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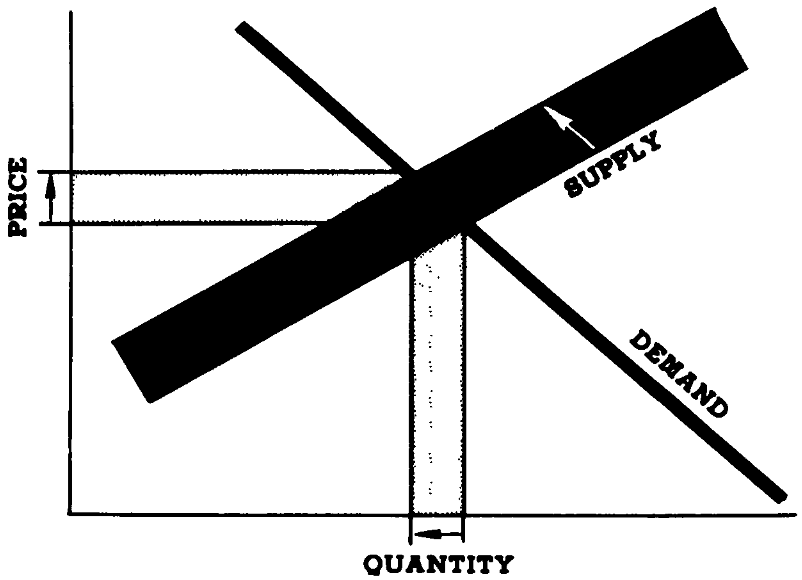
ECONOMIC ANALYSIS OF PROPOSED EFFLUENT GUIDELINES

THE INDUSTRIAL PHOSPHATE INDUSTRY



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ECONOMIC ANALYSIS
OF
PROPOSED EFFLUENT GUIDELINES

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PREFACE

The attached document is a contractors' study prepared for the Office of Planning and Evaluation of the Environmental Protection Agency ("EPA"). The purpose of the study is to analyze the economic impact which could result from the application of alternative effluent limitation guidelines and standards of performance to be established under sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended.

The study supplements the technical study ("EPA Development Document") supporting the issuance of proposed regulations under sections 304(b) and 306. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports promulgation of certain effluent limitation guidelines and standards of performance based upon an analysis of the feasibility of these guidelines and standards in accordance with the requirements of sections 304(b) and 306 of the Act. Presented in the Development Document are the investment and operating costs associated with various alternative control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the required application of various control methods and technologies. This study investigates the effect of alternative approaches in terms of produce price increases, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Planning and Evaluation of EPA. This report was submitted in fulfillment of Task Order No. 7, Contract 68-01-1541 by Arthur D. Little, Inc. Work was completed as of August 1973.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed rule making under sections 304(b) and 306 of the Act for the subject point source category. The study has not been reviewed by EPA and is not an official EPA publication. The study will be considered along with the information contained in the Development Document and any comments received by EPA on either document before or during proposed rule making proceedings necessary to establish final regulations. Prior to final promulgation of regulations, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who studied the subject industry. It cannot be cited, referenced, or represented in any respect in any such proceeding as a statement of EPA's views regarding the subject industry.

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SECTION I SUMMARY

I. SCOPE

The purpose of this report is to assess the economic impact of the 1972 Federal Water Pollution Control Amendments on the industrial phosphate industry. The specific products analyzed are as follows:

Phosphorus
Phosphoric acid produced from phosphorus
Phosphorus pentoxide
Phosphorus trichloride
Phosphorus oxychloride
Phosphorus pentasulfide
Sodium tripolyphosphate (STPP)
Calcium phosphates (excluding fertilizers, and defluorinated phosphates)

II. SEGMENTATION

The industry producing the products listed above was segmented for analysis on the basis of process similarity. This was considered a more valid basis than geographic location, age or size of plant, or other possible criteria.

The four segments selected were as follows:

1. Elemental phosphorus

2. Phosphoric acid

3. Anhydrous derivatives of phosphorus (phosphorus pentoxide, pentasulfide, trichloride, and oxychloride)

4. Derivatives of phosphoric acid (STPP and calcium phosphates)

III. COSTS

Manufacturing costs were estimated for each of the products under consideration, based on available information on investment and operating costs for plants producing each of the products. Representative plant sizes were selected on the basis of typical plants currently operating, but it was also realized that substantial variation in costs do exist, depending not only on plant size and age, but also on other factors, such as whether or not the production units are included in large multiproduct complexes, or operated independently.

The costs of water pollution control were taken, at the request of EPA, from an effluent guideline development document prepared for that agency.[1] It was not within the scope of this impact analysis study to confirm or modify the water pollution control costs presented in the effluent guidelines development document.

It was concluded in the guideline document that for all products under consideration, it was possible to achieve zero discharge on the basis of best practicable control technology currently available. These two products -- phosphorus oxichloride and pentoxide -- however, are required to achieve zero water discharge by 1983. For the purpose of analysis, these two products were analyzed for the impact of zero discharge, realizing that the actual cost for 1977 will be lower.

The costs to achieve zero discharge, as presented in the effluent guideline development document, are summarized in Table 1.

TABLE 1

COST OF ACHIEVING ZERO DISCHARGE

Product	Cost ($/ton)
Phosphorus	$4.60
Phosphoric Acid (75%)	0.65
Phosphorus Pentoxide	1.40
Phosphorus Pentasulfide	1.70
Phosphorus Trichloride	1.40
Phosphorus Oxychloride	1.25
STPP	0
Dicalcium phosphate (animal feed)	1.40
Dicalcium phosphate (food grade)	1.50

1. *Cost Information for the Waterborne Wastes in the Non-Fertilizer Phosphorus Chemicals Industry*, Supplement A, prepared by General Technologies Corporation.

IV. IMPACT ANALYSIS METHODOLOGY

In assessing the economic impact of the zero discharge costs, as presented in the effluent guideline development document, we took into consideration the fact that some of the products were raw materials for the manufacture of other products covered in this report. Therefore, we included not only the zero discharge costs associated directly with the production of each chemical, but also those arising from zero discharge costs for those raw materials used to make derivative products, where they were included in the list of chemicals covered in this report.

For example, food-grade calcium phosphate is produced from phosphoric acid, in turn manufactured from elemental phosphorus. Thus, we considered the total cost increases arising from the cost of achieving zero discharge in the production of calcium phosphate, in the production of phosphoric acid, and in the production of phosphorus, in analyzing the economic impact of zero discharge on calcium phosphate.

The total costs of achieving zero discharge for each of the products, based on the costs presented in the effluent guideline development document, are summarized in Table 2. Also included in this table is a calculation showing the relation of zero-discharge costs, to current sales prices, for each of the chemicals.

TABLE 2

PRICE INCREASES RELATED TO GTC PROPOSED COSTS OF ACHIEVING ZERO DISCHARGE

Product	Pollution Control Cost	Raw Material[2] Cost Increase	Total Cost Increase	Current[1] Price	Percentage Increase
	($/ton)	($/ton)	($/ton)	($/ton)	
Phosphorus	4.60	––	4.60	380	1.2
Furnace Acid	0.65	1.10	1.75	168	1.0
Phos. Pentoxide	1.40	1.09	2.49	400	0.6
Phos. Trichloride	1.40	1.09	2.49	220	1.1
Phos. Oxychloride	1.25	1.83	3.08	245	1.2
Phos. Pentasulfide	1.70	1.32	3.02	267	1.1
STPP	––	1.90	1.90	162	1.2
Feed-grade Dical	1.40	––	1.40	87	1.6
Food-grade Dical	1.50	1.35	2.85	257	1.1

1. Prices based on Chemical Marketing Reporter, 7/23/73.

2. Based on following usages:

0.24 tons phos/ton acid — 1.09 tons acid/ton STPP
0.24 tons phos/ton pentoxide — 0.77 tons acid/ton food-grade dical
0.24 tons phos/ton trichloride — 0.29 tons phos/ton pentasulfide
0.19 tons pentoxide + 0.55 tons trichloride/ton oxychloride

V. ECONOMIC IMPACT ANALYSIS

Based on the fact that the costs of achieving zero discharge, as presented in the effluent guideline document, are relatively insignificant in relation to selling price – in no case more than 1.6% of selling price – we conclude that cost increase of this magnitude would have no measurable impact on the production of any of the products covered in this report.

However, one product – STPP – faces the prospect of a substantial decline in market volume, as the use of this product in detergent formulations appears likely to continue to decline. Therefore it is likely that some reduction in productive capacity will take place, primarily due to reduction in demand, that may result in some plant closings. Decisions regarding such plant closings may be influenced by investments that are necessary to achieve zero discharge.

While the effluent guideline development document indicates no net increase in operating cost for achieving zero discharge in the production of STPP, it does assume that some new investment may be necessary, which would be offset over a period of time by recovery of a salable product. Faced with declining markets, certain STPP producers may be reluctant to make this mandatory investment, and this may influence decisions regarding plant shutdowns.

Apart from this factor, the costs presented in the effluent guideline development document would not appear to have any significant economic impact on any of the products covered. Cost increases of this magnitude will either be absorbed, or, more likely, passed on to consumers through price increases. The products covered in this report have rather specific use requirements based on their chemical properties, and are not easily susceptible to replacement or substitution by other products.

If actual costs to achieve zero discharge are significantly higher than indicated in the effluent guideline development document, as a number of producers believe to be the case, significant economic impacts may be felt. However, based on zero-discharge costs used for this report, we do not expect them to cause directly any plant closings, to lead to unemployment in any of the segments examined, or to have any significant impact on communities where production facilities are located.

SECTION II, DESCRIPTION OF INDUSTRIAL PHOSPHATE INDUSTRY

I. OVERALL INDUSTRY

That sector of the phosphate industry which is covered by this study generally consists of phosphorus and its principal nonfertilizer derivatives. Specifically, the products include the following, grouped into the four segments we have selected:

1. Phosphorus (P_4)

2. Anhydrous Derivatives of Phosphorus
   a. Phosphorus Pentoxide (P_2O_5)
   b. Phosphorus Trichloride (PCl_3)
   c. Phosphorus Oxychloride ($POCl_3$)
   d. Phosphorus Pentasulfide (P_4S_{10})
   e. Ferrophosphorus

3. Phosphoric Acid Derived from Phosphorus (Furnace Acid)

4. Major Derivatives of Furnace Acid
   a. Sodium Tripolyphosphate (STPP)
   b. Calcium Phosphates (excluding fertilizers, and defluorinated phosphates).

The sector of the chemical industry producing these products has the following significant characteristics:

- For the most part, the derivatives of phosphorus are manufactured by the same companies that produce elemental phosphorus.

- The producers of elemental phosphorus are, with two exceptions, large chemical or petroleum companies for whom phosphorus and derivatives represent only a small percentage of total sales.

- A large proportion of the products in this sector are used internally within the producing company for the production of other products and are not sold on the open market.

This last factor – the largely internal use of many of the products in this sector – makes it difficult to estimate the specific profitability of individual products, even for the companies producing them. They are generally included in a much larger range of products grouped together as a profit center and individual profitabilities are often not calculated for these specific products in this sector.

To give some perspective to the industrial phosphate sector, we have prepared a company – product matrix, in Table 3.

A. SEGMENTATION

Primarily because of similar technology, we have broken down the industry sector which is the subject of this proposal into four segments, by product groupings. They are as follows:

1. Phosphorus

This is produced in an electric furnace operation. Except for size, there is relatively little difference among the several furnaces operating in Florida, in Tennessee, and in the western United States.

2. Anhydrous Phosphorus Derivatives

The technology for producing phosphorus pentoxide, phosphorus trichloride, phosphorus oxychloride, and phosphorus pentasulfide, is generally similar in that all involve reaction with other chemicals under anhydrous conditions. The volumes involved in the production of these products are comparatively small in relation to other chemicals examined.

3. Furnace Phosphoric Acid

This is by far the largest volume use for elemental phosphorus. The production of acid involves an oxidation and absorption step. Plants for producing furnace acid are fairly standard and similar.

4. Derivatives of Furnace Acid

The production of sodium tripolyphosphate, and of the various calcium phosphates, are generally similar and involve the aqueous reaction of phosphoric acid with inorganic chemicals such as soda ash or lime. With the exception of one plant using wet process acid, all STPP is manufactured from furnace acid. Most feed-grade dicalcium phosphate is manufactured from wet process acid, while most technical calcium phosphates and all food grades are produced from furnace acid.

TABLE 3

PRODUCERS OF PHOSPHATE PRODUCTS

	Phosphorus	Phosphorus Pentoxide	Phosphorus Trichloride	Phosphorus Oxychloride	Phosphorus Pentasulfide	Furnace Acid	Sodium Tripolyphosphate	Feedstock Dicalcium Phosphate	Technical Calcium Phosphate
Holmes Company	0								
FMC Corporation	0		0	0		0	0		
Mobil Corporation	0		0			0	0		
Monsanto Company	0		0	0	0	0	0		0
Occidental Petroleum Corp.	0	0	0	0	0	0	0	0	
Stauffer Chemical	0	0	0	0	0	0	0		0
TVA	0					0			
Olin Corporation							0		
Goodpasture, Inc.						0			
American Cyanamid Co.								0	
Borden, Inc.								0	
Eastman Kodak Co.									0
Farmland Industries								0	
International Minerals & Chemical Corp.								0	
Knox Gelatine, Inc.									0
Richardson-Merrell, Inc.									0

B. RELATIVE IMPORTANCE OF EACH SEGMENT

The following table gives some perspective on the relative production capacity for each of the major segments and products as well as the number of plants in operation.

Product Volume

Product Segment	**Approximate Production, 1971 (000/tons)**	**Number of Plants**
Phosphorus	545	10
Furnace Acid	954	21
Anhydrous Derivatives	151	20
Furnace Acid Derivatives		
STPP	1040	15
Feed-Grade Dicalcium Phosphate	592	8
Technical Calcium Phosphates	50	6

It should be noted that there is some duplication in the location of plants, in that many of these products are produced in integrated chemical complexes which in many instances produce more than one of the products listed above. Therefore, in terms of plant locations, there are fewer than would be indicated by simply adding the number of plants for the product segments included above.

C. TYPES OF FIRMS

For the most part, the products included in this section of the phosphate industry are produced by divisions of large chemical or oil companies. The principal companies involved in the manufacture of most of these products are characterized in Table 4, in terms of annual sales, total number of plants, indicative estimate of the number of major products produced, and the number of employees. It can be appreciated that the products involved in this sector in the case of all of these companies represent only a small fraction of their total manufacturing operations.

We discuss in the following section individual characteristics of each of the four segments chosen. However, it should be appreciated that there is an unusually close interrelationship between the segments. There may be production facilities for products from two or three of the segments in a single chemical complex.

Furthermore, a very large part of the production of the chemicals included is used by a single producing company for the production of other of the chemicals discussed. Therefore, a major volume of the product is transferred internally within a single company rather than being sold commercially on a company to company basis.

TABLE 4

COMPANY DATA

	1972 Sales ($ million)	**No. of Plants**	**No. of Products**	**No. of Employees**
FMC	1,497.7	85	220 major products	46,000
Mobil	10,295.1	120*	More than 200 major products, plus a full line of petroleum products	75,600
Monsanto	2,225.4	85	71 major products	63,000
Occidental	2,720.8	92*	More than 200 major products, plus a full line of petroleum products.	33,000
Stauffer	544.2	103	62 major products	10,300
Olin	1,098.3	80	300 major products	29,000
Cyanamid	1,358.9	109	120 major products	41,400
Borden	2,192.9	147	200 brands	48,000
IMC	491.2	71	60 principal products	7,000

*Excluding pipeline and drilling facilities.

These two facts make it particularly difficult to determine individual product profitabilities. This is true not only because it is impossible to determine individual companies transfer pricing policies but also because the companies themselves in many instances do not look at the individual products as separate profit centers, and do not attempt to calculate or keep track of the profitability of the individual product or product segment.

Nevertheless, we have presented indicative cost data in the following sections to give an approximate idea of the economics of manufacture and sale of the specific products.

It should be pointed out that we have not discussed ferrophosphorus as an individual product. This is a by-product in the manufacture of elemental phosphorus. According to information from the producers, there are no water pollution problems uniquely associated with ferrophosphorus since no water is involved in its recovery or handling. The general aspects relating to the use and disposal of water in electric furnace operations are discussed under Phosphorus.

D. TYPES OF PLANTS

For the most part, the types of plants operated in each of the four segments discussed in this report are generally similar from company to company with principal variations occurring in size of plant, and age. More specific characteristics of the plants are discussed under the individual segment sections.

The one major exception to the generally uniform nature of plants is the fact that one plant, that operated by Olin Corporation, produces sodium tripolyphosphate from wet process acid rather than from furnace acid. The use of the wet process for producing phosphoric acid in this plant, presents quite a different range of water pollution problems, compared to a plant for producing phosphoric acid from phosphorus.

We have discussed the number of employees involved in each segment section. For this overall sector of the industry, it seems clear that the number of employees in the phosphorus segment is an order of magnitude higher than the employees involved in the production of the other three product segments. Total employment in the phosphorus segment may exceed 3,000 employees, while employment in each of the other segments is estimated to be substantially under 1,000.

E. FINANCIAL CONSIDERATIONS

It is important to note the highly integrated nature of that sector of the industry in which these four product segments are involved. The high degree of interrelationship between the various product segments makes a profitability analysis of any one segment difficult.

Sensitivity to price increases arising from water pollution control costs would have two major aspects. The first would be the differential increases among individual companies. Companies with above average pollution control costs would be put at a competitive disadvantage to those companies with lower costs.

The second aspect to price sensitivity would relate to the vulnerability of the specific products or class of plants to substitutable materials. In almost all cases, there is a very specific requirement for the final derivatives covered in this report, and it is unlikely that there would be direct substitution by alternate products. However, there is the possibility that some of these products could be produced in new plants from wet process acid at prices that would be competitive with furnace acid, particularly if there are substantial cost increases arising from pollution control measures.

There is only one plant in the United States producing industrial phosphates from wet process acid – the plant of Olin at Joliet, Illinois. This plant is about 40 years old and uses a rather conventional series of crystallization and filtration steps to produce products of a desired purity.

An alternative type of process has been under consideration by a number of companies. This involves the purification of wet process acid via the solvent extraction route. There are indications that these processes, which are still under development, may permit the production of the industrial phosphates at costs competitive with productions from furnace acid. Interest in these processes would be greatly stimulated if there were indications that the cost of products produced via the furnace acid route were to increase substantially because of pollution control measures.

However, since these processes are still under development and are of a highly proprietary and confidential nature, it is difficult to get information with any precision on the costs of this alternate route to the derivatives with which we are concerned in this report.

II. PHOSPHORUS

A. SEGMENT DESCRIPTION

Phosphorus is universally produced in an electric furnace operation, from phosphate rock. Phosphate rock, sometimes processed into nodules, is blended with coke and occasionally with silica. This mixture is then added to the electric furnace. Electric power is introduced through vertical electrodes and serves to provide the heat necessary for the reaction to take place. The coke reduces the phosphate content of the phosphate rock to elemental phosphorus which passes from the furnace as a gas along with carbon monoxide. Phosphorus is condensed by cooling, is filtered, and stored. Because it oxidizes on contact with the air, phosphorus is generally stored and transported under a water blanket.

A small amount of iron is contained in the phosphate rock, and combines with phosphorus to form ferrophosphorus. This sinks to the bottom of the furnace crucible and is tapped periodically as a molten material. It solidifies, is cleaned, graded, and stored for future shipment.

A slag forms in the process, consisting of the non-phosphatic components of the phosphate rock, and silica. This is also tapped as a liquid, cooled and broken up by water cooling, and used as a construction aggregate material.

Phosphorus is used entirely for the production of various phosphate chemicals, most of which are included in the other segments of this report.

Phosphorus is a solid at normal temperatures but is readily liquefied by heating to approximately 45° centigrade.

Phosphorus furnaces in the United States are generally of quite similar design although they range in size from smaller units with a capacity of approximately 10,000 tons of phosphorus per year, to the larger furnaces producing as much as 45,000 tons per year. In many instances several phosphorus furnaces are grouped together in a production complex although single furnace installations are in operation.

B. PLANTS AND COMPANIES

There are six companies producing phosphorus in the United States. In addition, the Tennessee Valley Authority (TVA) an agency of the U.S. Government is also a major producer.

Table 5 lists those companies producing phosphorus, together with the number of furnaces estimated in operation together with their capacity.

TABLE 5

PHOSPHORUS PRODUCERS

Company	Location	Number Operating Furnaces	Operating Furnace Capacity, Tons P_4
Holmes Company	Pierce, Florida	2	20,000
FMC Corporation	Pocatello, Idaho	4	145,000
Mobil Chemical	Nichols, Florida	1	5,000
Monsanto Company	Soda Springs, Idaho	3	110,000
	Columbia, Tennessee	6	135,000
Hooker Chemical	Columbia, Tennessee	3	60,000
Stauffer Chemical	Silver Bow, Montana	2	42,000
	Tarpon Springs, Florida	1	23,000
	Mt. Pleasant, Tennessee	3	45,000
TVA	Muscle Shoals, Alabama	3	40,000
			658,000

It can be seen that phosphorus production is concentrated in three general areas, associated with the nearby availability of phosphate rock. These are in Florida, in Tennessee, and in the Idaho-Montana area.

Because phosphorus plants are generally located because of raw material considerations rather than market locations, and because phosphorus is the most economic form in which to transport phosphate values, production of the derivatives of phosphate is generally undertaken at locations other than where the electric furances are located. The exceptions to this are Stauffer Chemical Company at Silver Bow, Montana, Occidental at Columbia, Tennessee, and the TVA at Muscle Shoals, Alabama. At these locations, phosphoric acid is also produced.

However, as shown in the company-product matrix in the previous section, five of the six companies producing phosphorus also produce at other locations phosphoric acid, sodium tripolyphosphate, and certain of the anhydrous phosphorus derivatives. The Holmes Company, which acquired their phosphorus furnace from Continental Oil, is the only company which produces only phosphorus and no derivatives.

It is important to note that because of this configuration of the industry, most elemental phosphorus is shipped substantial distances after manufacture to locations where it is processed into derivatives. As mentioned, it must be shipped under a blanket of water. The volume of water which is used to blanket the phosphorus both in transportation and handling becomes contaminated with phosphorus, and is therefore one aspect of water pollution concern which must be kept in mind.

In the manufacture of phosphorus, there appear to be two general water pollution problems. The first involves so called "phossy" water – water containing suspended phosphorus. Several water streams in the plant that pick up phosphorus are combined and generally treated by means of settling ponds.

A more serious problem in the production of phosphorus relates to the water treatment effluent both from the burden preparation facilities and also from water scrubbing of the effluent gases. Fluorides are a particular problem. The incoming phosphate ore contains about 3% fluoride. Approximately 20% of this is volatilized both in the burden preparation and in the furnace itself, and ends up in the waste treatment water. The remaining 80% of the fluorine is contained in the by-product slag. It is believed that there are some plants which have a total recycle for the scrubber water whereas others may go only part way and may be in fact discharging some fluorine.

It is difficult to generalize on the types of firms or plants that would be particularly affected by water pollution control measures. With the exception of the Holmes Company in Florida, phosphorus is manufactured as a minor portion of much larger enterprises and thus corporate characteristics would have little relevance to water pollution control impact.

As to the location of the phosphorus furnaces – generally concentrated in Florida, Tennessee, and the Idaho-Montana regions – it is also difficult to identify one area or another that would expect a moderately different impact from water pollution control measures. It is true that phosphate rock mined in Tennessee is generally beneficiated by washing, and effluent wash water has been identified as a major pollutant. However, these mining operations are generally quite separate from production of phosphorus, and do not lie within the scope of this segment.

The labor force in a phosphorus furnace operation is relatively high per unit of product, compared with other operations in the chemical industry. It appears that the labor force at a typical multifurnace phosphate operation will range from 250 to 600. Preliminary estimates would indicate that at the 10 locations where phosphorus is produced, involving some 26 furnaces, somewhere in the neighborhood of 3,000 men might be employed directly associated with the production of phosphorus, but not including mining operations. This would appear to be the largest labor force by far of the four segments included in this study.

C. FINANCIAL PROFILE

Since phosphorus is produced at locations where, with one exception, no other products are manufactured, the complications of attempting to allocate costs to calculate profits in a large multiproduct complex are not a factor in examining the financial profile for phosphorus. However, a very large proportion of phosphorus produced is consumed at other locations by the same company. Therefore, the profitability of phosphorus production in these instances should probably be judged by examining the transfer price, which generally is not available for individual companies. The proportion being sold on the open market is sufficiently small that it does not represent a meaningful indication of the average income being received by the phosphorus producing unit. However, lacking other data, this is probably the best available measure of income for a phosphorus production unit.

As a preliminary indication of the financial profile for the production of phosphorus we present in Table 6, an estimate of the cost of manufacturing phosphorus in Tennessee including depreciation, and typical input costs.

There is a fairly wide range in cost of the major variable costs for phosphorus production particularly regarding electric power. These range from 2.3 mills per kwh for power from the Bonneville Power Administration in Montana to an estimated 7.26 mills for power supplied by the Tampa Electric Company to some of the operations in Florida. This difference of 4.93 mills per kwh is equivalent to about $59.00/ton of phosphorus.

The cost of phosphate rock is another cost which varies substantially between one operation and another. This cost is much more difficult to ascertain because for the most part phosphate rock is mined by the phosphorus producer and transferred at an unknown price to the phosphorus furnace operation.

There is less variation in the cost of coke, but this again will lead to some variation in the cost of production. Producers in the Tennessee and Florida area are believed to be paying around $23.00 to $26.00 per ton of coke delivered. Producers in Idaho and Montana are paying an estimated $35.00 per ton, currently.

The price of phosphorus is obviously the most important single item affecting profitability. Factors affecting price will be discussed in more detail in the following section. However, the fact that over 90% of phosphorus produced is transferred within the producing company to other chemical manufacturing facilities, makes it extremely difficult to ascertain what in effect was the net income for the individual plants.

The Department of Commerce, in its statistics on inorganic chemical production, permits calculation of an average annual f.o.b. price for phosphorus. This is probably the best indication of price, but still leaves the possibility open that the transfer prices established by the companies on the one hand might be somewhat arbitrary and artificial in nature.

TABLE 6

ESTIMATED COST OF ELEMENTAL PHOSPHORUS MANUFACTURE

Basis: Three (3) electric furnaces rated at 35,000 KW each, producing a total of 72,700 tons of P_4 per year
Location: Tennessee

Capital Investment: $45 million

Manufacturing Cost

Cost Item	Units	Units/Ton P_4	Cost/Unit	Cost($)/Ton P_4
Raw Materials:				
Tennessee matrix (26% P_2O_5)	tons	10.0	5.20	52.00
Silica	tons	0.45	1.98	0.89
Coke	tons	1.42	25.00	35.50
Electrodes	lbs	.42	0.32	13.44
Utilities:				
Electricity	kwh	12,500	0.0068	85.43
Water	Mgal	20	0.05	1.00
Fuel	MSCF	12	0.23	2.76

	Cost($)/Year	Cost($)/Ton P_4
Salaries, Wages, and Overhead	3,500,000	48.14
Operating Supplies	400,000	5.50
Maintenance	4,000,000	55.02
Taxes and Insurance (2% of investment)	900,000	12.38
Depreciation (6.67% per year)	3,001,500	41.29
Total		353.35
By-products credits		−19.00
Net manufacturing cost		334.35

Using the cost figure indicated above, plus an arbitrary charge for GS&A of $35.00/ton the profitability can be estimated for various phosphorus prices. This is presented in Table 7. This shows that with an average cost of $370 per ton of phosphorus as a manufacturing cost, including GS&A, the profitability after taxes ranges from $5 with a $380/ton phosphorus price, f.o.b. plant, to $25/ton at a $420/ton selling price. Using an estimated fixed investment of $620/ton, the after-tax return, as a percentage of fixed assets, ranges from 0.8% at $380 phosphorus, to 4.0% at $420 phosphorus.

This table is useful *only* to indicate the sensitivity of profitability to price of phosphorus. Our estimates of the cost of manufacture have been for one specific hypothetical furnace operation in Tennessee, and wide variations between plants can be expected on the basis of increases in power costs, coke costs, phosphate rock costs, operating rate, etc. This table is *not* in any sense to be taken as a representative estimate of the profitability of the phosphorus industry.

As an indication of the wide swings which prices have taken in recent years, we present in Table 8 the average value of phosphorus shipment as reported by the U.S. Department of Commerce in their publication, "Current Industrial Reports – Inorganic Chemicals," series M28 A-14.

More recent trade information indicates that phosphorus prices have risen sharply recently. Current commercial sales are reportedly being made at a level of 21¢ per pound, equivalent to $420.00/ton.

As can be seen from the figures in Table 6, raw material and utility cost present about 57% of the total direct manufacturing costs for phosphorus. This means that the portion of total costs which would be affected by added water pollution costs would be less than 50% of the total. Thus, the leverage on total manufacturing costs of added investment and operating costs necessary for water pollution control would be less than in processes where the raw materials were not such a major factor in manufacturing costs.

The salvage value of a phosphorus installation is likely to be negative – that is, the cost of dismantling and disposing of the facilities would probably be greater than any credits for equipment re-use or resale.

D. PRICES AND MARKETS

It is important in examining the pricing situation regarding phosphorus to appreciate the largely captive nature of phosphorus movements. Over 90% of the phosphorus produced by the six companies, and the TVA, is used within the producing organization (although generally at other locations) for the production of phosphoric acid and phosphorus derivatives.

TABLE 7

SENSITIVITY OF PHOSPHORUS PROFITABILITY
(dollars per ton)

Price of Phosphorus/Ton		$380	$400	$420
Cost of Manufacture				
Direct Cost	$335.00			
GS&A	35.00			
		370	370	370
Profit Before Taxes		10	30	50
Profit After Tax		5	15	25
After Tax Return (% on assets)[1]		0.8	2.4	4.0

1. Basis: $620/annual ton

TABLE 8

RECENT PHOSPHORUS PRICES
($/ton f.o.b. plant)

	All Shipments[1]	Commercial Shipments[2]
1968	$336	$300
1969	356	329
1970	358	287
1971	381	356

1. Both intracompany and intercompany.
2. Intercompany only.

Source: U.S. Department of Commerce "Current Industrial Reports – Inorganic Chemicals," Series M28A-14.

The Department of Commerce in its Bulletin M28-14, reports monthly and annual movements of phosphorus both in total, and for commercial sales alone. These have been presented earlier in Table 8. Along with tonnages, total values are indicated. This is generally considered a good measure of the actual prices at which phosphorus does move.

In Table 8, we have listed the average value per ton of phosphorus for the period from 1968 to 1971 for both total shipments and for commercial sales. It is interesting to note that the value of commercial sales has been consistently below the value of total shipments. Since 90% of the total is represented by intra-company shipments, the value for total movements is very close to that of intra-company movements.

Because they represent only a small portion -- less than 10% – of total phosphorus production – commercial sales can expect to show fairly wide fluctuation in prices since this small sector of the total production would be expected to reflect any overall supply/demand imbalance that might develop. In other words in periods of over-capacity, prices on the open market would be expected to drop substantially and in periods of shortages to rise significantly.

The prices for intra-company shipments as in most internal transfer situations, is arbitrary to a degree. Often such transfer prices particularly between separate divisions of a company, are set by policy at the prevailing price in the open market. However, this does not appear to be the case in phosphorus since intra-company shipments have consistently been substantially higher than open market prices.

Because of the somewhat arbitrary nature of intra-plant transfer values, it will be difficult to assess the effect of water pollution control costs on this particular price. Increases in costs will undoubtedly be reflected in increased prices of the ultimate derivatives, although not necessarily properly reflected in the reported transfer prices, as in the Department of Commerce Series M28 A-14.

There is no alternative to phosphorus in the production of its derivatives. Therefore, there is no sensitivity to price in the direct demand for phosphorus itself. There may however, be some sensitivity to price in the demand for some if its derivatives, and this will be reflected ultimately in the demand for phosphorus.

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III. FURNACE PHOSPHORIC ACID

A. SEGMENT DESCRIPTION

Phosphoric acid can be produced by two quite different processes. The first – the "wet process" route – involves the treatment of phosphate rock with sulfuric acid and the subsequent filtration of solid gypsum, to produce a relatively crude phosphoric acid. The second route, which produces a purer acid, involves burning elemental phosphorus to form phosphorus pentoxide, and then absorbing this in water to form phosphoric acid.

With minor exceptions, wet process acid is generally used for the production of various liquid and solid fertilizer materials while phosphoric acid produced from phosphorus or "furnace acid" is predominantly used for the production of various industrial phosphate products. Nevertheless, there is one plant in the United States producing industrial phosphates from wet process acid, and some small use of furnace acid in liquid mixed fertilizers.

Almost all of the furnace acid produced in the United States is manufactured by the producers of phosphorus. All producers except the Holmes Company also produce furnace acid and other derivatives.

Furnace acid is used primarily for the production of a wide variety of phosphate chemicals, principally salts of sodium, potassium, and calcium. The material produced in largest volume from furnace acid is sodium tripolyphosphate, for the detergent market. Its production and that of other calcium phosphates is covered in the fourth segment of this industry sector.

Only two furnace acid plants are located adjacent to a phosphorus furnace; that of Stauffer in Silver Bow, Montana, and Occidental's plant at Columbia, Tennessee. All other phosphorus production used to make acid is shipped to other locations.

B. PLANTS AND COMPANIES

There are estimated to be 23 furnace acid plants in the United States. Twenty-one of these are operated by basic phosphorus producers. One plant in Texas uses purchased phosphorus. Acid plants are listed in Table 9 with their locations, and total company capacity. Individual plant capacities were not available at the time of writing this draft.

As in the case of phosphorus, it is difficult to identify types of firms or types of plants, involved in the production of furnace acid, that would be impacted to a greater or lesser degree by water pollution control measures. Furnace acid plants

TABLE 9

LOCATION OF FURNACE ACID PLANTS

Producers	Plant Location	Grouped Company Capacity (tons P_2O_5)
FMC Corporation	Carteret, New Jersey	
	Lawrence, Kansas	340,000
	Newark, California	
	Green River, Wyoming	
Mobil Oil Corporation	Carteret, New Jersey	115,000
	Fernald, Ohio	
Monsanto Company	Augusta, Georgia	
	Carondolet, Missouri	455,000
	Kearny, New Jersey	
	Long Beach, California	
	Trenton, Michigan	
Occidental Petroleum Corp.	Dallas, Texas	
	Jeffersonville, Indiana	85,000
	Columbia, Tennessee	
Stauffer Chemical Company	Chicago, Illinois	
	Chicago Heights, Illinois	
	Morrisville, Pennsylvania	
	Nashville, Tennessee	250,000
	Richmond, California	
	Silver Bow, Montana	
	South Gate, California	
TVA	Muscle Shoals, Alabama	75,000
Goodpasture, Inc.	Brownfield, Texas	45,000
Total		1,365,000

are generally located close to concentrated markets and thus tend to be placed in more densely populated areas than phosphorus furnaces for example.

The labor force for an individual furnace acid plant is not large. If operated as an independent unit and not as part of a complex, the labor force for a furnace acid plant might vary from 20 to 40 people depending on size. If included in a complex of several plants, the labor component might be significantly less. Assuming an average of 30 men per plant, with some 20 furnace acid plants in operation, a total industry force in this segment of some 600 could be approximated.

The technology is generally quite similar for all of the furnace acid plants with the major difference lying in the lining of the furnace in which phosphorus is burned to phosphorus pentoxide. In the older plants, these were lined with carbon bricks, which were cooled by dribbling cooling water over them. This led to some pickup of the phosphorus pentoxide in this cooling water resulting in contamination of this water with phosphoric acid.

All of the more recent plants that have been built substituted a stainless steel water cooled jacket for the carbon brick, and cut down to a very high degree on this contamination of the cooling water. In all other aspects we believe that all of the furnace acid plants are generally quite similar.

C. FINANCIAL PROFILE

As pointed out previously, in the entire group of phosphorus based products being examined in this report, there is a great deal of vertical integration with most products being produced by companies that either manufacture the basic raw materials or consume the products themselves in the further manufacture of other derivatives. (Thus, we are faced with the problem of estimating or ascertaining intra-company transfer values rather than examining open market prices.) This is particularly confusing in the case of the products like furnace acid, where both the raw material input – in this case phosphorus – and the final product – furnace acid – are generally transferred on an intra-company basis.

On the other hand, the financial analysis of furnace acid manufacture is greatly simplified by the fact the cost of the basic raw material – phosphorus – the overwhelmingly most important cost component in the overall manufacturing cost of furnace acid, comprises approximately 94% of the final cost. Thus, any increases in process costs that might arise because of water pollution control measures, even if relatively substantial, would have only a minor effect on the overall cost of manufacturing furnace acid.

We show in Table 10 the representative breakdown of the cost of making furnace acid. We have used the current list price for open market purchases of phosphorus of \$380.00 per ton although we believe that current spot sales are actually being made substantially above this.

Prices for furnace acid currently are well below this calculated cost of manufacture and have been for recent years. This suggests that phosphorus is being transferred into the furnace acid plants at substantially below the list price, although the Department of Commerce figures for intra-company do seem to indicate the transfer at essentially list. This would indicate that the furnace acid plants are operating at or below the manufacturing cost on this transfer basis.

D. PRICING

As in the case of phosphorus, only a small percentage of furnace acid produced is sold on the open market to other companies. Almost all is used internally by the producer for the manufacture of other derivatives. Furthermore, only about 25% of production is shipped from the point of production to another plant. It is only this portion that is reported by the Department of Commerce in a way in which its value f.o.b. plant can be calculated. However, we have extracted these figures for the years of 1968 to 1971, summarized below:

Furnace Acid Values
(\$/ton P_2O_5, f.o.b. plant)

	Value per Ton P_2O_5
1968	142.00
1969	165.00
1970	156.00
1971	168.00

It is interesting to note that all of these prices are substantially below the direct manufacturing cost of furnace acid, calculated from a typical recent transfer value of phosphorus of \$380.00. This underlines again, the somewhat arbitrary and unreliable nature of the reported intracompany transfer figures as a reflection of true price and realistic profitability.

For two reasons, it is unlikely that the effects of water pollution control costs will be major or significant in terms of furnace phosphoric acid. In the first place, over 90% of the cost of furnace acid, as mentioned above, consists of the cost of phosphorus and the effect of major changes of water pollution control costs associated directly with the manufacture of acid would not be particularly significant. Furthermore, since most of furnace phosphoric acid involves

TABLE 10

ESTIMATED COST OF MANUFACTURING PHOSPHORIC ACID FROM ELEMENTAL PHOSPHORUS

Basis: 54% P_2O_5 Phosphoric acid equivalent to 45,000 tons/year of P_2O_5

Plant located in Midwestern U.S.A.
Phosphorus cost (f.o.b. furnace plant) at \$380.00 per ton P_4; freight, \$5.00 per ton P_4

Capital Investment: \$1 million (includes storage for 3,000 tons P_2O_5; no P_4 storage)

Manufacturing Cost

Cost Item	Units	Units/Ton P_2O_5	Cost/Unit	Cost(\$)/Ton P_2O_5
Raw Materials and Freight:				
Phosphorus	Tons P_4	0.44	380.00	167.20
Freight	Tons P_4	0.44	5.00	2.20
Utilities				
Electricity	Kwh	60	0.0068	0.41
Water	Mgal	23	0.05	1.15

	Cost(\$)/Year	Cost(\$)/Ton P_2O_5
Salaries, Wages, and Overhead	180,000	4.00
Operating Supplies	5,000	0.10
Maintenance (4% of investment)	40,000	0.89
Taxes and Insurance (2% of investment)	20,000	0.45
Depreciation (6.67% per year)	67,000	1.48
		177.88

intra-company transfers of both raw material and finished product, its pricing is somewhat academic.

As in the case of phosphorus with only a small portion of total production moving in open market sales, it is likely that there would be relatively wide fluctuation in the price of this small open market segment reflecting changing supply/demand conditions. As has happened in the past, when there have been substantial surpluses of furnace phosphoric acid, these have moved at relatively low prices primarily into the liquid fertilizer market, to maintain capacity operation at phosphorus furnaces, where costs are quite sensitive to the operating rate. In the same vein, during periods of short supply, quantities available on the open market would be limited and would undoubtedly rise sharply in price. Thus, price fluctuations in open market phosphoric acid are much more likely to depend on the factors related to the supply/demand situation, than on water pollution control costs associated with the acid manufacture.

IV. DERIVATIVES OF ELEMENTAL PHOSPHORUS

A. SEGMENT DESCRIPTION

Four of the products comprising this segment are produced from elemental phosphorus ($POCl_3$, P_2S_5, P_2O_5, and PCl_3). The fifth, ferrophosphorus, is a by-product of the phosphorus furnace. In fact, ferrophosphorus is not impacted by water pollution abatement considerations and may be appropriately excluded from this segment.[1] The first four derivatives, however, do merit common consideration as a segment because all four are produced under anhydrous conditions and are similarly impacted to the extent that any water pollution aspect exists. Further community of consideration is warranted because several of the four elemental phosphorus derivatives are frequently produced at a common site for both merchant sale or further processing as chemical intermediates.

B. COMPANIES AND PLANTS

The primary producers of the elemental phosphorus derivatives are major components of the U.S. chemical industry, namely FMC Corporation, Hooker Chemical Corporation (subsidiary of Occidental Petroleum Corporation), Mobil Chemical Company (subsidiary of Mobil Oil Company), Monsanto Company, and Stauffer Chemical Company. All of these are integrated back to production of elemental phosphorus. In general these producers are also integrated forward, with the derivatives as intermediates, for synthesis of such end products as pesticides, plasticizers, lube oil additives, flotation agents, and surfactants.

There are also several small specialty chemical producers of the products, primarily for electronic markets, but these represent such a minor part of the segment that their separate consideration is unwarranted.

Two of the five integrated producers of elemental phosphorus derivatives have a single producing location. The others have multiplant locations for the derivatives but may produce only one of the derivatives at a given location. Of the four derivatives considered ($POCl_3$, P_2S_5, P_2O_5, and PCl_3), both Hooker Chemical Company and Stauffer Chemical produce all four. The other major producers manufacture one to three of them.

The primary plant sites are Nitro, West Virginia; Niagara Falls, New York; Sauget, Illinois; Anniston, Alabama; Charleston, South Carolina; Morrisville, Pennsylvania; Mt. Pleasant, Tennessee; Nashville, Tennessee; and Cold Creek, Alabama.

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1. Ferrophosphorus is drawn off before the slag and it is important that it not come into contact with water with which it may react explosively at this point in the furnace production cycle.

Producing Company	Derivatives Manufactured $POCl_3$	P_2S_5	P_2O_5	PCl_3
FMC	X			X
Hooker	X	X	X	X
Mobil				X
Monsanto	X	X		X
Stauffer	X	X	X	X

Because most of the plant sites are large multiproduct, integrated operations producing fifty or a hundred individual chemical products, the derivatives of elemental phosphorus within the sector constitute only a small fraction of the plant site output, plant site employment, or plant site water pollution impact. Furthermore, this segment represents only about 5% of the total tonnage of the nonfertilizer phosphate industry which is analyzed in this report.

C. FINANCIAL PROFILE

Because industry manufacturing costs were not made available to us on the derivatives of elemental phosphorus, these were calculated based primarily on our internal engineering estimates. As such, they are presented in the following Tables 11 through 14 for $POCl_3$, P_2S_5, P_2O_5, and PCl_3. It is important to note that for production of P_2S_5, P_2O_5, and PCl_3, the phosphorus is introduced into the reaction at a market price of $380 per ton delivered. In the case of $POCl_3$, the two phosphorus derived raw materials are also introduced at the published market prices, i.e., $400 per ton P_2O_5 and $220 per ton for PCl_3. It is assumed that both these raw materials for $POCl_3$ are produced at the same plant as the $POCl_3$ and no freight costs are involved.

Using current published selling prices for the four derivatives of elemental phosphorus considered herein, the following estimated plant cash flows may be developed in cents per pound at the plant site.

	$POCl_3$	P_2S_5	P_2O_5	PCl_3
Selling Price	12.25*	14.20**	20.00**	11.00*
Plant Cost	12.70	10.30	9.90	9.20
Plant Margin	(0.45)	3.90	10.10	1.80
Depreciation	4.10	3.41	4.55	2.53
Plant Cash Flow	3.65	7.31	14.65	4.33

*in bulk
**in carloads of drums.

TABLE 11

ESTIMATED COST OF MANUFACTURING PHOSPHORUS OXYCHLORIDE

Plant Location **Eastern United States**
Annual Production **10,000 tons**
Fixed Investment **$900,000**[1]

Variable Costs	**Quantity**	**$/Unit**	**$/Ton**
Phosphorus Pentoxide	0.189 T	400	75.60
Phosphorus Trichloride	0.548 T	220	120.56
Chlorine	0.283 T	70	19.81
Power	25 kwh	0.01	0.25
Cooling Water	11.1 M gal	0.03	0.33
Steam	0.73 M lbs	1.40	1.02
Operating Supplies			0.50
			218.07
Semi-Variable Costs			
Operating Labor	2 men/shift	4.50/hr	7.88
Supervision	1/2 of 4 foremen	13,000/yr	2.60
	1/2 of 1 super.	17,000/yr	0.88
Maintenance	7½% of Investment/yr		3.75
Labor Overhead	30% of Op. Labor and Supervision		3.41
			18.52
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision		7.95
Depreciation	9.1% of Investment/yr		8.19
Local Taxes and Insurance	1½% of Investment/yr		1.35
			17.49
Total Cost of Manufacture, Bulk Liquid			254.08

1. Assumes part of complex receiving cooling water, steam, services, etc. from central facility.

TABLE 12

ESTIMATED COST OF MANUFACTURING PHOSPHORUS PENTASULFIDE

Plant Location	**East Coast**
Annual Production	**10,000 tons**
Fixed Investment	**$750,000[1]**

Variable Costs	**Quantity**	**$/Unit**	**$/Ton**
Phosphorus	0.287 T	380	109.06
Sulfur	0.736 T	35	25.76
Power	7.8 kwh	0.01	0.08
Water	1.95 M gal	0.03	0.06
Steam	0.08 M lbs	1.40	0.11
Operating Supplies			0.50
Drums, 450 lb ea.	4.45	5.73	25.46
			161.03
Semi-Variable Costs			
Operating Labor	3 men/shift	4.50/hr	11.83
	2 men days	4.50/hr	1.87
Supervision	1/2 of 4 foremen	13,000/yr	2.60
	1/2 of 1 super.	17,500/yr	0.87
Maintenance	8% of Investment/yr		3.20
Labor Overhead	30% of Op. Labor and Supervision		5.15
			25.52
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision		12.02
Depreciation	9.1% of Investment/yr		6.83
Local Taxes and Insurance	1.4% of Investment/yr		1.13
			19.98
Total Cost of Manufacture, 450 lb drums			206.53

1. Assumes plant part of complex with steam, water and other services supplied from central facilities.

TABLE 13

ESTIMATED COST OF MANUFACTURING PHOSPHORUS PENTOXIDE

Plant Location	**Eastern United States**
Annual Production	**5,000 tons**
Fixed Investment	**$500,000**

Variable Costs	**Quantity**	**$/Unit**	**$/Ton**
Phosphorus	0.237 T	380	90.06
Steel Cans	6.15	5.40	33.21
Power	85 kwh	0.01	0.85
Water	0.6 M gal	0.03	0.02
Steam	nil	1.40	–
Operating Supplies			0.50
			124.64
Semi-Variable Costs			
Operating Labor	2 men/shift	4.50/hr	15.77
	5 men, 200 days	3.00/hr	4.80
Supervision	1/2 of 4 foremen	13,000/yr	5.20
	1/2 of 1 super.	17,500/yr	1.75
Maintenance	7% of Investment/yr		7.00
Labor Overhead	30% of Op. Labor and Supervision		8.26
			42.78
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision		19.26
Depreciation	9.1% of Investment/yr		9.10
Local Taxes and Insurance	1.5% of Investment/yr		1.50
			29.86
Total Cost of Manufacture, Drums			**197.28**

TABLE 14

ESTIMATED COST OF MANUFACTURING PHOSPHORUS TRICHLORIDE

Plant Location **Eastern United States**
Annual Production **9,000 tons**
Fixed Investment **$500,000[1]**

Variable Costs	**Quantity**	**$/Unit**	**$/Ton**
Phosphorus	0.237 T	380	90.06
Chlorine	0.815 T	70	57.05
Power	24.5 kwh	0.01	0.25
Cooling Water	22.6 M gal	0.03	0.68
Steam	0.76 M lbs	1.40	1.06
Operating Supplies			0.30
			149.40
Semi-Variable Costs			
Operating Labor	2 men/shift	4.50/hr	8.26
Supervision	1/2 of 4 foremen	13,000/yr	2.89
	1/2 of 1 super.	17,500/yr	0.97
Maintenance	7½% of Investment/yr		4.17
Labor Overhead	30% of Op. Labor and Supervision		3.64
			19.93
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision	8.48	8.48
Depreciation	9.1% of Investment/yr		5.06
Local Taxes and Insurance	1½% of Investment/yr		0.83
			14.37
Total Cost of Manufacture, Bulk			183.70

1. Assumes plant part of complex receiving cooling water, steam, services, etc., from central facility.

Actual salvage values of the assets of these plants were not determined. It may be expected that specific items such as pumps, piping, centrifugal equipment, etc., will have some salvage value. In general, however, we expect that such salvage value will be less than 25% of capital cost, and frequently much less than 25%.

D. PRICE EFFECTS

The published prices of P_2S_5 and PCl_3 have remained stable for the past five years. Those of $POCl_3$ and P_2O_5 have risen in the past 2-3 years. The published price of $POCl_3$ increased about 15% in 1972; that of P_2O_5 about 25% over the longer period of 1971-1973.

While LCL transactions tend to be at published prices, it can be expected that larger volumes are sold at negotiated contract prices covering extended periods of time. Because much of the industry has an internal requirement for part of its capacity to produce the elemental phosphorus derivatives, merchant contract sales may be more advantageous to one seller than another at any given time depending upon that seller's internal requirements. So in general the prices of significant volumes are negotiated prices while lesser volumes are published price transactions.

Published price increases are usually initiated by a major producer and either followed or not by the other producers. If price changes are not followed, the initiator rescinds the price. Because the elemental phosphorus derivatives are produced in large integrated chemical plants where the impact of water pollution control is not readily isolated on a product-by-product basis, the cost of pollution control will result in price increases for selected products only where the general competitive situation permits such increases. Over extended periods increased manufacturing costs of any type generally exert an upward pressure on chemical prices, but changes take place only at those points in time when the competitive aspects permit. In the case of the derivatives of elemental phosphorus, specific price increases directly attributable to pollution control are not expected.

V. DERIVATIVES OF PHOSPHORIC ACID

A. SEGMENT DESCRIPTION

The segment is restricted to (1) the largest volume sodium salt of phosphoric acid, sodium tripolyphosphate, and (2) those calcium phosphates used industrially or in the manufacture of animal feeds.[1] The phosphoric acid from which these derivatives are made can be of either furnace or wet process origin.

Sodium tripolyphosphate (STPP) is generally produced from furnace grade phosphoric acid because of the improved color of its salts. However, there is one major producer, Olin Corporation, which uses wet process acid to produce STPP.

For the production of feed-grade dicalcium phosphates, the general practice is to use wet process phosphoric acid and limestone as the primary reactants. Dentifrice and food-grade calcium phosphates generally use furnace acid.

The traditional market for STPP has been as a detergent builder. Historically, the detergent manufacturers have been responsible for 90% of the STPP consumed in the United States, most of it in household laundry formulations. This market is now threatened by various state and local legislative measures designed to restrict the phosphate content of detergent formulations.

In the case of the calcium phosphates considered within the definition of this segment more than 90% of the consumption is for animal feeds. In addition there are specialty grades suitable for use in dentifrices and as leavening agents in baking.

B. PRODUCING COMPANIES AND PLANTS

1. Sodium Tripolyphosphate (STPP)

Table 15 indicates the manufacturers, their plant locations, and estimated plant capacities for STPP production.

With the exception of the Olin plant at Joliet, Illinois, each of these locations is also a location for furnace acid production. Thus the plants may be considered as integrated operations. The plant locations are determined to a major degree by the amount of freight equalization required to be paid on shipments to major detergent producing plants. Thus the freight on STPP tends to associate

1. Specifically excluded are fertilizer grades of calcium phosphate and defluorinated phosphate rock.

specific STPP producing locations with specific detergent plants. In fact proximity to the market is the most important factor in determining the location for a furnace acid and STPP complex.

TABLE 15

U.S. PRODUCERS OF STPP

Company	Plant Location	Capacity[1] (thousands ST/yr)
FMC	Carteret, New Jersey	100
FMC	Green River, Wyoming	75
FMC	Newark, California	50
FMC	Lawrence, Kansas	75
Mobil	Fernald, Ohio	50
Monsanto	Augusta, Georgia	50
Monsanto	Kearny, New Jersey	125
Monsanto	Long Beach, California	75
Monsanto	Trenton, Michigan	75
Monsanto	Carondelet, Missouri	100
Occidental	Dallas, Texas	35
Occidental	Jeffersonville, Indiana	100
Olin	Joliet, Illinois	150
Stauffer	Chicago, Illinois	40
Stauffer	Morrisville, Pennsylvania	75
		1175

1. Subject to significant variation, depending on grades produced.

There is a significant water pollution aspect to the production of STPP because of the wet scrubbing of the dust at various points in the process. To the extent that such water is returned to the system, water pollution is minimized. To the extent which it is not, lime precipitation and clarifiers are required.

2. Calcium Phosphates

Among the nonfertilizer types, dicalcium phosphate, primarily used for animal feed, predominates. Table 16 identifies major producing locations, most of which are located in proximity to either a wet phosphoric acid producing location or the primary feed markets. Capacities are not readily identified because part of the plant capacity in some cases can be utilized for fertilizer grades of calcium phosphate.

The water pollution aspects of feed grade dicalcium phosphate are similar to those of STPP for which wet scrubbing operations are required. Where wet process acid has not been defluorinated there is the additional problem of fluorsilicate disposal. With purified grades for dentifrice and human consumption, the impact is amplified by larger water requirements for manufacture and in the case of anhydrous product, the dewatering process.

TABLE 16

U.S. PRODUCERS OF CALCIUM PHOSPHATES

Company	Plant Location
Cyanamid	Weeping Water, Nebraska
Cyanamid	Alden, Iowa
Cyanamid	Hannibal, Missouri
Borden	Plant City, Florida
Central States*	Weeping Water, Nebraska
Eastman Kodak	Peabody, Massachusetts
Farmland	Hannibal, Missouri
IMC	Bonnie, Florida
Monsanto	Carondelet, Missouri
Occidental	Davenport, Iowa
Occidental	White Springs, Florida
Stauffer	Chicago Heights, Illinois
Stauffer	Nashville, Tennessee

*destroyed by fire but currently being rebuilt.

C. FINANCIAL PROFILE

Because industry manufacturing costs were not made available to us for either STPP or feed grade dicalcium phosphate, these have been calculated on the basis of our internal knowledge of the production costs involved.

1. Sodium Tripolyphosphate (STPP)

Table 17 establishes a manufacturing cost of $224 per ton for an STPP plant operating at a production rate of 50,000 tons per year utilizing furnace acid produced at the same site. The acid transfer price as indicated is $149 per ton. On this cost basis and using a published selling price of $162 per ton and $3 of freight equalization, the estimated plant cash flow is as follows:

Selling Price	159 $/ton
Plant Cost	224 $/ton
Plant Margin	(65) $/ton
Depreciation	4 $/ton
Plant Cash Flow	(61) $/ton

TABLE 17

ESTIMATED COST OF MANUFACTURING SODIUM TRIPOLYPHOSPHATE

Plant Location	**Midwest**
Plant Capacity	**150 T/SD**
Annual Production	**50,000 T**
Fixed Investment	**$2,440,000**

Variable Costs	**Quantity/Ton**	**$/Unit**	**$/Ton**
Phosphoric acid, 75%	1.087 T	149.00[1]	161.96
Soda Ash	0.735 T	44.50[2]	32.71
Operating Supplies			0.50
Power	38.9 kwh	0.01	0.39
Fuel	13.9 MM Btu	0.80	11.12
			206.68
Semi-Variable Costs			
Operating Labor	4 men/shift	4.50/hr	3.15
Supervision	4 foremen	13,000/yr	1.04
	1 super.	17,500/yr	0.35
Maintenance	5% of Investment/yr		2.44
Labor Overhead	30% of Op. Labor and Supervision		1.36
			8.34
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision		3.18
Depreciation	9.1% of Investment/yr		4.44
Local Taxes and Insurance	1.5% of Investment/yr		0.73
			8.35
Total Cost of Manufacture			223.37

1. FOB plant value, assumes STPP plant at same site as acid plant.
2. $35.50 FOB plant plus $9.00 freight.

However, if the phosphoric acid made in the same plant is transferred at cost, or $96 per ton, a plant cash flow close to breakeven results.

Selling Price	159 $/ton
Plant Cost	165 $/ton
Plant Margin	(6) $/ton
Depreciation	4 $/ton
Plant Cash Flow	(2) $/ton

If a reasonable GS&A charge of $3.50 per ton is applied, there is a net loss before taxes of $10 per ton. Furthermore, the bulk of the sales to the large household detergent producers are generally made below list. For these a net back after freight equalization of $153 is more realistic than $159. Under such conditions the net loss before taxes becomes $7-8 per ton.

Actual salvage values of the STPP were not determined. In general, however, we expect that such salvage value will be less than 25% of capital cost, and frequently much less than 25%.

2. *Calcium Phosphates*

Table 18 develops the manufacturing cost of a plant manufacturing 65,000 tons per year of feed grade (18.5% P) dicalcium phosphate. Currently this product is in short supply and from Midwest manufacturing locations is priced at $87.25 per ton in bulk, freight equalized with competitive locations. In order to calculate a typical plant cash flow and profit before tax we have taken $4.25 as typical freight equalization with a net back to the plant of $83 per ton. The plant cash flow then becomes:

Selling Price	$83 per ton
Plant Cost	70 per ton
Plant Margin	13 per ton
Depreciation	2 per ton
Plant Cash Flow	15 per ton

If the GS&A allowance is $3 per ton, the profit before tax is $10 per ton.

Table 19 similarly develops the manufacturing cost for dicalcium phosphate dihydrate which is one of the refined grades. This and other refined grades serve the dentifrice and human food markets. The plant cash flow for dicalcium phosphate dihydrate is characteristically higher than for feed grade dicalcium phosphate.

TABLE 18

ESTIMATED COST OF MANUFACTURING DICALCIUM PHOSPHATE
(Feed Grade 18.5% P)

Plant Location	Midwest
Annual Production	65,000 T
Fixed Investment	$1,200,000

Variable Costs	Quantity	$/Unit	$/Ton
Defluorinated Phosphoric Acid, P_2O_5 basis	0.458 T	125.00[1]	54.59
Ground Limestone	.728 T	9.00[2]	6.55
Power	18.2 kwh	0.01	0.18
Water	0.06 Mgal	0.05	–
Fuel	0.1 MM Btu	0.80	0.08
Operating Supplies			0.10
			61.50
Semi-Variable Costs			
Operating Labor	2 men/shift	4.50/hr	1.21
	2 men days	4.50/hr	0.29
Supervision	4 foremen	13,000/yr	0.80
	1 superintendent	17,500/yr	0.26
Maintenance	5% of Investment/yr		0.92
Labor Overhead	30% of Op. Labor and Supervision		0.77
			4.25
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision		1.79
Depreciation	9.1% of Investment/yr		1.68
Local Taxes and Insurance	1.5% of Investment/yr		0.28
			3.75
Total Cost of Manufacture, Bulk			**69.50**

1. $110/T P_2O_5 plus $15 freight
2. $4/ton plus $5 freight.

TABLE 19

ESTIMATED COST OF MANUFACTURING DICALCIUM PHOSPHATE DIHYDRATE

Plant Location	**Midwest**
Annual Production	**20,000 tons**
Fixed Investment	**$730,000**

Variable Costs	**Quantity**	**$/Unit**	**$/Ton**
Hydrated Lime	0.453 T	28.00[1]	12.68
Phosphoric Acid 75%	0.774 T	159.00[2]	123.07
Cooling Water	2.3 Mgal	0.03	0.07
Power	37 kwh	0.01	0.37
Water, Process	1.25 Mgal	0.03	0.04
Fuel	1.1 MM Btu	0.80	0.88
Operating Supplies			0.50
Bags	20.1	0.20	4.02
			141.63
Semi-Variable Costs			
Operating Labor	3 men/shift	4.50/hr	5.91
	5 men, 250 days	4.00/hr	2.00
Supervision	4 foremen	13,000/yr	2.60
	1 superintendent	17,500/yr	0.88
Maintenance	5% of Investment/yr		1.83
Labor Overhead	30% of Op. Labor and Supervision		3.42
			16.64
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision		7.97
Depreciation	9.1% of Investment/yr		3.32
Local Taxes and Insurance	1.5% of Investment/yr		0.55
			11.84
Total Cost of Manufacture, Bagged			170.11

1. $22 fob plus $6.00 freight
2. $149 fob plus $10.00 freight

TABLE 18

ESTIMATED COST OF MANUFACTURING DICALCIUM PHOSPHATE
(Feed Grade 18.5% P)

Plant Location	Midwest
Annual Production	65,000 T
Fixed Investment	$1,200,000

Variable Costs	Quantity	$/Unit	$/Ton
Defluorinated Phosphoric Acid, P_2O_5 basis	0.458 T	125.00[1]	54.59
Ground Limestone	.728 T	9.00[2]	6.55
Power	18.2 kwh	0.01	0.18
Water	0.06 Mgal	0.05	–
Fuel	0.1 MM Btu	0.80	0.08
Operating Supplies			0.10
			61.50
Semi-Variable Costs			
Operating Labor	2 men/shift	4.50/hr	1.21
	2 men days	4.50/hr	0.29
Supervision	4 foremen	13,000/yr	0.80
	1 superintendent	17,500/yr	0.26
Maintenance	5% of Investment/yr		0.92
Labor Overhead	30% of Op. Labor and Supervision		0.77
			4.25
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision		1.79
Depreciation	9.1% of Investment/yr		1.68
Local Taxes and Insurance	1.5% of Investment/yr		0.28
			3.75
Total Cost of Manufacture, Bulk			**69.50**

1. $110/T P_2O_5 plus $15 freight
2. $4/ton plus $5 freight.

TABLE 19

ESTIMATED COST OF MANUFACTURING DICALCIUM PHOSPHATE DIHYDRATE

Plant Location	**Midwest**
Annual Production	**20,000 tons**
Fixed Investment	**$730,000**

Variable Costs	**Quantity**	**$/Unit**	**$/Ton**
Hydrated Lime	0.453 T	28.00[1]	12.68
Phosphoric Acid 75%	0.774 T	159.00[2]	123.07
Cooling Water	2.3 Mgal	0.03	0.07
Power	37 kwh	0.01	0.37
Water, Process	1.25 Mgal	0.03	0.04
Fuel	1.1 MM Btu	0.80	0.88
Operating Supplies			0.50
Bags	20.1	0.20	4.02
			141.63
Semi-Variable Costs			
Operating Labor	3 men/shift	4.50/hr	5.91
	5 men, 250 days	4.00/hr	2.00
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	1 superintendent	17,500/yr	0.88
Maintenance	5% of Investment/yr		1.83
Labor Overhead	30% of Op. Labor and Supervision		3.42
			16.64
Fixed Costs			
Plant Overhead	70% of Op. Labor and Supervision		7.97
Depreciation	9.1% of Investment/yr		3.32
Local Taxes and Insurance	1.5% of Investment/yr		0.55
			11.84
Total Cost of Manufacture, Bagged			170.11

1. $22 fob plus $6.00 freight
2. $149 fob plus $10.00 freight

Selling Price	$230 per ton
Plant Cost	170 per ton
Plant Margin	60 per ton
Depreciation	3 per ton
Plant Cash Flow	63 per ton

With GS&A costs of $30 per ton the profit before tax is $33 per ton.

D. PRICE EFFECTS

The published prices of STPP as sold in bulk and shipped in hopper cars, freight equalized with competitive locations, have increased from $135 per ton in 1967 to $152 per ton in 1972 to a current level of $162. Over this same period the major detergent producers have generally paid $140-$155. With freight equalization and a generally low level of profitability, most producing plants rely on one or two major volume detergent plants for a majority of their STPP sales and these one or two plants are those for which freight equalization is minimal.

Prices for STPP have been traditionally established by highly competitive bidding for the large annual requirements of such major detergent plants. This bidding process has resulted in low margins and a reluctance on the part of the producers to expand capacity. Currently STPP is in short supply, but because of price controls cannot rise to levels where return on investment is adequate to stimulate expanded production.

If pollution considerations significantly reduce the use of STPP in detergents, the current tight supply situation would be alleviated, and excess capacity might appear. This would produce a downward pressure on prices.

The pricing of calcium phosphates for feed use is complex with major differentials based on geographic location and freight equalization. Thus for the producing point of Bonnie, Florida, which is distant from the major Midwest markets, the price of feed grade dicalcium phosphate is $74.00 per ton freight equalized. Similarly, at Weeping Water, Nebraska, for a plant much closer to the major markets the price is $87.25 per ton freight equalized. This combination of price differentials and freight equalization permits a high degree of market selectivity.

The purified dentifrice and human food grades of calcium phosphates, which are more costly to produce, command premiums ranging from $140 to $170 per ton over feed grades.

The prices of the calcium phosphates, when not in short supply, are determined by competitive processes in the marketplace. Currently, however, they are in short supply and would rise if there were no controls.

Because of the low margins of profit currently generated by STPP, it can be expected that producers will attempt to pass on any cost increases that result from water pollution control measures. This is also probable with feed grade dicalcium phosphate, but the results will be somewhat dependent upon the supply-demand situation at the time of increased costs.

SECTION III

ECONOMIC IMPACT ANALYSIS

I. INTRODUCTION

This section assesses the economic impact of water pollution control costs on the production of the following nonfertilizer phosphate products:

Phosphorus
Phosphoric Acid produced from phosphorus
Phosphorus Pentoxide
Phosphorus Trichloride
Phosphorus Oxychloride
Phosphorus Pentasulfide
Sodium Tripolyphosphate
Calcium Phosphates (except defluorinated phosphate and fertilizer phosphate).

As requested by EPA, this impact analysis is confined to those water pollution control costs submitted to EPA in Supplement A of a report entitled "Cost Information for the Water-borne Wastes in the Nonfertilizer Phosphorus Chemicals Industry" prepared by General Technologies Corporation, referred to as the effluent guideline development document. In this report, it was concluded that zero discharge is a reasonable and achievable goal, and it was recommended that this guideline be established for all of the products covered in this report.

At the same time, the effluent guideline development document acknowledges that there may be substantial variation from the costs presented in their report, to achieve zero discharge for individual plants in the industry. That such variations are likely was confirmed in our discussions with some of the major producers of several of the products in this category. If such variations from the costs presented in the effluent guideline development document are significant for individual plants, then the impact of water pollution control costs to achieve discharge may be significantly different than those presented in this analysis.

Because we were unable to quantify the variations for individual plants, we did confine ourselves, as requested by EPA, to assessing the impact of the costs presented in the effluent guideline development document. It was not within the scope of our assignment to evaluate or confirm the validity of the technical and economic information presented in this document.

II. IMPACT ANALYSIS

A. WATER POLLUTION CONTROL COSTS

The effluent guideline development document states that zero water discharge is either being currently achieved, or could be achieved with little difficulty, in exemplary plants now operating in each product category, and therefore have recommended that this be established as the pollution guideline. The technology proposed by the effluent guideline development document for each product segment, and the estimated costs, are presented below.

1. Phosphorus

Three companies are producing phosphorus in separate locations in Florida with a total of four furnaces, three companies are operating in Tennessee with a total of ten furnaces, and three companies are operating in Idaho and Montana with a total of nine furnaces. In addition the TVA operates three furnaces in Alabama.

There is at least one existing plant that is reported in the effluent guideline development document to achieve zero discharge by using complete recycle of phossy water, evaporation of some process water, lime treatment and sedimentation of remaining process water prior to discharge. Other plants were estimated to be able to achieve 100% recycle of process waste water back to the head end of the plant by installing pumps, piping, and appropriate controls.

The cost of achieving zero discharge through installation of the equipment described above is estimated in the effluent guideline development document to be $4.60 per ton of phosphorus.

2. Furnace Phosphoric Acid

There are an estimated 21 plants producing furnace phosphoric acid from phosphorus, operated by six companies, and the TVA. Many of these have associated with them units for the production of various sodium and potassium phosphates. A number of these are in urban areas; their location, particularly when associated with the production of sodium tripolyphosphate, has been dictated by proximity to major detergent factories.

The measures necessary to achieve zero discharge at furnace acid plants, according to the effluent guideline development document, are generally associated with improved housekeeping and maintenance. Costs included construction of dikes and dams around pipes, valves, tanks, etc., the provision of sumps and sump pumps, and treatment with lime. The resultant sludge is used for landfill.

In the effluent guideline development document, it is estimated that the cost of achieving zero discharge in furnace acid plants is $0.65 per ton of 75% phosphoric acid.

3. Anhydrous Derivatives of Elemental Phosphorus

The four derivatives comprising this segment are phosphorus oxychloride, phosphorus pentasulfide, phosphorus pentoxide, and phosphorus trichloride. All four are produced under anhydrous conditions and the water pollution aspects are limited to disposal of water used for wet scrubbing of air emissions. However, the disposal of such water is critical because there is no remedy available through return of this water to the reaction process because of the anhydrous conditions of manufacture.

The primary plant sites are Nitro, West Virginia; Niagara Falls, New York; Sauget, Illinois; Anniston, Alabama; Charleston, South Carolina; Morrisville, Pennsylvania; Mt. Pleasant, Tennessee; Nashville, Tennessee; and Cold Creek, Alabama. In general these are large multiproduct, integrated operations producing dozens of individual chemical products of which the volume represented by the derivatives of elemental phosphorus may be only a portion of the chemical output of the site.

In general the process water used for wet scrubbing of air emissions is commingled with plant effluent water and not treated separately to remove dissolved or particulate impurities. In some cases water from the wet scrubbing may be used as process water in other processes where such opportunities are available but this is not a practical general solution.

In the case of the four derivatives of elemental phosphorus, the effluent guideline development document recommends the attainment of zero discharge via (1) concentration of impurities through reuse of wet scrubbing effluent by return to the wet scrubbing process; (2) lime treatment of concentrated effluent; (3) settling tanks; and (4) land fill of sludge.

The costs presented in the effluent guideline development document for total treatment of effluent to achieve zero discharge are as follows, on the basis of $/per ton of product manufactured.

Product	Zero Discharge Cost
Phosphorus oxychloride	$1.25/ton
Phosphorus pentasulfide	1.70/ton
Phosphorus pentoxide	1.40/ton
Phosphorus trichloride	1.40/ton

4. Derivatives of Phosphoric Acid

This segment is restricted to sodium tripolyphosphate (STPP) and those calcium phosphates used industrially or in the manufacture of animal feeds. The latter category of calcium phosphates, i.e., those used for the manufacture of animal feeds, accounts for more than 90% of the calcium phosphates included in the segment. Excluded from the segment is fertilizer consumption of calcium phosphate.

The primary plant sites are indicated in Table 20. The STPP locations and several of the calcium phosphate locations are large multiproduct integrated operations producing a number of individual chemical products. This is less typical of the feed grade calcium phosphate plants which are sited for either proximity to wet process acid or the animal feed compounders representing the market.

TABLE 20

PLANT LOCATION SITES – PHOSPHORIC ACID DERIVATIVES

STPP	Calcium Phosphates
Carteret, New Jersey	Weeping Water,* Nebraska
Green River, Wyoming	Alden, Iowa
Newark, California	Hannibal,* Missouri
Lawrence, Kansas	Plant City, Florida
Fernald, Ohio	Peabody, Massachusetts
Augusta, Georgia	Bonnie, Florida
Kearny, New Jersey	Carondelet, Missouri
Long Beach, California	Davenport, Iowa
Trenton, Michigan	White Springs, Florida
Carondelet, Missouri	Chicago Heights, Illinois
Dallas, Texas	Nashville, Tennessee
Jeffersonville, Indiana	
Joliet, Illinois	
Chicago, Illinois	
Morrisville, Pennsylvania	

*Location of more than one plant.

To a considerable degree the water used for wet scrubbing of dust at various points in the process is returned to process. Where such return to process is not readily accommodated, lime precipitation and clarification are required. The purified grades of calcium phosphates in particular require large volumes of process water. Special problems relate to the disposal of water removed from anhydrous calcium phosphate and the disposal of fluosilicates from those calcium phosphate plants using wet process acid which has not been defluorinated.

In the case of the derivatives of phosphoric acid only the calcium phosphates have costs associated with the achievement of zero discharge as reported in the effluent guideline development document. This asserts that dry dust collection filters constitute an investment which obviates water pollution in the case of STPP and the investment *per se* is compensated for by savings in product recovery.

In the case of dicalcium phosphate manufacture, the costs associated with zero discharge are generally related to (1) lime treatment, (2) settling or filtration, (3) recycle of clarified water to the process, and (4) land fill of sludge or filter cake.

The costs presented in the effluent guideline development document for total treatment of effluent to achieve zero discharge are as follows on the basis of dollars per ton of product manufactured.

Product	Zero Discharge Cost ($/ton)
STPP	–
Dicalcium phosphate – Feed Grade	1.40
Dicalcium Phosphate – Food Grade	1.50

B. IMPACT ON PRICES

We have summarized in Table 21 the increases in prices that would result from the costs of achieving zero discharge that are presented in the effluent guideline development document. It should be noted that we have included not only the costs of water pollution control for individual products, but also the increases in the costs of the raw materials covered in this segment which are used for the production of derivatives, arising from the same water pollution control considerations. For example, the overall increase in prices for Food Grade calcium phosphate would result not only from the cost of water pollution control in the dicalcium phosphate plant, but also the increase in the cost of furnace grade phosphoric acid arising from water pollution control considerations in that plant, and also the increase in cost of phosphorus used to make the furnace acid, arising from water pollution control considerations in the phosphorus plant.

The price increases that would result from passing on the cost of achieving zero discharge, as presented in the effluent guideline development document, are of such small magnitude that we do not believe there will be any significant impact on profitability arising from these increases. The maximum increase as a percent of current selling price was 1.6% for Feed Grade Dicalcium Phosphate. All other increases were 1.2% of sales price or less. Incidentally, we have used in these calculations the current list prices for the various products, realizing that in some instances actual sales are being made at somewhat different prices. However, for the purposes of relating the magnitude of the cost increases arising from achieving zero discharge, the use of the list prices is not significantly in error.

TABLE 21

PRICE INCREASES RELATED TO GTC PROPOSED COSTS OF ACHIEVING ZERO DISCHARGE

Product	Pollution Control Cost ($/ton)	Raw Material[2] Cost Increase ($/ton)	Total Cost Increase ($/ton)	Current[1] Price ($/ton)	Percentage Increase
Phosphorus	4.60	–	4.60	380	1.2
Furnace Acid	0.65	1.10	1.75	168	1.0
Phosphorus Pentoxide	1.40	1.09	2.49	400	0.6
Phosphorus Trichloride	1.40	1.09	2.49	220	1.1
Phosphorus Oxychloride	1.25	1.83	3.08	245	1.2
Phosphorus Pentasulfide	1.70	1.32	3.02	267	1.1
STPP	–	1.90	1.90	162	1.2
Feed-grade Dical	1.40	–	1.40	87	1.6
Food-grade Dical	1.50	1.35	2.85	257	1.1

1. Prices based on Chemical Marketing Reporter, 7/23/73.

2. Based on following usages:

0.24 tons phos/ton acid	1.09 tons acid/ton STPP
0.24 tons phos/ton pentoxide	0.77 tons acid/ton food grade dical
0.24 tons phos/ton trichloride	0.29 tons phos/ton pentasulfide

0.19 tons pentoxide + 0.55 tons trichloride/ton oxychloride.

Our conclusion that the cost increases of the magnitude indicated in the effluent guideline development document would be of insignificant consequence, is further supported by the nature of the markets for the products in question. The uses of the products in this segment are such that there is little if any ability to substitute other products, should price increases so suggest. Because of the specific requirements for the individual products in this segment, it is almost certain that the price increases, particularly of the small magnitude which apparently would result, would be passed on to the ultimate consumer.

The one possible exception is Feed Grade Dicalcium Phosphate, where there is a possibility of substituting other phosphate materials without too much difficulty, if the price increase in the dicalcium phosphate were substantial. Such materials as defluorinated phosphate rock could be used although there are specific advantages which the dicalcium phosphate does have for certain feed formulations. Even in the case of this product, however, the price increase is so small that we do not foresee any impact of a major nature on profitability.

If the premise is accepted that the costs of achieving zero discharge as presented in the effluent guideline development document would have a negligible effect on profitability, then it follows that no production curtailments or plant closings would be foreseen for any of these products nor would there be restrictions on industry growth, as a direct result of the cost increases for achieving zero discharge.

No significant impact would then be expected on employment in the plant producing these products or on the communities in which they are located, as a result of the cost increases to achieve zero discharge.

III. LIMITS OF THE ANALYSIS

The cost increases for achieving zero discharge, as presented in the effluent guideline development document, have been shown to be relatively small in relation to current sales prices – in no case more than 1.6%. This order of magnitude of cost increase is substantially below the variations which we believe exist among the individual plants producing these products, in their cost of manufacture, and also less than the cyclical variation in prices which may be expected as market conditions change. Therefore the range of error in the conclusions drawn from the cost presented is believed to be small and would be overshadowed by uncertainties in the estimates of the cost of manufacturing, and in the variation in manufacturing costs from plant to plant.

The critical question concerning these conclusions is of course the extent to which the costs presented in the effluent guideline development document can be realistically used as a basis for estimating the costs that will be incurred by specific individual plants within the industry. In several cases, producers felt that the costs presented in the effluent guideline development document were unrealistically low, and also that in certain cases, the technology to achieve zero discharge was of questionable validity. Preliminary contacts with major producers of several of the products examined have confirmed that major variations do occur among individual plants regarding the applicability of both the technology, and the cost estimates as presented in the effluent guideline development document. It was not within the scope of our report to evaluate or confirm the validity of either the technology or of the estimates of the investment and operating costs to achieve zero discharge, which were presented in the effluent guideline development document.

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15. Supplementary Notes

16. Abstracts

An initial analysis of the economic impact of proposed water effluent guidelines upon certain products in the industrial phosphate industry. This analysis was based on abatement cost data supplied by the EPA. The products covered included phosphorous, phosphoric acid produced from phosphorous, and anhydrous phosphorous derivatives, and certain derivatives of phosphoric acid but not including fertilizers.

The effluent guideline development document supplying the abatement costs used in this analysis indicated that zero discharge was a practical goal and that the cost of achieving zero discharge did not exceed 1.6% of the selling price of any of the products studied. On the basis of these costs, it was concluded that there would be no significant economic impact on the products studied.

17. Key Words and Document Analysis. 17a. Descriptors

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17b. Identifiers/Open-Ended Terms

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