirements of each plant will be:

a) Chlorinator Capacity, M lbs/year

TABLE VIII

	1972 Sales Forecast	Maximum Capacity Based on 1972 Product Split
For Internal Use:		
Continuous System (1142)	15.9	6.5
For Sales:		
Continuous System (1142)	25.6	36.5

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IV. Capacity (Continued)

F. Expansion - Continuous Chlorination (Cont'd)

3. Capacity (Cont'd)

	1972 Sales Forecast	Maximum Capacity Based on 1972 Product Split
For Sales (Cont'd)		
Batch System using 1142 as feed for 1148, 1154, and 1160	19.8	9.0
Batch System using Biphenyl as feed for 1148, 1154, 1160	0	24.5
Total Aroclors For Sales	45.4	70.0

b) Still Capacity, M lbs/year

TABLE IX

Still No.	Product	1972 Sales Forecast	Maximum Capacity Based on 1972 Product Split
1	1260-62	8.6	Boil-downs
2	Boil-down only, all aroclors		20.0
3 (new)	1242	25.0	25.0
4 (new)	1242	0.6	10.0
	1248	4.9	6.5
	1254	6.3	8.5
Total Aroclors		45.4	70.0

V. Quality

A. Goals

The following Aroclor quality goals were set at the corporate Aroclor meeting held on May 9-10, 1967:

1242	Resistivity x 10^9 ohm-cm	10,000
	Power Factor, %	0.6
	TCC, ppm	<0.1
1254	Resistivity x 10^9 ohm-cm	15,000
	Power Factor, %	0.3
	TCC, ppm	<0.1

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V. Quality (Continued)

B. 1967 Aroclor Quality

In December 1966 the removal of the catalyst baskets from the chlorinators was completed at W.G.K. No other normal operating conditions have been changed. During 1967 the only quality shift has been an improvement in the electrical properties of both 1242 and 1254 during the third quarter. This is unexplained. Normal quality ranges have been as follows:

TABLE X

W.G.K. - 1967 - In Plant Analysis

		1967 Normal Range	8/67-11/67 Average	Spec.
1242:	Resistivity x 10^9 ohm-cm	1,000-10,000	6,000	500
	Power Factor, %	0.5-3.0	0.7	5.0
	TCC, ppm	0.45-0.6	0.49	0.65
1254:	Resistivity x 10^9 ohm-cm	5,000-40,000	40,000	None
	Power Factor, %	0.2-1.0	0.2	None
	TCC, ppm	0.6-1.0	0.8	None

For a complete storage tank analysis record of Aroclor 1242 and 1254, see Appendix B.

C. Batch Quality Studies and Recommendations

Since early in 1967 there has been a concerted effort to improve Aroclor stability and electrical properties. This is a corporate effort headed by D. C. Armstrong of W. G. K., PR & D. It was initiated by the realization that Monsanto's Aroclor was surpassed in quality by foreign competitor's products.

The following quality factors have been considered and/or investigated: (For a complete report of PR & D batch work, see J. A. Gloeckner's progress report 91370:3794(1).)

1. Chlorination

a) Higher temperature chlorination will improve Aroclor quality. Four storage tanks of 1242 have been made at 195°C with an average 0.30 ppm TCC. The normal material made just prior to the tests averaged 0.45 ppm TCC. Optimum temperature has not been determined.

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V. Quality (Continued)

C. Batch Quality Studies and Recommendations (Cont'd)

1. Chlorination (Cont'd)

b) Higher ferric chloride concentrations (0.2%) are beneficial at 150°C. At 200°C, the benefit is doubtful.

c) Catalyst particle size was checked and found to vary considerably. (See Appendix C). Pennsalt is the only supplier of anhydrous ferric chloride and they do not attempt to control particle size.

d) Biphenyl quality is an important variable under normal conditions. At higher temperature or catalyst level the effect of biphenyl quality is greatly reduced.

e) Initial reaction temperature does not affect quality as long as it is at least 120°C.

f) Bromine was added to the chlorine to a 700-800 ppm level and used to make a storage tank of 1242. At reaction conditions of 195°C and 8 lbs. $FeCl_3$/batch, a TCC of .047 was obtained. This material was life-tested by Electric Utilities and approved.

g) Sparger design has been changed to give better chlorine distribution and to prevent catalyst settling. Resulting quality data has not been obtained.

h) Off-gas condensate is not suitable as a raw material for electrical grade Aroclor, but could be used for non-electrical grade. Off-gas losses increase by five times when increasing the reaction temperature from 150°C to 195°C. Cost of yield loss will increase by $30,000 for production of 30 M lbs.

Conclusion: Only one change can be recommended to improve Aroclor quality in the chlorination step. A temperature of 195°C should be used.

2. Filtration of Crude Aroclor

If catalyst concentrations higher than 0.05% are used, the undissolved ferric chloride should be removed before distillation. A centrifuge installation would cost $25-40,000.

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V. Quality (Continued)

C. Batch Quality Studies and Recommendations (Cont'd)

3. Distillation

a) A lime charge equivalent to 0.8% of the chlorination mass should be used (present practice).
b) For good process control, a level recorder is recommended for No. 2 Still. Especially during boil-downs, guess work risks line pluggage and considerable downtime.

4. Earth Treatment vs Porocel

In the present plant, 20 lbs. of attapulgus earth is mixed into a blend tank of distilled Aroclor for 30 minutes and then filtered to a finished product tank. Varying amounts of earth and porocel were tried, but no significant quality difference was noted. Power factor was measured on a temporary in-line instrument.

5. Storage and Transfers

a) All Aroclor storage tanks should be 21-25,000 gallon aluminum tanks with a nitrogen blanket. The existing nitrogen system does not work and is being checked for modifications. It will be operable by 4/1/68.
b) Separate aluminum transfer lines should be available for each aroclor product.

D. Continuous Chlorination Recommendations

WGK PR & D recommends the following process conditions be used in the continuous chlorination Aroclor plant expansion:

1. Chlorination

a) Biphenyl

Biphenyl will be monitored for water content. If high levels (80 ppm and above) are encountered frequently, the biphenyl should be dried with a molecular sieve prior to chlorination.

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V. Quality (Continued)

D. Continuous Chlorination Recommendations (Cont'd)

TABLE XI

b) Temperature	Min. Temp.	Max. Temp.
Biphenyl Feed Tank	100°C	120°C
Chlorinator 1	140	160
2	150	170
3	170	190
4	190	210

c) Catalyst

Use 0.1% $FeCl_3$ having a mesh size specification of 50% less than 15 microns and 100% less than 50 microns. Direct addition of the catalyst to the chlorinators is being explored. No baskets are to be used.

d) Yield Losses - Based on laboratory continuous chlorinations, vapor losses are expected to be 2-3 times that experienced at the Anniston Plant. This material should be used for non-electrical grade Aroclor production.

e) Circulation rate should be as high as possible compatible with good maintenance (narrows isomer distribution).

2. Crude Aroclor (1142) Storage

a) Temperature should be as high as possible, 150-190°C minimum.

b) Residence times should be as long as possible with a 12 hour minimum. The new intermediate storage tanks are sized for a 48 hour residence time.

c) The catalyst present improves stability.

d) Agitation is recommended for optimum contact of catalyst and 1142. It will also minimize catalyst build-up in the tank.

e) HCl removal will be accomplished by maintaining a mild vacuum (650 mm absolute) on the 1142 storage tank. Further work will determine if this is necessary. Air blowing is not recommended.

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TOWOLDMON0045339

V. Quality (Continued)

D. Continuous Chlorination Recommendations (Cont'd)

3. Distillation

a) Lime charge of 0.8% adequately handles up to 0.2% catalyst concentration.

b) Pressure is not very critical, but the lower the better. Starting with the same crude and distilling to the same yield, pressure and TCC are related as follows:

TABLE XII

Pressure	Temperature	TCC
5 mm	190°C	0.22 ppm
40	240	0.27
60	280	0.32

c) A forecut of 1% will result in an improvement of 0.01-0.03 ppm TCC, independent of earth treatment method, chlorination conditions, or ageing. The forecut could be added to the condensate from the chlorinators and used for non-electrical Aroclors. Present plant expansion does not anticipate making this forecut. Further PR & D investigation is scheduled.

4. Earth Treatment

Use porocel columns as demonstrated at Anniston.

5. Future Work

	EDC
a) Assist in plant demonstration at Anniston using chlorination conditions of 190-195°C in the third chlorinator and $FeCl_3$ added to each mix tank. Evaluate results. (Test scheduled for 3/11/68).	5/1/
b) Define where $FeCl_3$ should be added (pending Anniston demonstration).	4/1/
c) Determine necessity and means of HCl removal from crude.	3/1/
d) Investigate effect of water and trace impurities in biphenyl on Aroclor stability. Monitor H_2O level in department biphenyl storage.	9/1/
e) Monitor bromine content of department chlorine.	3/1/
f) Evaluate additional routes for improving Aroclor stability.	9/1/

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V. Quality (Continued)

E. Aroclor Blends

Specifications are normally met on all Aroclor blends, but sometimes with great difficulty. The following conditions hinder the production of high quality blends:

1. General

a) The blend tanks are inadequate in size and TTCB storage non-existent. Project 2884 will provide a third blend tank (20,000 gallons). It is recommended that one of the underground storage tanks (15,000 gallons) be retained for TTCB storage.
b) There is only one supplier (Hooker) of TCB and TTCB. These raw materials have poor electrical qualities and are difficult to clean up.
c) To aid in the mixing process, the blends are blown with plant air. This is not a good practice and an alternate method should be used.
d) Earth treatment of the blends does little good, sometimes degrading the electrical properties. During 1967 earth treatment of 1260 PPO and 1254 PPO has been stopped. Less difficulty in meeting specifications has resulted.
e) The chloride scavenger harms electrical properties.

2. Specifications

a) Pydrauls - No problems
b) 1254 PPO - No problems
c) 1260 PPO - Two causes make the specific gravity and refractive index specification difficult to meet:
   (1) The specifications for the blend are narrower than for the components.
   (2) The specific gravity and refractive index specifications do not correlate well with each other.

The per batch average is three blend adjustments and eight control sample analyses. This means increased lab costs, but more importantly, delay in shipments, below minimum drummed inventory, and poor TCB and TTCB yields.

A program to correct this problem was set up in 1966 by Don Harris and Bill Caraway, but was dropped after preliminary work because the dollar value was low ($10-12M/year). Completion of this work is still needed as the time factor becomes more important and blend sales increase.

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V. Quality (Continued)

E. Aroclor Blends (Cont'd)

d) A 13 B 3 B - This blend suffers from the same specific gravity and refractive index problems as does 1260 PPO. In addition, blends must be adjusted with 1260 since there is no TTCB storage. Finally, because of the poor quality TTCB, the electrical property specifications are difficult, and occasionally impossible to meet. Five electrical property checks and seven specific gravity and index analyses are made on an average batch.

VI. Yields

A. Biphenyl

TABLE XIII

Year	Actual Yield	Standard
1964	96.57%	
1965	98.39	
1966	98.66	
1967	98.30	97.0%

The yield loss is in the off-gas condensate and is worth $7,000 in 1968 when chlorinating at 150°C and $37,000 when chlorinating at 195°C. In the continuous chlorination plant this material will be used in the feed stream when producing non-electrical grade Aroclor.

B. Chlorine

Chlorine usages are calculated by the chlorine department and therefore are not a meaningful gauge to the Aroclor Department operations.

C. TCB and TTCB

TABLE XIV

	Actual Yield 1967	Standard
TCB	98.23	98.0%
TTCB	94.11	98.0

The yield losses are worth $10-12 M in 1968 and are due to lack of TTCB storage and mix tank capacity.

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VII. Manufacturing Costs (Year 1967)

Total cost variance on the Aroclor production and blending operation was (-) $9,298 for 1967. The following items represent the larger cost variances:

A. Compressed Air Act $12,132 Sch $6,007 Var (-) $6,125

Compressed air is pro-rated to the using departments.

B. Supplies Act $17,381 Sch $22,543 Var $5,162

Supply costs appear normal and are itemized in Appendix D.

C. Packing Containers Act $120,886 Sch $113,295 Var (-) $7,591

A larger than expected percentage of Aroclor and Arclor blends are being sold in drums.

D. Laboratory Act $35,995 Sch $31,772 Var (-) $4,223

As noted previously, many control samples are analyzed in achieving blend specifications.

E. TSD, Experimental, and PR & D

Act $107,635 Sch $30,794 Var (-) $76,841

Since early in 1967, an intensive program has been planned and pursued in an effort to improve Aroclor quality.

F. Mechanical Expense

Act $129,008 Sch $192,778 Var $63,770

A plant expansion expected in 1967 which did not materialize causes the large positive variance.

Mechanical expenses and downtime during 1967 were above 1966, but in line with 1964-65. Other downtime results primarily from low chlorine pressure. This should be corrected with the completion of projects 3824 and 4864. For a summary of 1964-1967 mechanical expense and downtime, see Appendix E.

Appendix F itemizes the mechanical expenses for 1966-1967. Pumps continue to be a source of high maintenance costs. It is recommended that all new pumps installed be equipped with mechanical seals. Replacement or modification of existing pumps to pumps with mechanical seals will be evaluated.

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VII. Manufacturing Costs (Continued)

F. Mechanical Expense (Cont'd)

Appendix G lists all projects currently pending, or completed during 1967.

VIII. Stream and Air Pollution

The principal stream pollutants from Dept. 246 are biphenyl and chlorinated biphenyl. These are sewered at a rate of 700-800 lbs/day and are not considered a pollution problem. The sewering of this material will be eliminated with the Aroclor plant expansion by January, 1969.

The principal air pollutant is HCl gas. This is minimized by drowning the blow tank vapors.

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APPENDIX "A"

DRUMMING OF AROCLOR & BLENDS, 6/66 - 5/67

Prod.	Type Container, Gallons											
	55	30	5	55	30	5	55	5	55	30	5
	June 1966			July			Aug.		Sept.		
1232							22				
1242			39	302			40		195		61
1248	88			158			192		20		
1254	985		36	510		66	402	30	183		
1260											
1262							19				
A 13 B 3 B	138	64		251	7		352	132	297	148	255
1254 PPO				95	22						
1620 PPO	249		16	91			96		153		
PYD A-200	196			203			438		377		
PYD A-280									60		
1254 + 10% XYL							76				
THERM 1	40			42					190		4
THERM 2				104			4				
THERM 3											
TOTALS	1696	64	91	1656	29	66	1641	162	1475	148	320

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APPENDIX "A" (CONTINUED)

DRUMMING OF AROCLOR & BLENDS, 6/66 - 5/67

Prod.	Type Container, Gallons											
	55	30	5	55	30	5	55	5	55	30	5
	Oct. 1966			Nov.			Dec.		Jan.		
1232											
1242	150			231			138		120		
1248				12			84				
1254	345		142	178		35	354		221		
1260									24		
1262	23										
A 13 B 3 B				91		1034	170	200	58	100	
1254 PPO							64		70		10
1260 PPO	216						161	52	134	50	61
PYD A-200	366			231			174		116		
PYD A-280									152		
1254 + 10% XYL				39					39		
THERM 1									28		32
THERM 2	59			52			174		75		
THERM 3	70										
TOTALS	1229		142	834		1069	1319	252	1037	150	103

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APPENDIX "A" (CONTINUED)

DRUMMING OF AROCLOR & BLENDS, 6/66 - 5/67

Prod.	Type Container / Gallons	FEB.		MAR.			APRIL			MAY			TOTAL		
		55	5	55	30	5	55	30	5	55	30	5	55	30	5
1232		41											63		
1242		176	53	92			18			98			1560		
1248		108		72			104			201			1039		
1254		134		250			448		36	456		71	4456		416
1260													24		
1262		37											79		
A 13 B 3 B		2		30			52	35	53	130	99	175	1571	453	1849
1254 PPO				14	15		1						244	37	10
1260 PPO		143	74	255			141			151			1790	50	203
PYD A-200		223		60			224			158			2766		
PYD A-280													212		
1254 + 10% XYL		39		38									231		
THERM 1		16		52			112						480		36
THERM 2		110		90			143		34	14			825		34
THERM 3				16		16	44						130		16
TOTALS		1029	127	969	15	16	1287	35	123	1208	99	246	55 Gal.		15,479
													30 Gal.		540
													5 Gal.		2,717

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APPENDIX B

ANALYSIS ELECTRICAL GRADE 1242

	Spec.	0.65 max.	500 min.	5.0 max.	
Mo., 1967	Lot No.	TCC	Resistivity x 10^9	P.F.	Comments
January	KI-				
	401	0.25	1850	0.66	Normal operating conditions unless otherwise noted. (195°C, 2 lbs $FeCl_3$)
	402	0.29	3950	0.82	
	403	0.30	2000	1.83	
	404	0.37	600	2.20	
	406	0.41	800	1.29	
	407	0.49	600	2.64	
February	408	0.51	1030	4.44	
	411	0.45	3200	0.90	All other material sold as non-electrical
	412	0.33	2040	0.76	
March	415	0.59	1600	1.80	
	417	0.40	960	3.00	
	421	0.28	700	3.03	
	422	0.34	680	2.37	
April	423	0.45	900	3.38	
	427	0.47	1600	1.62	
	428	0.52	880	3.06	
	431	0.48	750	1.86	
May	436	0.32	2150	0.26	
	437	0.36	1300	3.24	
June	440	0.62	4240	0.66	
	444	0.61	2500	0.84	
	447	0.53	3250	0.85	
	448	0.28	2880	0.81	— (195°C, 8 lbs $FeCl_3$)
July	451	0.59	2620	0.89	
August	455	0.55	2040	1.39	
	456	0.49	7489	0.31	
	457	0.47	5000	1.56	— (195°C, 8 lbs $FeCl_3$ 700-800 ppm Br_2)
September	459	0.55	2560	0.99	
	462	0.63	2610	0.94	
	465	0.46	10400	0.52	
	469	0.47	6900	0.78	
October	471	0.38	22400	0.40	
	472	0.30	13600	0.36	— (195°C, 2 lbs $FeCl_3$)
	475	0.44	13690	0.23	
	476	0.41	7350	0.40	
	477	0.26	13750	0.24	— (195°C, 2 lbs $FeCl_3$)
November	480	0.50	4000	1.26	
	482	0.37	8000	0.19	— (195°C, 2 lbs $FeCl_3$)
	485	0.53	2000	1.74	
	488	0.64	1300	2.64	
December	489	0.35	1450	2.96	— (195°C, 2 lbs $FeCl_3$)
	492	1.81	1545	4.41	
	493	0.40	2500	2.46	— (195°C, 2 lbs $FeCl_3$)
	494	0.35	2880	1.23	
	KK-				
January 1968	402	0.34	1320	2.49	
	403	0.37	10600	0.66	
	406	0.35	1880	1.53	
February	408	0.50	1900	2.27	

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APPENDIX B (Continued)

ANALYSES ELECTRICAL GRADE 1214

Spec. - No plant specifications.

Mo., 1967	Hot No.	TCC	Resistivity x 10^9	P.F.	Comments
	KI-				
January	601	0.69	3800	0.63	Operating con-
February	604	0.65	510	4.12	ditions were
March	605	0.68	5450	1.06	150°C, 2 lbs
	606	0.69	4080	0.90	FeCl$_3$.
	607	1.00	22000	0.24	
April	609	1.07	1200	2.53	
May	613	1.00	10400	0.49	
	616	0.99	22400	0.29	
June	618	1.19	6650	0.31	
	619	0.89	5900	0.63	
July	621	0.96	6400	0.76	
	623	0.79	36020	0.14	
August	625	1.06	24015	0.15	
September	628	1.05	43250	0.23	
October	631	0.50	800460	0.11	
	632	0.67	160000	0.20	
November	633	0.85	4160	0.31	
	634	1.34	13500	0.43	
December	636	1.24	6950	0.76	
	637	0.82	8805	0.70	
	KK-				
January 1968	602	0.85	2650	1.44	
February	605	0.57	16000	0.31	

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APPENDIX C

SOLVAY CALCIUM CHLORIDE PARTICLE SIZE

Particle size was determined by St. Louis Testing Laboratories, Inc.

Plant	WGX	Anniston	WGX	Anniston
Date Sample Tested	5/8/67	5/25/67	7/6/67	7/6/67
Per Cent less than 1 micron	---	6.6	5.4	---
Per Cent less than 5 micron	---	24.5	69.9	---
Per Cent less than 10 micron	17.4	42.5	91.4	8.5
Per Cent less than 20 micron	46.6	93.4	---	21.8
Per Cent less than 50 micron	85.5	---	---	69.7
Per Cent less than 100 micron	98.1	---	---	89.7

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APPENDIX D

SUPPLIES

Items over $200 bought from the storeroom during 9 months of 1967:

Filter paper, Sparkler	$662.50
Glass bottles, 5 pt.	607.52
Oakite cleaner	502.26
Seals (labels)	475.00
Filter cartridges	462.00
Soaps and detergents	351.88
16 oz. bottles and caps	335.93
Kerosene	277.20
Filter cartridges, Alsop	272.00
Pressure gauges	245.40
Rags	244.86
Steam hose	221.61
3-2" flanged tees, 4 gate valves	200.00

The above items account for about 50% of the total supply cost. The balance is made up of non-repeating items bought through the storeroom and through purchase orders.

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TOWOLDMON0045351

APPENDIX E

SUMMARY OF TRUE REPAIR, MECHANICAL EXPENSE, AND DOWNTIME FOR 1964 - 1967

Category	1964	1965	1966	1967
True Repair	$80,404	$82,302	$70,450	$
Mechanical Expense	116,834	100,379	88,592	129,008
Repair D. T.	1.92%	2.93%	0%	3.13%
Process D. T.	3.29	2.00	0.46	4.48
Total D.T.	9.03	9.20	2.76	10.50

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TOWOLDMON0045352

APPENDIX F

MECHANICAL EXPENSES,

1966-1967 YTD (JULY)

Category	1967 Thru July	% of Total M.E.	1966	% of Total M.E.
Pump	$10,571	17.0%	$10,046	11.3%
Furnace	1,384	2.2	1,844	2.1
Dept. repairmen	4,799	7.7	8,560	9.7
Instrument	3,539	5.7	7,340	8.3
Ejector	2,030	3.3	2,554	2.9
Platform	15,338	24.7	13,2[illegible]	14.[illegible]
Plant Improvement	8,684	14.0	9,132	10.3
Work to Assist	5,702	9.2	9,124	10.3
Tank, Closed	575	0.9	2,647	3.0
Piping	2,844	4.6	8,722	9.8
Electrical	686	1.1	4,351	4.9
Miscellaneous	1,820	2.9	3,439	3.9
All Others	4,236	6.8	7,623	8.6
Total M.E.	$62,208		$88,592	

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APPENDIX G

PROJECTS CURRENTLY PENDING

OR COMPLETED DURING 1967

Engr. Auth. No.	Est. No.	Date App.	Description	Cost	Status
	5334	8/67	Install heat exchanger	$ 8,000	EDC 2/1/68
	2844	4/66	Blending & Loading Facilities	60,000	Given to CED for construction; mat'l being ordered. EDC 7/1/68
	5639	10/67	Relocate TCB Dock	2,100	
	1138	12/66	Install alarms on chlor.	3,450	Comp. 8/67
	4263	1/67	Dism. gravity instrument	500	Complete
	4467	3/67	Replace steel & handrails	18,810	Complete
	4448	4/67	Replace vacuum jet	4,620	Complete
	4871	4/67	Install Exp. Filter	2,600	Complete 6/67
	5018	5/67	P.M. painting steel	23,380	Complete
	5411	8/67	P.M. insulation repairs	5,375	Complete
S-842	3446	7/66	Install safety showers	2,700	Comp. 5/67
S-892	3528	7/66	Alter shower tracing	1,000	Comp. 5/67
S-893	2698	12/65	Alter three loading docks	5,700	Complete
S-670			Dismantle & replace lean-to	30,500	Held up pending study of drumming required.
S-650			Upgrade control room	4,000	Held up pending department expansion by CED.
S-647			Upgrade office	6,000	Est. sub. 8/67
S-7060			Upgrade lighting		
M-6049	R3771	8/66	Relocate 6" fire protection line		Complete 5/67
M-5034	3491	8/66	Roof over loading dock		Complete 2/67
	Minor		Install mech. remote Ram valve		Scheduled for December 1967 T/A
			Install spare #2 still pump	8,000	Estimate submitted

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APPENDIX H

Using the cost standard prepared by H. F. Ray for the expanded Aroclor plant operating at a maximum capacity of 70 $\overline{M}$ lbs/year, the following manufacturing costs and net profits/year were calculated:

	1968	1969	1970	1971	1972	1976-77
Sales Forecast, $\overline{M}$ lbs.	32.75	35.76	39.01	42.47	45.34	70.00
Unit Mfg. Cost	$6.84	$7.66	$7.47	$7.29	$7.16	$6.48
Net Profit (B.T.) $\overline{M}$ $	1.59	1.45	1.65	1.87	2.06	3.65
Increased Profit Compared to 1968, $\overline{M}$ $	--	-0.14	0.06	0.28	0.47	2.06

Payout should occur during 1974.

Assumptions:

1. Average sales price of 15.0¢/lb.
2. SARE of 22%.
3. Salary and wage increase of 4% annually over 1968.
4. 1967 prices on biphenyl and ferric chloride, 1968 prices on other raw materials.
5. Depreciation based on addition of 1.5 $\overline{M}$ $ capital with 12 year life.
6. Addition of four operators, one packer, and one foreman.
7. Biphenyl yield of 97%; chlorine - 93%.

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