COMPANY CONFIDENTIAL

MONSANTO INDUSTRIAL CHEMICALS COMPANY
APPROPRIATION REQUEST

Patent 9/27.

Sept. 16, 1971

TO: MR. E. J. Bock
President

Messrs. J. M. Depp (4
P. J. Dowd (2
J. J. Kerley (3
L. F. Steinbach (2

TITLE: SANTOWAX REFINING EXPANSION
(Specialty Products Business Group)

NEW FIXED CAPITAL REQUESTED: $ 870,000

DIVISION: Functional Products Group PLANT: Anniston

REQUEST NO. CEA 2472 FORECAST NO. 1101

FIRST LISTED IN THE CONSTRUCTION FORECAST: 1st Quarter 1971

I - SUMMARY

Benzene is pyrolyzed at Anniston to make biphenyl and terphenyl. Crude terphenyl is called Santowax C, while the refined product is called Santowax R. Biphenyl and crude terphenyl (Santowax C) are presently separated in a continuous distillation system. Santowax C is then refined in a second continuous column, with the bottoms (higher polyphenyls) discarded as still residue.

One aspect of Monsanto's announced PCB (polychlorinated biphenyl) control program is the replacement of PCB products in

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"non-controllable" applications. Several of the replacement products are terphenyl derivatives, notably HB-40 (hydrogenated terphenyl) in some carbonless copy paper applications and Solid Aroclor (chlorinated terphenyl) in industrial hydraulic fluids and plasticizers. The resulting demand calls for more Santowax R than can be processed in the existing continuous Santowax column. Although an existing idle batch still has been pressed into service, this expensive expedient will suffice only until late 1973. This project provides a new Santowax fractionation column rated at 60 $\overline{M}$ lbs./year to match the next feasible increment of furnace capacity. A major debottlenecking of the pyrolysis furnaces will eventually be needed to supply sufficient Santowax C, but is outside the scope of this project.

The existing Santowax column will be converted to biphenyl stripping service, and stripped Santowax fed to the new column, thus eliminating a potential route of entry of PCB into the environment. This important result is an important part of the PCB Plan, which was approved in concept by the Corporate Management Committee in May 1970.

Finally, the present problem of disposing of polyphenyl still resides, mainly quaterphenyl, can be converted into a profit

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opportunity by using the quaterphenyl as a low-cost feedstock for new products. The first of these is WCM, which is 40% hydrogenated quaterphenyl, and will be used in plasticizer blends with Santicizer 711 in the wire and cable market. This project provides additional trays below the feed on the new Santowax column, plus a side-draw condenser, so that refined quaterphenyl (called Santowax Q) can be produced for 1-1/2¢/lb. as needed up to 10 $\overline{M}$ lbs/yr. This will reduce the volume of still residue by 60%. The rapid acceptance of the blends makes this project more urgent; debottlenecking of the hydrogenation facility is probably needed and $160M is included under "undeveloped design" to provide for this contingency.

Earnings are based on the sales of the new WCM blends, and cost savings in labor, yield, and waste disposal. Significant further benefits were not included for the sake of simplicity. Return on New Capital is 23% in 1974. This is especially attractive considering that a portion of the capital is required to improve stripping of biphenyl.

Central Engineering has reviewed this request and its comments are incorporated in those sections where it has shared responsibility.

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	YEAR FIRST ACHIEVED 1974 THIS PROJECT	
NEW FIXED CAPITAL REQUESTED	$ 870	
NEW WORKING CAPITAL REQUESTED	$ 1034	
TOTAL NEW CAPITAL	$ 1904	
ALLOCATED CAPITAL	$ 3616	
GROSS INVESTMENT	$ 5520	
RETURN ON NEW CAPITAL	7.8%	
RETURN ON GROSS INVESTMENT	22.7%	
PAYOUT PERIOD	4.6	YEARS
CAPITAL TURNOVER	.5	TIMES/YEAR

C. P. CUNNINGHAM,
MANAGING DIRECTOR

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SCHEDULE 1

RETURN ON INVESTMENT AT NORMAL OPERATING LEVEL (1)

(Dollars in Thousands)

	YEAR FIRST ACHIEVED 1974 THIS PROJECT (2)
ANNUAL NET SALES	
AMOUNT (25,800# X 10.6¢/lb.)	$ 2735
COST OF GOODS SOLD	1799
GROSS PROFIT FROM SALES	936
GROSS PROFIT FROM COST SAVINGS	209
TOTAL GROSS PROFIT	1145
SARE DIVISION	160
INVESTMENT CHARGE	120
INCOME CHARGES - NET	-
FEDERAL INCOME TAXES (50%)	432
NET INCOME	$ 433
NEW FIXED CAPITAL REQUESTED	870
NEW WORKING CAPITAL REQUESTED	1034
TOTAL NEW CAPITAL	1904
ALLOCATED CAPITAL	3616
GROSS INVESTMENT	$ 5520
RETURN ON NEW CAPITAL	7.8%
RETURN ON GROSS INVESTMENT	22.7%
CAPITAL TURNOVER	.5 TIMES/YEAR

(1) Normal operating level for this project is 72% of capacity.
(2) This project is based on a new blend with no existing "present line".

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SCHEDULE 11

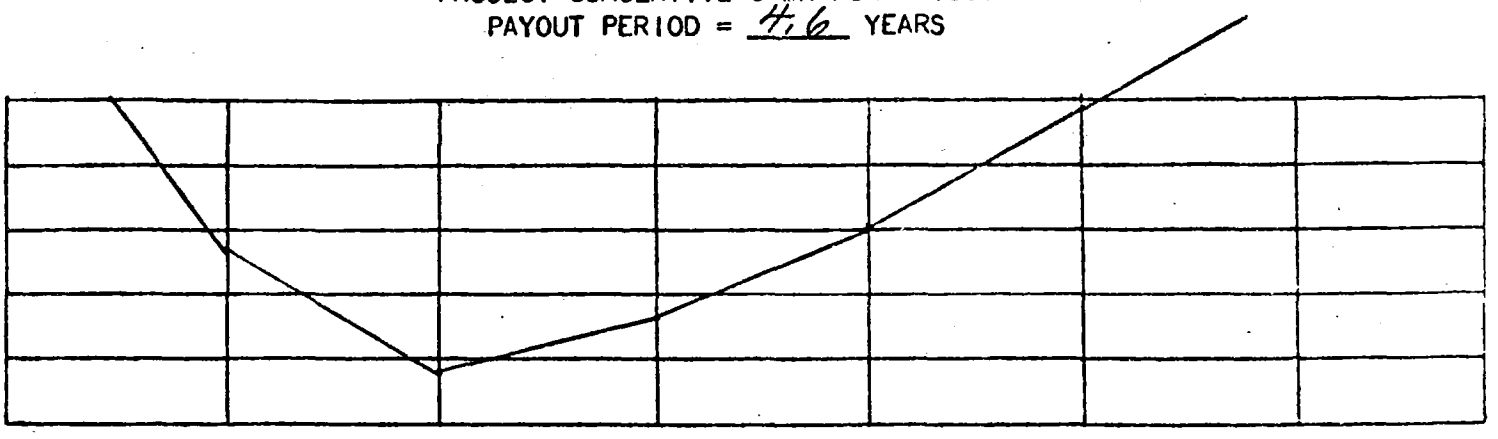
PAYOUT STATEMENT
(DOLLARS IN THOUSANDS)

	1971	1972	1973	1974	1975	1976	19__
NEW FIXED CAPITAL	580	290	___	___	___	___	___
NEW WORKING CAPITAL	101	612	213	108	97	39	___
PROJECT EXPENSES (AFTER TAXES)	12	5	___	___	___	___	___
PRECOMMERCIAL SARE EXPENSES (AFTER TAXES)	___	___	___	___	___	___	___
START-UP & CORRECTION EXPENSE (AFTER TAXES)	7	13	___	___	___	___	___
DISMANTLING EXPENSES, NET OF SALVAGE (AFTER TAXES)	7	___	___	___	___	___	___
TOTAL CASH REQUIREMENTS	707	920	213	108	97	39	___
ADDED NET INCOME*	(6)	238	287	410	542	598	___
DEPRECIATION AND DEPLETION TAX CREDIT ON WRITEOFFS	___	105	148	132	116	102	___
TOTAL CASH SOURCES	(6)	333	435	542	658	700	___
NET CASH AVAILABLE FOR PAYOUT	(713)	(587)	222	434	561	661	___
CUMULATIVE CASH AVAILABLE FOR PAYOUT	___	(1300)	(1078)	(644)	(83)	578	___

*AFTER SYD DEPRECIATION, AND TAXES (50%).

FIGURE 1

PROJECT CUMULATIVE CASH FOR PAYOUT
PAYOUT PERIOD = 4.6 YEARS



1971	1972	1973	1974	1975	1976	19__
	5.8%	6.0%	7.8%	9.9%	10.6%	

R.O.I. ON GROSS INVESTMENT
(THIS PROJECT TO PAYOUT)

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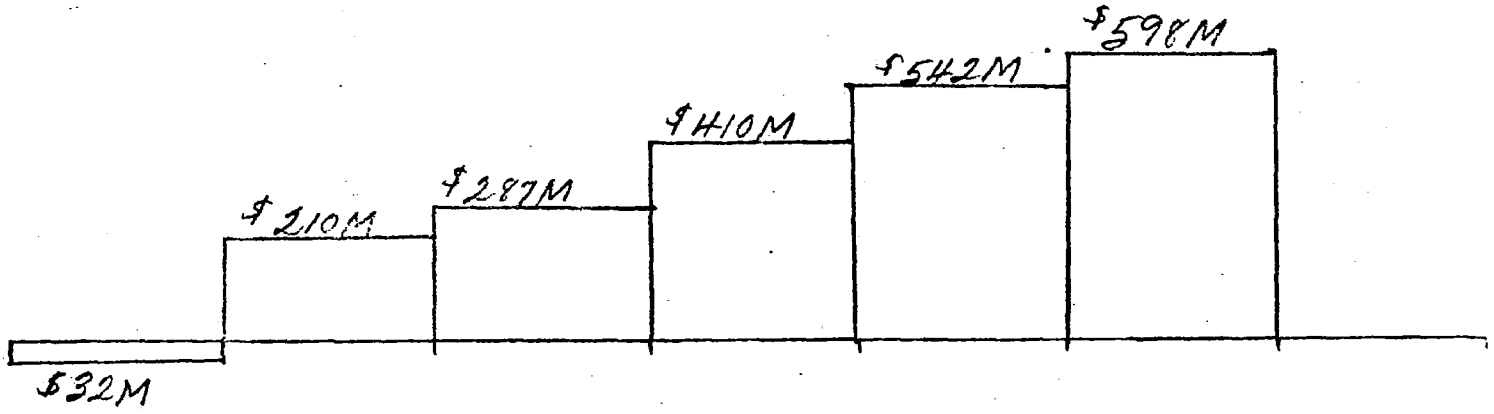
SCHEDULE III

EFFECT OF PROJECT ON REPORTED CORPORATE NET INCOME
(DOLLARS IN THOUSANDS)

	1971	1972	1973	1974	1975	1976	19__
ADDED NET INCOME*	(6)	228	287	410	542	598	____
EXPENSES (AFTER TAXES)	26	18	____	____	____	____	____
RETIREMENT LOSS (AFTER TAXES)	____	____	____	____	____	____	____
NET EFFECT	(32)	210	287	410	542	598	____

*AFTER SYD DEPRECIATION AND TAXES (50%)

EFFECT ON REPORTED NET INCOME



1971 1972 1973 1974 1975 1976 19__

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II - PREMISES

The key commercial premise of this project is that those "PCB replacement" products that are based on terphenyls will succeed in the market place at the forecasted levels. As discussed in the Market Section, several possible events could markedly influence Santowax requirements beyond 1973. However, the short term requirements are quite firm and the longer term requirements are unlikely to be so low as to prevent an adequate project payout.

Central Engineering has based its estimate on the data in the Project Scope Report dated 2/23/71, and on the Addendum issued 6/18/71. Sufficient information was available for preparation of a reliable estimate.

The distillation concept for recovering terphenyls will be basically the same as for the existing system. The stripping operation for removing biphenyl from Santowax and the recovery of Santowax Q have been demonstrated by Research.

Quaterphenyl will be hydrogenated for sale in plasticizer blends. Sales of these blends are already under way and market acceptance is excellent.

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Sensitivities are:

Volume 0.1 % R.O.I. per 10% volume change

Price 2.3 % R.O.I. per 10% price change

Cost 1.7 % R.O.I. per 10% cost change

III - ALTERNATIVE COURSES

A) Install a New Biphenyl Stripping Column

If the proposed project did not make the existing Santowax column available as a biphenyl stripper, installation of such a column would be required to prevent contamination of chlorinated terphenyl. Since this would cost about $300,000 NFC and yield no return, it is obviously an inferior alternate. Sales of WCM blends would be lost immediately, and eventually sales of Santowax derivatives would be lost.

B) Refine Quaterphenyl Batchwise

Introductory quantities of WCM have been made from quaterphenyl refined batchwise in the "old" Santowax still (predecessor to the current continuous still). This operation is unsatisfactory for volume production because of the lack of adequate tankage to accumulate sufficient feedstock for an economical hydrogenation run. Capital to make this an acceptable operation would be approximately the same ($200,000) as the increment needed on this project to provide continuous quaterphenyl

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refining, and manufacturing cost would be $80,000/yr. higher. Therefore, this alternate is not recommended.

The Alternate proposed herein was selected during Scope preparation during the 2nd quarter of this year. At that time, forecasts indicated a Santowax R shortage by the beginning of 1972, making the selected alternate a clear-cut choice. Because of the need to reduce biphenyl content of Santowax, equipment was ordered on pre-project approval from the General Manager. Since that time, forecasted requirements have been reduced, based primarily on a more realistic assessment of the European carbonless copy paper requirement. It could be argued, based on present forecasts, that a combination of Alternates "A" and "B" would meet requirements for the next 2 years and reduce the capital immediately required by $200,000; the need for more capacity might never materialize. Thus the selection of the best alternate is now more a matter of judgment, based on probable minimum capital over the next 2 - 4 years and lowest operating cost. In any case, since the column has been built and will be delivered this month, there is now no economically feasible way to change course.

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IV - MARKET

Monsanto is the only significant domestic source of terphenyl. A small amount is sold as such, but most is used as an intermediate for Solid Aroclors and HB-40.

A) Solid Aroclors

1) As such

Chlorinated terphenyls, mainly Aroclor 5460, have been sold for many years as plasticizers for use in water-proofing compounds, adhesives, etc. This is considered a stable growing market.

2) In Plasticizer Blends

Blends of monochlorobiphenyl and Aroclor 5460 are being promoted as replacements for the PCB Aroclors withdrawn from Plasticizer markets. The present forecast is a prediction of the success of these replacements. Results to date are essentially on target.

3) In Fire-Resistant Industrial Hydraulic Fluids

The Pydraul fluids have been reformulated to eliminate the use of PCBs. A principal component of the new blends is 32% chlorinated terphenyl (Aroclor 5432) which is needed for viscosity and fire resistance. Monsanto has an excellent position in this market although there is significant competition from phosphate ester/oil fluids and water/glycol fluids.

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Research to date on ecological implications of using chlorinated terphenyls in hydraulic fluid is reassuring. In addition, we will have competitive phosphate ester-based fluids ready for introduction in 1972 or later as necessary. An appropriation request covering expenditures necessary to make our phosphate ester facilities capable of this is being prepared. There is also a possibility the hydrogenated quaterphenyl will be a component in these blends.

B) HB-40

1) Carbonless Copy Paper Solvent

A large volume is being exported to NCR (Europe). This market is profitable and growing rapidly, but is firm only through 1973-4 because of potential changes in technology which could lead NCR to switch to some other solvent. The export volume will be reduced somewhat when supplemental quantities become available from a proposed small unit at Newport (UK). Other U.S. makers of carbonless copy paper use smaller amounts of HB-40 and HB-30, a modified version of the same product.

2) As Therminol 66

HB-40 is sold as Therminol 66, a non fire-resistant heat transfer fluid usable to 650°F. Performance is excellent,

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sales are growing and very profitable. Competition is Dowtherm A and petroleum fluids.

3) HB-40 Reactor Grade

This small profitable volume is used by Atomic Energy of Canada Limited in their experimental Organic Cooled Reactor Program. Large volume is a long way off, even if the program is successful, but could represent a high potential for the future.

4) In Plasticizers

HB-40 is used as secondary plasticizer in wire and cable insulation. Because of performance deficiencies, its price must remain below that of dioctyl phthalate. This is the least profitable use of Santowax. Some or all will be displaced by hydrogenated quaterphenyl (WCM), which will be both cheaper and better.

C) Santowax Sales As Such

A small amount of Santowax R is sold as such and as Therminol 88, a heat transfer fluid of limited application. Various mixtures of the ortho, meta and para isomers have been promoted from time to time but the volume is insignificant.

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D) Quaterphenyl Derivatives

When hydrogenated to the 40% level, quaterphenyl becomes a useful blend component (with Santicizer 711) to make plasticizers for wire and cable insulation. These new blends are superior to previous HB-40/DIDP blends in both performance and cost. Customers are eagerly changing over to the new blends at a rate which is hard to satisfy via the present make-shift production arrangement.

Hydrogenated quaterphenyls also show promise as heat transfer media and as blend components in hydraulic fluids, but work has not progressed to the point that these applications can be included in the forecast.

E) Forecast

Since the demand for Santowax R stems from a wide diversity of applications, overall economics are not heavily dependent on any single market. Current forecast is as follows (in $\overline{M}$ lbs.):

	1972	1973	1974	1975
For HB-40 and HB-30.....	16.0	19.7	25.5	27.6
For Solid Aroclor	10.0	11.0	11.7	12.2
Sales of Santowax as such..	.1	.1	.1	.1
Santowax Q for WCM*	5.0	7.0	7.2	7.2
TOTAL REFINED SANTOWAX	31.1	37.8	44.5	47.1

* In the present situation, about 3 times the occupancy is required to make Q as to make R.

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V - TECHNOLOGY

The key area of technological concern is the effectiveness of the proposed stripping operation for reducing biphenyl content of terphenyl (Santowax). Because of this concern, the best possible stripping of biphenyl is desirable. This project is taking a logical major step toward reducing biphenyl content in Santowax by converting the existing Santowax column for stripping biphenyl. A Research simulation of the proposed operation demonstrated that this conversion will reduce biphenyl content in Santowax to 10 ppm, although the large scale-up factor introduces some uncertainty as to the exact extent of this improvement.

Continuous distillation for recovery of terphenyls should have a minimal risk since it is being done in the plant today. Conditions will be changed slightly because additional trays are being added to the column for recovery of quaterphenyls. The additional trays will necessitate a slightly higher bottoms temperature but still within the operating region for materials of construction. Quaterphenyl (Santowax Q) is currently being recovered by batch distillation. This project will produce Santowax Q by continuous distillation.

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Research has successfully demonstrated continuous distillation of Santowax Q and produced material equivalent to or better than the batch distilled product. The laboratory material was hydrogenated successfully to WCM, a major Santowax Q end use. The color of the hydrogenated laboratory material was worse than hydrogenated batch distilled Santowax Q. This color difference is attributed to thermal degradation caused by inadequate agitation due to a limited amount of sample in the laboratory autoclave.

The lab distilled Santowax Q also proved to contain more quaterphenyl and less light and heavy ends than batch distilled Santowax Q. The absence of the more volatile light ends is an advantage in the application of Santowax Q as a plasticizer. Lack of heavy ends could be a disadvantage if the demand for Santowax Q exceeds the supply of quaterphenyl. More heavy ends may be included in the production version of Santowax Q by varying column conditions.

VI - SIGNIFICANT CONTRACTS

The contract for HB-40 to NCR (Europe) runs through 1974. No other significant contracts relate to this project.

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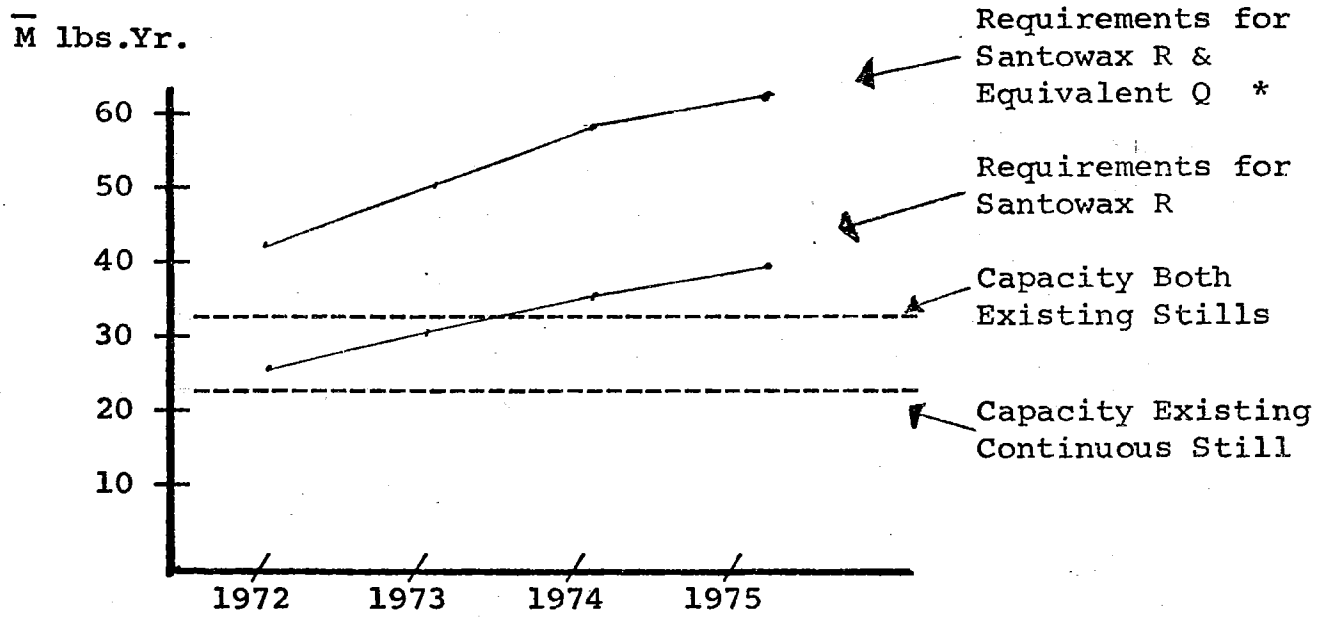
VII - PATENT SITUATION

No problems of patent infringement are associated with the process or apparatus as disclosed and defined herein.

VIII - EARNINGS

The present situation on capacity versus requirements can be graphically shown as follows:



* Equivalent Q = 3 X R Equivalent

This shows that both existing stills are needed now for Santowax R, while the addition of Q makes the situation hopeless. While the present equipment forces a 3:1 tradeoff of Q capacity for R capacity, the new system will be capable of up to 15 $\overline{M}$ lbs./yr. Santowax Q capacity (although only 10$\overline{M}$ will be available) without affecting the 60 $\overline{M}$ lb./yr. Santowax R capacity.

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The earnings resulting from this project include:

1) New earnings from sale of the WCM/Santicizer 711 blends, which cannot be supported without this project. Not included in the Financial Summary is a "loss avoidance" of over $300,000/year in Santicizer 711 unscheduled capacity charges (i.e., absorption of fixed and budget expenses), and a further potential penalty of $400,000/year in olefin contract obligations, both of which are prevented by sale of the new blends.
2) Improvement in chlorine usage in Solid Aroclor resulting from higher quality (less quaterphenyl) Santowax R.
3) Savings in waste disposal cost for Solid Aroclor still residue (because of better yield) and polyphenyl still residue (because quaterphenyl will be recovered).
4) Earnings from Santowax R derivatives in excess the amount available from both existing stills. These earnings, which begin in 1974 and rise to $70,000 in 1975, are not included in the Financial Summary because of the resulting complicated capital flow.
5) Savings from shutdown of the old batch still, now needed to supply Santowax requirements even without the new quaterphenyl business.

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Return on New Capital in 1974 is a highly attractive 22.7%. Return on Gross Investment is diluted to 7.8% because of the substantial backup capital flowed to the blends from Santicizer 711.

A further comment on earnings: The installation of a new biphenyl stripper, costing about $300,000 would be required if this project did not make the existing continuous still available. If the earnings are measured against the $570,000 of "optional" New Capital, ROI is 35% in 1975.

IX - CAPITAL

A) Scope of Project

Major new equipment items to be added include:

1) A 20 tray Santowax column with a jet ejector vacuum system
2) Condenser for Santowax R and Santowax Q
3) Receivers for biphenyl strippings and for Santowax Q
4) Seven high temperature pumps
5) A Santowax Q storage tank

The existing Santowax column will be modified and repiped for use as a biphenyl stripper; the existing Santowax R receiver will be converted for use with the new column.

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B) Estimate

CAPITAL	
Machinery & Equipment	$ 710,000
Building	0
Uninstalled Spare Equipment and Instruments	0
Undeveloped Design	160,000
TOTAL CAPITAL	$ 870,000
DISMANTLING EXPENSE (AFTER TAXES)	
Dismantling	$ 6,900
PROJECT EXPENSE (See Appendix I)	

These costs are based on a detailed preliminary "Project Scope Report" dated February 23, 1971, and on an Addendum to the scope report dated June 18, 1971. Both the scope report and the addendum included an "Equipment Information Summary, " "Instrument Summary", a preliminary equipment layout, and preliminary bills of materials. The $160,000 under "undeveloped design" provides for a 3rd hydrogenation autoclave which will be installed for WCM production if current work to improve cycles is unsuccessful.

Dismantling costs cover the removal of a furnace at the Queeny Plant for use as a reboiler on this project, removal of a 25,000 gallon horizontal storage tank, and removal of miscellaneous piping. Relocation and modification costs include blanking strips for trays in the intermediate stripping column, modifications to the re-used furnace, and relocation of 150 feet of benzene piping.

This estimate has an accuracy range of ±15%.

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C) Project Status

Authorization has been received for pre-approval funds for definitive design and equipment ordering. The major factor in the project schedule is the long delivery time required for the column. Construction will be performed under fixed-cost contracts and completion will be in late February 1972.

D) Supporting Capital

Current forecasts for biphenyl and Santowax derivatives exceed rated polyphenyl pyrolysis capacity in late 1973. A vigorous technical program aimed at a 30% increase in pyrolysis capacity is currently underway and feasibility has been demonstrated. Depending on the outcome of this work, capital expenditures will be required in the range of $20 to $200 M. This expenditure is not included in the earnings calculation.

X - LEGAL

No unusual legal problems are anticipated.

XI - PERSONNEL

The new equipment will be operated by the existing work force through use of remote operated controls.

XII - RISK EVALUATION

In this department, the major safety hazards result from handling flammable materials at elevated temperature above

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their flash points. The most probable cause of extended down-time is explosion or fire in the reboiler furnace. This could result in a cost of $25,000 for repairs and $200,000 business interruption loss based on a complete production outage of 7 days and partial reduction to 40% of maximum capacity for 3 weeks.

Two hydrants with monitor nozzles will be installed for fire protection. The column skirt will be fireproofed to protect the column from damage.

Safety and Property Protection has reviewed and concurs in this evaluation.

XIII - POLLUTION AND TOXICITY PROBLEMS

The bottoms (Montar) from the Santowax column will be disposed of by using the present method of pumping to the Montar pit. Organic fumes emitted at the pit during the pumping operation are an air pollution problem both within the plant and at the adjacent highway. This project may reduce the fume problem by removing some of the more volatile material in Montar as Santowax Q for sale. Anniston plant personnel have work planned for development of improved disposal methods.

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Emissions of biphenyl and terphenyl vapors from the Santowax column vacuum jet and the Santowax R receiver vent will be small and will not present an air pollution problem.

No water pollution problems are expected on this project. A non-condensing vacuum jet will be used on the Santowax column to avoid discharging any process water streams to the sewer.

A toxicity screening test was performed on WCM which indicated no special precautions in handling or use are required.

XIV - INTERNATIONAL ASPECTS

Crude Santowax produced as a by-product of Newport (United Kingdom) biphenyl is not presently utilized. This material will be imported if needed into the U.S. on a duty drawback basis with export HB-40 to supplement Anniston crude production until a small production unit is completed at Newport.

Worldwide terphenyl production is relatively small. Bayer (Germany) and Kanegafuchi (Japan) have some terphenyl derivatives in the market place, and Prodelac (France), Kuhlman (France), Flic (Spain), and Caffaro (Italy) are

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potential competitors, since they have small amounts of by-product terphenyl.

XIV - CORPORATE DISTRIBUTION REVIEW

The expansion of Santowax at Anniston will not introduce any unusual distribution problems. However, the greater market area and expanded use of Santowax in blends will be studied for possible distribution cost reduction.

XVI - FINANCE

Finance recommends approval of this project which is expected to earn an 7.8% ROI in 1974. The new Santowax distillation equipment provided by this project solves one aspect of the PCB problem while producing a refined by-product serving as an intermediate for a new product which ties in with improving the profitability of Santicizer 711 sales. The project appears to be well justified by earnings from incremental new sales plus cost savings.

If the recently proposed investment credit is enacted, a credit of $70M will be available on this investment.

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