EXECUTIVE SUMMARY

ECONOMIC IMPACT STUDY OF THE POLLUTION ABATEMENT EQUIPMENT INDUSTRY

report to

ENVIRONMENTAL PROTECTION AGENCY

EPA CONTRACT NO. 68-01-0553

Arthur D. Little, Inc.

- EXECUTIVE SUMMARY -

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December 1972

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ABSTRACT

ECONOMIC IMPACT STUDY OF THE POLLUTION ABATEMENT EQUIPMENT INDUSTRY
by Arthur D. Little, Inc., (December 1972 - Cambridge, Massachusetts)
for the Environmental Protection Agency (Contract No. 68-01-0553)

The objective of this study was *to analyze the economic impact of environmental standards on the industries providing pollution abatement equipment to be required by both industry and government.* This objective is accomplished through: 1) a characterization of the air and water pollution control equipment industries; 2) an analysis of demand for their products and services; and 3) an evaluation of the impact of that demand upon those industries.

The demand and impact analyses are performed under assumptions of three alternative futures for the 1972-80 period. A *Baseline* (I) scenario extrapolates pollution abatement activity from a base year predating major environmental legislation. *A Federal Compliance Schedule* (II) simulates on-time enforcement of existing standards. *An Expected Compliance Schedule* (III) reflects the contractor's forecast of what may alternatively occur.

The pollution abatement industries analyzed in this study include air pollution control equipment (for particulate and gaseous emissions from stationary sources), water pollution control equipment, instrumentation for air or water pollution abatement, and chemicals for water pollution control. Although these industries suffer from overcapacity and although growth and profitability have not been up to expectations, current profitability is at least equivalent to the returns of companies who might enter these markets from similar businesses. With a return to improved operating rates, there should be no problem in the attraction of investment interest.

The aggregate expenditures needed to control air pollution control from stationary sources are $12.8 billion. Environmental legislation has already had a major positive impact upon the air pollution control business. The major uncertainty about future demand centers around the availability of proven technology to control sulfur oxide emissions. The analysis of impact, accordingly, is made under two assumptions: a) present technology and practice and b) adequate proven technology in time for 1975-77 application.

Assuming less than adequate technology (a) ,the on-time enforcement (II) of particulate standards and (where possible) enforcement of gaseous emission controls is projected to unilaterally increase the average costs of equipment over the 1972-80 period by 10.3% for particulate control and 11.9% for gaseous control. Under the expected compliance schedule (III), this cost push inflation is estimated at 2.9% for particulate and 6.7% for gaseous. Under the assumption of adequate technology (b), on-time enforcement (II) would result in a 3.9% inflation of particulate costs and 15.9% for gaseous. Similarly, under the expected compliance schedule (III), the inflation for separate particulate control is 1.7% and that for gaseous control is 13.5%.

The aggregate demand for municipal sewerage expenditures is estimated at $27 billion. A review of recent municipal construction indicates that actual activity has fallen behind an extrapolated baseline (I) projection from the pre-1965 period. By 1980, however, cumulative expenditures surpass those of the baseline (I) projection in both the on-time (II) and expected (III) compliance schedules. Under the on-time (II) scenario, activity peaks in 197576 and then declines to a level associated with new plant construction. Under the expected (III) scenario, municipal plant construction increases steadily until 1980 before it declines to new plant construction levels.

The aggregate demand for industrial water pollution control expenditures is $9.7 billion. Recent industrial wastewater treatment activity has been substantially above baseline (I) activity. Both on-time (II) and expected (III) compliance schedules are projected to take care of the estimated backlog of needs by the mid-1970's, after which the level of activity will decline to that of new plant construction needs. This indicates that either the cost of industrial wastewater treatment has been underestimated or that industry will soon be in a position to handle another level of standards (e.g., those implicit in the 1972 Amendments to the Federal Water Pollution Control Act).

The anticipated average inflation in water pollution control costs is small under both on-time (II) and expected (III) scenarios. With consideration of the associated water treatment business, the combined water and wastewater treatment equipment business is expected to experience supply-related inflations of 0.8% and 0.3% for scenarios II and III respectively. Water treatment chemicals are forecasted to have an average inflation between 1972, and 1980 of only 0.2% under both alternative futures. Instrumentation for air or water applications is estimated to have an inflation of 4.6% under on-time (II) enforcement and 2.3% under the expected (III) schedule.

Employment in all the industries studied is roughly estimated at 100,000 by 1975 under on-time (II) enforcement schedules. This is about four times as great as 1975 employment (24,000) under the baseline (I) scenario, is about twice as great as that (49,000) under the expected (III) schedule, and may be compared to the more than 200,000 employed in 1967 in the four-digit SIC industries encompassing the pollution abatement equipment industries. At its peak, 1980, the expected (III) schedule exhibits higher employment (75,000) than the baseline (I-31,000) and on-time (II-27,000) schedules.

EXECUTIVE SUMMARY

INTRODUCTION

A. OBJECTIVES

In its contract (No. 68-01-0553) with Arthur D. Little, Inc. (ADL), the Environmental Protection Agency (EPA) stated the objective of this study to be:

> "To analyze the economic impact of environmental standards on the industries providing pollution abatement equipment to be required by both industry and government."

To fulfill that objective, it was further specified that the analysis should be divided into three parts, as follows:

- A characterization of the industry.
- An analysis of demand.
- An evaluation of economic impact.

The analyses of demand and derivative impact upon the pollution abatement equipment industry were to be carried out under the assumptions of three alternative futures:

Case I: Baseline

An extrapolation of pollution abatement activity assuming major environmental legislation had not been passed.

Case II: Federal Compliance Schedule

A simulation of pollution abatement activity to be expected from rigid enforcement of current legislation and standards.

Case III: Expected Compliance Schedule

An alternative simulation of the pattern of activity which ADL believes may more likely occur.

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[1]The legislative targets and related standards considered herein are those in force in mid-1972. Hence, the amendments to the Federal Water Pollution Control Act of October 1972 have not been integrated into our analysis.

B. SCOPE

In general, the pollution abatement equipment industry described in this report includes those companies which supply products and related services for the control of air and water pollution.[2]

Regionality was not viewed as critical to this analysis of the equipment portion of the pollution abatement industry. The leading suppliers are located in a representative sample of the largest metropolitan areas, and their customers are as widespread as urban population and manufacturing industry. Hence, our analysis has focused on a national market served by a national industry.

1. Air Pollution Control.

Our analysis of the air pollution control (APC) equipment industry is addressed to the control of large-scale emissions from stationary sources; it excludes the control of emissions from mobile sources, the alteration of fuels, and process improvements.

Air pollution control equipment is differentiated into its particulate removal and gaseous control segments. Particulate removal is considered in terms of traditional product lines: electrostatic precipitators, fabric filters, wet scrubbers, and mechanical collectors. Gaseous control equipment is separated into the emerging SO_2 control systems and the traditional devices for fume and odor control.

Instrumentation markets associated with the control and monitoring of stationary sources are considered separately. Finally, we examine the substantial association services provided by air pollution control equipment manufacturers: design, assembly, erection, and the supply of auxiliary equipment. However, those services which are supplied by the construction industry, although identified, have been excluded from our impact analysis.[3]

2. Water Pollution Control.

In our analysis, the most important distinction in the water pollution control (WPC) equipment business is between its municipal and industrial sectors. We have emphasized specialty equipment (i.e., that produced largely for WPC applications), giving specific attention to 15 major product areas. Instrumentation for water pollution control we analyzed separately. Although they are not, strictly speaking, an equipment item, we have also included in our analysis the specialty chemicals (and their related services) needed for water pollution control. The greater portion of water pollution control expenditures, that of facility construction, is included in the demand analysis and excluded from the impact analysis in this report.[4]

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[2] Initially, the work was to address radiation control along with air and water pollution, but the lack of any meaningful statistics on equipment markets prevented our analyzing that market.

[3] The analysis of the impact of pollution legislation upon the construction services industry was covered in a concurrent study funded by EPA.

[4] *Idem.*

C. SOURCES OF INFORMATION

The information used in this study was gathered from many sources. Much of it, particularly that related to industry characteristics, was obtained from ADL staff members with knowledge and experience in the pollution control business. This information was supplemented during the study through personal contacts with leading companies and associations in the pollution control industry; with leading financial institutions and manpower recruiting firms; and with state agencies, the Department of Commerce, and EPA. We are indebted to more than 25 companies and their executives for their contributions and have also benefited from the cooperation of the Industrial Gas Cleaning Institute (IGCI), the Water Pollution Control Federation (WPCF), the Water and Wastewater Equipment Manufacturers Association (WWEMA), the Process Equipment Manufacturers Association (PEMA), and the National Sanitation Foundation (NSF).

I. THE INDUSTRY

A. ITS STRUCTURE

The major sectors of the pollution abatement equipment industry are:

- air pollution control equipment.
- water pollution control equipment.
- instrumentation for air and water.
- water pollution control chemicals.

By commonly accepted standards, these pollution industries are not overly concentrated. The concentrations in the APC and WPC equipment industries are typified by their specialty equipment sectors.

More than 300 companies participate in the APC equipment business (hardware plus associated services) estimated at $466 million in 1971. The 4 leading suppliers of equipment account for about 35% of the market; similarly, the top 12 and 20 suppliers are estimated to account, respectively, for 60% and 70% of the total.

Although there has been a slight trend toward further concentration in the APC equipment industry by way of mergers and acquisitions, there is not yet cause for concern. Moreover, the advent of a sizeable SO_2 control market should contribute to a redistribution of the APC business among a larger number of firms.

More than 400 firms participate in a total business that encompasses both water pollution control and its more established counterpart, water treatment. The 4 volume leaders in this combined category hold about 20% of a market which totaled about $475 million in 1971: about $275 million for wastewater treatment and $200 million for water treatment.

As associated services are much less a part of a supplier's business in water pollution control, our concentration analyses are based solely on the equipment market. Including the 4 leaders, the top 12 and top 20 firms probably account for 45% and 60%, respectively, of the combined market. There has been significant concentration in recent years: of the top 12 firms, 5 have been involved in major mergers or acquisitions. Yet, the water and wastewater treatment equipment business remains less concentrated than the APC equipment business. There is no reason to believe that an overly concentrated industry structure will present a major impediment to the near-term supply of needed pollution abatement systems.

B. ITS MARKETS

1. Domestic.

A customer-market of great concern in this study is municipal sewage treatment, because of its multi-layered structure of municipal governments, consulting engineering firms, contractors, local health authorities, state health departments, and federal authorities. One effect of this marketing structure is an extended delay (3 to 5 years) between decision and equipment delivery. A second - and maybe more important - effect is the pressure on these parties to protect their respective positions by conservative decision-making. As a result, the municipal WPC market will be slow to respond to federal compliance pressures and to technological change. Moreover, the difficulties of selling to these markets reduces corporate profits and thereby incentives in serving it.

The pollution control customer is a reluctant one, primarily because his investment can only subtract from his profitability. In simple terms: *if he is not legally forced to invest he will not, and if he is he will.* This customer characteristic reflects the major link between the rate of pollution control investment and the degree of federal enforcement.

2. Foreign.

Theoretically, the U.S. lead in environmental legislation over the rest of the world could present an opportunity for significant export of technological know-how. However, in examining the most likely of the near-term foreign markets - i.e., Western Europe and Japan - to determine the magnitude of this export potential, we find that the actual potential is not encouraging. Technologically, we may enjoy a slight advantage, but the markets are not only small but effectively protected against import competition. Of the 1969 import (U.S. export) markets in Western Europe, for example, the U.S. share in APC equipment was less than 15%, but as much as 40% in water treatment equipment. Even at that, our export volumes in each case represented 2% or less of our domestic market. Until now, the participation of U.S. producers in foreign markets has been concentrated in licensing agreements, affiliations, and partial ownership of foreign suppliers. As a result, foreign markets (and foreign competition) do not play a role in our analyses of demand and economic impact.

C. ITS PERFORMANCE

Because of the great publicity about pollution control, the business has become a glamour industry to investors, its participants and its potential new entrants. Its performance, however, has thus far been a relative disappointment. Given this history, we examined the financial statistics of the industry to assess its attractiveness to both its leading companies and to potential new entrants. We were concerned that if the business were not sufficiently attractive, there might be a problem in attracting future investment. After considerable examination, we believe that the pollution abatement equipment business is attractive enough to encourage the development of as much long-term supply as may be needed through 1980, for several reasons.

First, the profit margins enjoyed by pollution control companies on their pollution businesses have generally exceeded the margins received in their other businesses.

Second, comparing the return on assets enjoyed by companies for which pollution control is a significant activity (greater than 5% of sales) to those companies in which pollution control is a minor activity, we found that the former slightly out-performed their less involved competitors.

Third, comparing the return on assets of companies “in” the pollution business to their broader SIC industries to determine whether similar companies would be attracted to the business, we found that the performance of pollution companies was generally above that of its SIC neighbors.

Finally, examining the returns of selected companies in two industries which have indicated strong interests in entering the pollution business - the chemical and aerospace industries - we found that the returns of WPC specialty chemical companies were greater than the returns of major chemical forms. Also, average returns of the pollution control equipment suppliers were more attractive than the average returns of leading aerospace companies.

Since the pollution abatement industry now seems to be in severe overcapacity, its profitability will become even more attractive with a return to normal or higher operating rates.

In summary, although the returns in the pollution business have appeared low to many observers, we find no cause for concern about a shortage of investment in the business.

II. THE DEMAND

The major task in analyzing the market for the pollution abatement equipment industry was converting gross estimates of needed pollution control expenditures into an aggregate demand for products and services and distributing those expenditures over time. Specifically, the objectives of our analysis were:

- to determine the aggregate demand (in constant dollars) for pollution abatement equipment over the period 1972-80.
- to determine that portion of aggregate demand which represents a business for equipment manufacturers.
- to determine component markets for major product lines.

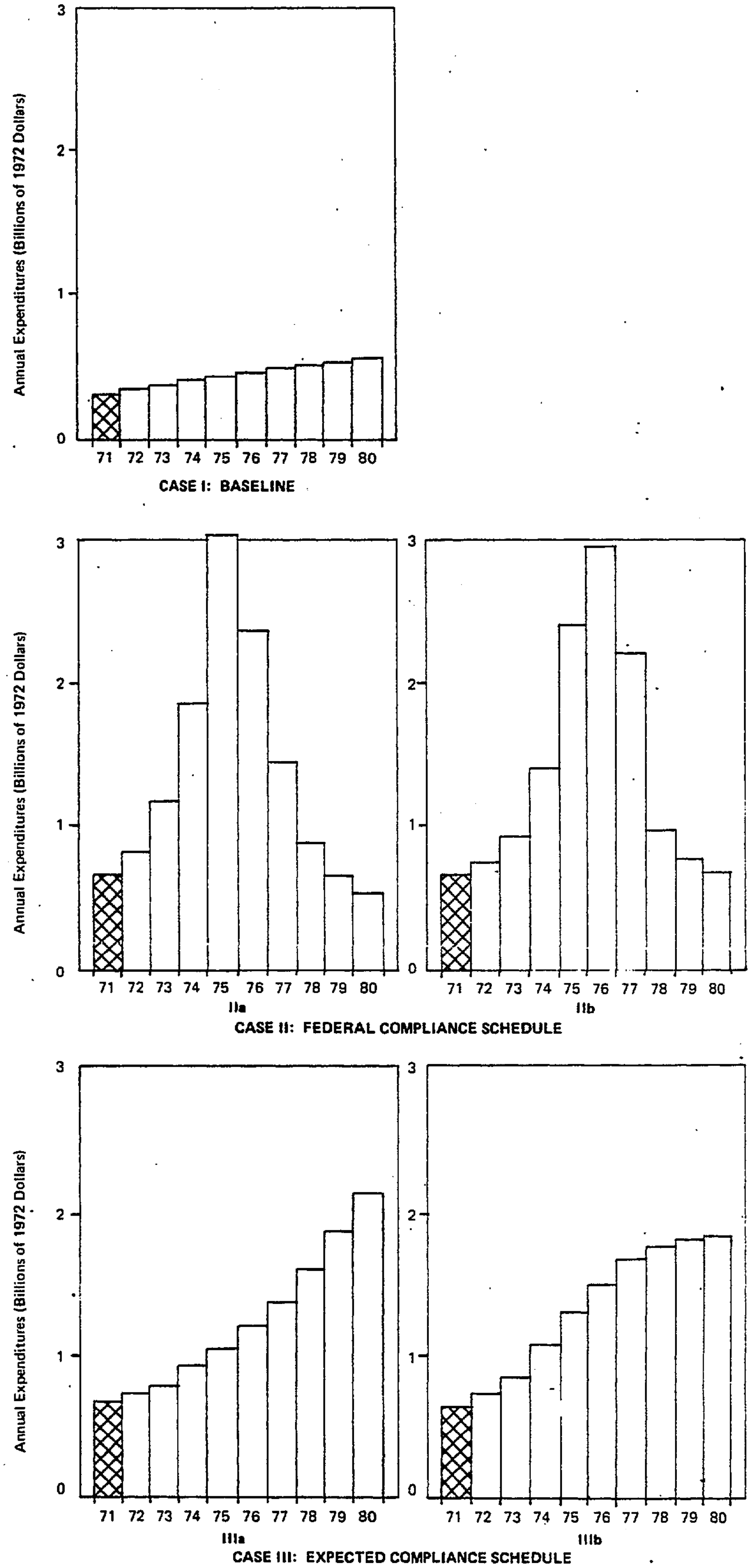
These demand analyses were performed for each of the following market segments: air pollution control, municipal sewage treatment, industrial wastewater treatment, and water treatment chemicals. In each segment, the demand was forecasted under the three alternative futures: Case I - Baseline; Case II - Federal Compliance Schedule; and Case III - Expected Compliance Schedule. (The results of these analyses are summarized in Table 1).

A. AIR POLLUTION CONTROL

The aggregate needs for air pollution control expenditures were developed from industry studies sponsored by EPA for its annual report to Congress, the *Economics of Clean Air*. This aggregate investment need of $12.8 billion is similar to numbers published elsewhere by EPA and the Council on Environmental Quality. Estimates of current markets in particulate and gaseous control hardware ($233 million in 1971) were based on adjusted figures from. the Industrial Gas Cleaning Institute. The current product mix was estimated from IGCI figures, while the changes in product mix over the decade were based on the views of ADL staff.

1. Case I - Baseline.

The projection of baseline equipment activity (Figure 1) was developed by choosing a base year, 1963, after which major legislation began to affect APC expenditures. The market level in 1963 was first increased at the actual rate of gross private domestic investment from 1963-71 (7.6% per year). The projection of that index for the 1972-80 period was taken from ADL's Input/Output Model of the National Economy. Thus, in Table 1 and Figure 1 the baseline growth begins with a 1971 baseline volume (extrapolated from 1963 activity) and is extrapolated at 5.4% per year through 1980.



Source: Arthur D. Little, Inc. estimates.

FIGURE II-2 AIR POLLUTION CONTROL COMPARATIVE EXPENDITURES, 1972-80

2. Case II - Federal Compliance Schedule.

A federal compliance deadline of mid-1975 (consistent with the deadlines for compliance to primary standards) was used as the prime pressure point around which to build the Case II scenario. This schedule was adjusted to reflect the process of granting waivers to selected states; otherwise, a more dramatic shape than shown in Figure 1 would have resulted.

The changing status of SO_2 control technology made it imperative to distinguish between two situations in both Cases II and III:

(a) Present Gaseous Control Technology

Assumes further difficulties in developing and proving current candidate technologies.

(b) Adequate Gaseous Control Technology

Assumes availability of proven technologies in time for 1975-77 installations.

One concern with Case II is the implied creation of an over-stimulated pollution control industry which, after its fall from peak demand, would become over-populated, and unprofitable.

3. Case III - Expected Compliance Schedule.

Case III (Figure 1) adjusts the Federal Compliance Schedule to better reflect the historical realities of pollution control enforcement, the historical rate of market growth, and a prescription for a healthier supplying industry. Again, projections are made under the dramatically different situations of: (a) further difficulties in developing SO_2 control technology and (b) availability of proven SO_2 control systems early in the forecast period. The result in both situations is a forecast of activity which does not begin to really pick up until 1974, that peaks with the 1975 deadlines, and then recedes to lower but still attractive growth rates through 1980. If new legislation does not increase APC targets, these expected compliance schedules will also result in a falling market after 1980.

B. MUNICIPAL SEWAGE TREATMENT

Aggregate needs for municipal sewage plants and ancillary facilties were developed from figures in EPA's annual *Economics of Clean Water*. Current market and product mix estimates were based on surveys made by the Department of Commerce. Projections of changes in product mix were developed by the ADL staff with assistance from our contacts in the industry. On a constant dollar basis, the recent history of municipal expenditures has been disappointing. The average annual growth since 1965 has only been 0.6%/year, down from a 1958-65 average growth of 7.6% per year. This plateau of municipal demand has resulted from the waiting by municipalities for promised Federal assistance - assistance which has not been up to those expectations. The aggregate demand for total municipal sewage system expenditures between 1972 and 1980 is estimated at $27 million. The mix of expenditures between treatment plants, ancillary facilities, and collection systems were further adjusted to reflect EPA's survey of specific municipal needs. The results of the demand analyses under the three alternative futures are shown in Table 1 and Figure 2.

1. Case I - Baseline.

The starting line for our baseline projection was 1965, which marked the first promise of significant federal funds for municipal construction (and correspondingly marked the beginning of a plateau in municipal spending which only recently has been exceeded). From the 1965 level of expenditures, the baseline was updated to 1971 by a multiplier (about 1.04) corresponding to the growth in municipal water usage over that period. Similar multipliers were used to grow the baseline over the 1971-80 period. Figure 2 shows that the baseline exceeds the level of activity in Cases II and III until 1974, thus emphasizing the impact which the municipal waiting game has had upon not only the progress of our national water pollution control program but upon the operating rates and profits of the WPC equipment industry.

2. Case II - Federal Compliance Schedule.

We anticipate at least some flexibility in waiving compliance to contemplated 1976 water effluent standards in selected situations, particularly in recognition of the long delay between federal grant and final equipment delivery in the municipal market. As in air pollution control, the federal compliance schedule portrays a fast growing industry which peaks quickly and then falls to a presumed situation of low operating rates and low profits.

3. Case III - Expected Compliance Schedule.

Our projection of the growth of the municipal sewage treatment demand looks to a continuation of lower growth rates in annual investment through 1973, an acceleration of expenditures in 1974-76, and the tapering off to an acceptable growth rate through 1980. Hidden within the curves in Figure 2 are the greater growth rates of specialty equipment indicated in Table 1. These higher growth rates for the equipment proportion of the total are due to changes in product mix and the relative proportion of total investment represented by treatment plant expenditures. From the point of view of either specialty equipment or total expenditures, the pattern of growth in Case III presents a more favorable future for the WPC equipment industry. However, Case III will also suffer a declining market after 1980, providing new legislative targets are not set by then.[5]

[5] The passage of the 1972 amendments to the Federal Water Pollution Control Act affect more the source of monies for municipal sewage treatment than targets of control. Thus, the backlog of needs remains roughly the same ($27 billion) as in this analysis.

TABLE 1

ESTIMATED POLLUTION ABATEMENT EQUIPMENT SHIPMENTS, 1972-80

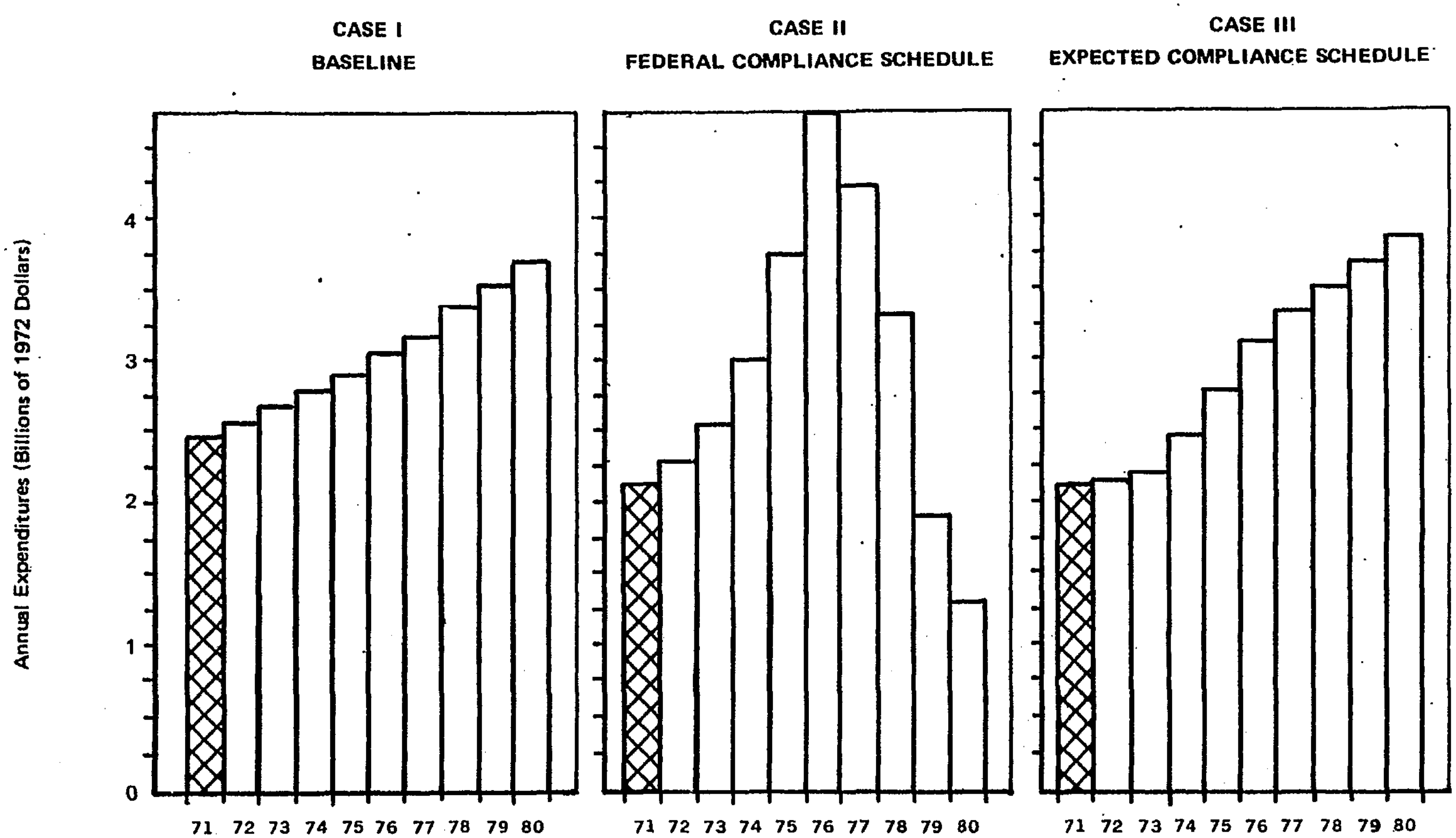
	Annual Shipments (Millions of 1972 Dollars)										Growth (%/year)	
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1971-75	1975-80
A. AIR POLLUTION CONTROL												
Case I: Baseline												
Particulate Control	104	111	117	124	130	137	144	152	160	167	5.4	5.4
Gaseous Control	10	11	11	12	13	14	14	15	15	16	5.4	5.4
Subtotal	114	122	128	136	143	151	158	167	175	183	5.4	5.4
Instrumentation	8	8	8	9	9	10	10	11	11	12	5.4	5.4
Case IIa: Federal Compliance Schedule												
Particulate Control	201	247	361	570	935	530	269	151	97	78	46.9	-39.2
Gaseous Control	42	50	66	95	152	243	164	99	76	64	37.9	-15.9
Subtotal	243	297	427	665	1087	773	433	250	173	142	45.4	-33.5
Instrumentation	15	28	40	62	102	80	49	29	21	17	61.4	-30.2
Case IIb: Federal Compliance Schedule												
Particulate Control	201	221	251	326	496	220	158	126	99	80	25.3	-30.6
Gaseous Control	42	50	76	135	262	525	374	135	106	94	57.9	-18.5
Subtotal	243	271	327	461	758	745	532	261	205	174	32.9	-25.5
Instrumentation	15	25	31	43	71	70	50	25	19	16	47.5	-25.8
Case IIIa: Expected Compliance Schedule												
Particulate Control	201	214	234	281	310	340	357	395	441	471	11.4	8.7
Gaseous Control	42	46	53	62	70	86	108	142	171	208	13.6	24.6
Subtotal	243	260	287	343	380	426	465	537	612	679	11.8	12.3
Instrumentation	15	20	25	31	40	46	53	61	70	80	27.7	14.9
Case IIIb: Expected Compliance Schedule												
Particulate Control	201	214	234	281	310	320	285	153	104	74	11.4	-24.9
Gaseous Control	42	51	63	86	113	147	199	292	327	344	28.1	24.9
Subtotal	243	265	297	367	423	467	484	445	431	418	14.9	-0.2
Instrumentation	15	20	25	31	40	46	53	61	70	80	27.8	14.9

TABLE 1 (CONTINUED)

ESTIMATED POLLUTION ABATEMENT EQUIPMENT SHIPMENTS, 1972-80

	Annual Shipments (Millions of 1972 Dollars)										Growth (%/year)	
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1971-75	1975-80
B. MUNICIPAL SEWAGE TREATMENT												
Case I: Baseline												
Specialty Equipment	96	100	104	109	114	119	125	132	138	145	4.3	5.0
Instrumentation	11	12	12	13	13	14	15	15	16	17	4.3	5.0
Case II: Federal Compliance Schedule												
Specialty Equipment	110	126	159	221	292	368	300	211	113	73	27.6	-24.4
Instrumentation	17	21	28	39	54	78	65	52	23	15	33.0	-23.0
Case III: Expected Compliance Schedule												
Specialty Equipment	110	114	123	152	186	222	239	255	277	293	14.1	9.5
Instrumentation	17	19	21	26	33	42	48	54	62	69	17.9	15.9
C. INDUSTRIAL WASTEWATER TREATMENT												
Case I: Baseline												
Specialty Equipment	56	59	63	66	69	73	77	81	86	91	5.4	5.4
Instrumentation	13	14	14	15	16	17	18	19	20	21	5.4	5.4
Case II: Federal Compliance Schedule												
Specialty Equipment	172	192	211	228	239	248	151	85	75	63	8.6	-23.4
Instrumentation	26	31	35	38	42	44	28	17	14	13	12.7	-21.0
Case III: Expected Compliance Schedule												
Specialty Equipment	172	184	197	207	213	217	198	124	80	73	5.5	-19.3
Instrumentation	26	30	32	34	36	38	36	23	16	15	8.5	-16.1
D. WATER AND WASTEWATER TREATMENT CHEMICALS												
Case I: Baseline												
Bulk Chemicals	122	127	132	138	143	148	155	162	170	179	4.0	4.6
Specialty Chemicals	271	282	294	306	318	332	345	360	376	392	4.1	5.5
Case II: Federal Compliance Schedule												
Bulk Chemicals	125	132	139	147	155	163	171	178	185	191	5.5	4.3
Specialty Chemicals	275	289	305	321	339	358	375	391	405	419	5.4	4.3
Case III: Expected Compliance Schedule												
Bulk Chemicals	125	132	139	145	152	160	169	176	184	191	5.5	4.7
Specialty Chemicals	275	289	305	320	336	354	371	388	403	418	5.1	4.5

SOURCE: Arthur D. Little, Inc., estimates.



Source: Arthur D. Little, Inc. estimates.

FIGURE 2 MUNICIPAL SEWAGE TREATMENT COMPARATIVE EXPENDITURES, 1972–80

C. INDUSTRIAL WASTEWATER TREATMENT

Among the sectors we have studied, reliable information on industrial wastewater treatment expenditures is the most difficult to obtain. Department of Commerce surveys were used for estimating the level of current equipment shipments and the product mix therein. On the basis of that information, we estimated the 1971 market for specialty equipment and instrumentation to be about $192 million (current dollars). Aggregate demand estimates for the 1972-80 period were, with slight modifications, based on EPA's *Economics* of *Clean Water* reports. The aggregate demand for industrial expenditures estimated therefrom for the period was $9.7 billion.

1. Case I - Baseline.

Again, 1965 was selected as the base year. The baseline (Figure 3) was constructed using the level of shipments in 1965, a growth index reflecting industrial plant investment (the same 5.4% used in the APC analysis), and a constant product mix of equipment.

2. Case II - Federal Compliance Schedule.

Since industry has a faster response time to federal enforcement than municipalities, we were able to assume that the majority of industrial wastewater treatment will be taken care of by the 1976 deadline (Figure 3). Indeed, the apparent level of expenditures by industry in 1971 are already so high that it took only a small growth rate to achieve the needed expenditures by 1975 (about 7.2%).

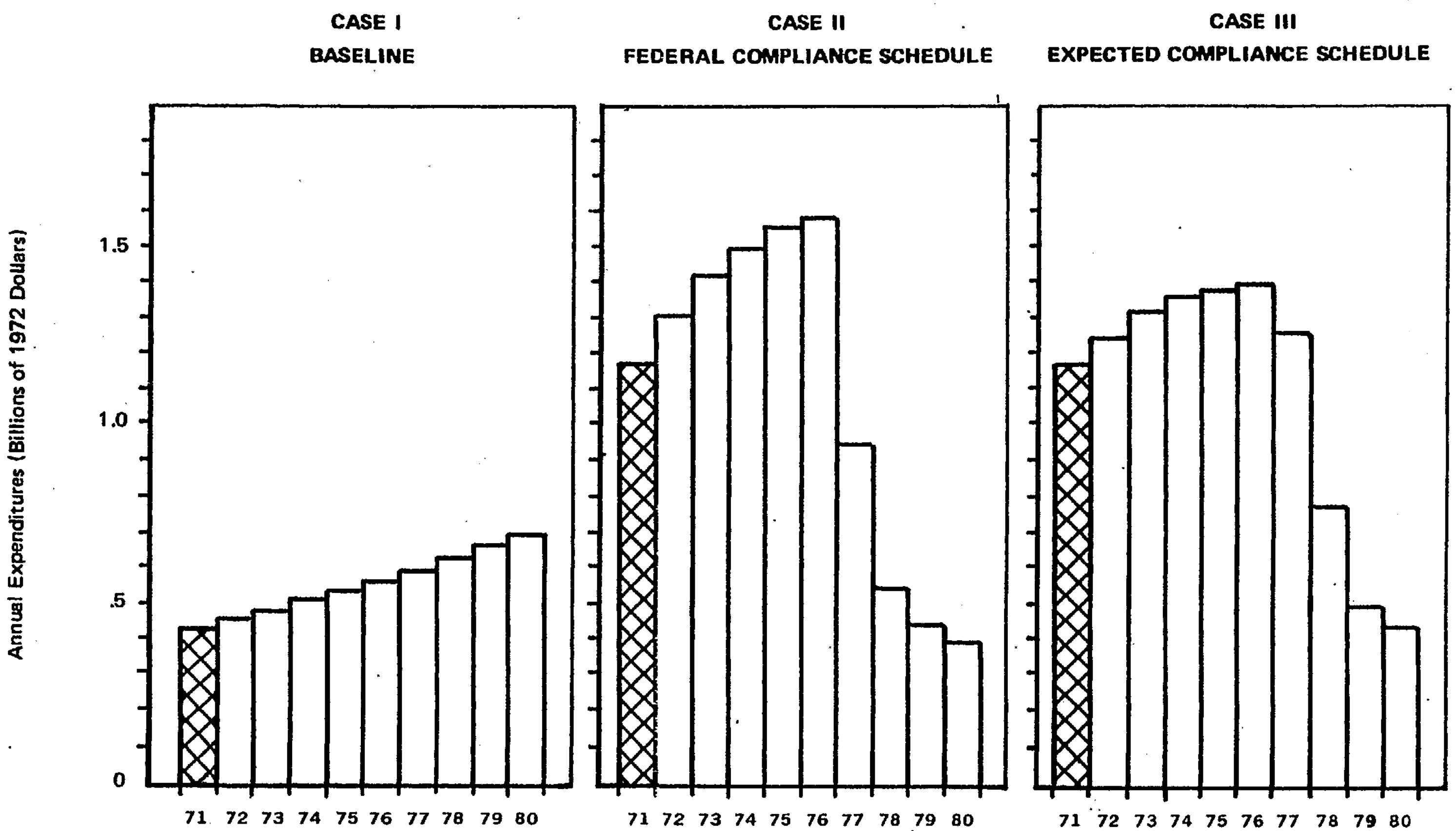
3. Case III - Expected Compliance Schedule.

We see no great difficulty in having industry accomplish most of the backlog (as now measured) by 1976. This is partly based on our estimates that industrial expenditures are already at a level ($1.2 billion) which, with only a modest growth, could reach the estimated target by 1976-77. As a result, in industrial wastewater treatment, the possibilities of a declining market during the 1970's exist in Case III just as they do in Case II. This implies that either industry is close to solving its water pollution problems under present objectives[6] or that the costs of control have been greatly underestimated. Again, specialty equipment expenditures will grow at a faster rate than total expenditures because of the trend toward advanced treatment.

D. WATER AND WASTEWATER TREATMENT CHEMICALS

This is the only case in which we have considered in detail a non-equipment item and one that is tied to operating rather than to investment expenditures. In projecting the demand

[6] Excluding the implications of the amendments to the Federal Water Pollution Control Act of October 1972.



Source: Arthur D. Little, Inc. estimates.

FIGURE 3 INDUSTRIAL WASTEWATER TREATMENT COMPARATIVE EXPENDITURES, 1972–80

for wastewater treatment chemicals, we have tied its growth to the cumulative growth of investment. We have also considered this business in terms of the larger business of specialty chemical companies which, for the most part, are water treatment-based at this time. Our estimates of recent and current markets for specialty chemicals are based on ADL experience and producers' judgments. We estimate that in 1971 the markets for chemicals (bulk and specialty) in wastewater treatment were about $75 million; to this, we added $325 million of water treatment business for a total of $400 million. We increased chemical consumption proportionately with the rate of installation of both water and wastewater facilities. The only exception to this general rule was our giving a 25% greater bonus to specialty chemicals in sewage and industrial wastewater applications.

For chemical demand, there was not much difference between Cases I, II, and III. Chemical usage is not tied directly to federal deadlines, although their growth can accelerate somewhat as construction put-in-place increases near those deadlines. Even after a deadline has passed cumulative investment enables chemicals to still experience an increasing market.

E. COMPARATIVE REVIEW

In all of the industrial sectors except water and wastewater chemicals, the Federal Compliance Schedule threatens to create a booming industry through 1975 or 1976, thereafter quickly falling to a situation of low operating rates, low profits, and venture failures. Our Expected Compliance Schedules reflect the realities of enforcement, technology, and construction delays and have the added appeal of creating a healthy pollution abatement industry with attractive growth rates throughout the 1970's. It must be noted that after 1980, the Expected Compliance Schedules will result in declining demands and operating rates - providing legislative targets are not raised.

Each of the sectors embodies a particularly interesting story that bears repeating.

In air pollution control, the major uncertainty is the availability of technology to control SO_2 emissions. As a result, in both Case II and Case III, we have considered results of two very different situations: (A) where technological difficulties continue and (B) where an adequate technology is proven.

In municipal sewage treatment, the headline story is the effect that recent daleys in municipal spending have upon the comparison of Case I to Cases II and III. In short, these projections indicate that it will be 1974 before either the federal or expected compliance schedules catch up with the rate of spending in the baseline scenario.

In industrial wastewater treatment, our best estimates of recent industrial expenditures indicate that those expenditures cannot grow very much for very long before the estimated backlog of needs is exhausted. This indicates either that, under current objectives, there is not much that remains to be done or that the backlog has been underestimated.

III. THE IMPACT

A. APPROACH

Our impact analysis has focused upon balancing our estimates of demand against the supply capabilities of the pollution abatement equipment industry. This analysis was hindered by a serious lack of reliable data on industry supply capacities when received as physical plant and equipment. The problems presented by this lack of statistical data on industry supply capabilities were reduced by our consideration of a broader definition of capacity. From economic theory we have taken a production function approach and adapted it to the available data on supply capabilities in the industry. In this context, "supply" is looked upon in terms of not only physical plant and equipment (the input of capital) but also in terms of the input of labor and materials.

We believe both the statements of the industry and the limited amount of secondary statistics which show that there is now a substantial overcapacity of physical plant and equipment. Furthermore, given the heavy dependence of the pollution abatement industry on the broader metal fabricating industry, it is difficult to define its capacity. Therefore, we sought to quantify only the general levels of operation.

Combining traditional production theory with basic accounting practice, we worked from the basic identity that total revenue equals the sum of total payments to labor, capital, and materials. We estimated the proportions of these three production factors (as a part of total revenues) from data on selected SIC industries in the *Census of Manufactures* and from contacts with leading manufacturers. We then surveyed three to five companies in each of the industry sectors (also employment agencies) to determine the supply elasticities of different kinds of labor and materials. This survey was not an exhaustive one but was made primarily to assure that the supply elasticities used in this analysis were of the right magnitude. Separately, we made an analysis of the elasticity of interest rates for corporate borrowing over time, in order to ascertain the effects of increased capital costs upon the final price to customers. These analyses of the capital markets for this industry were confirmed through conversations with leading financial institutions.

The elasticity information from these surveys was then combined into individual supply curves for skilled labor, production labor, materials, and capital. These supply curves were used as annual short-run supply curves, relating increased cost premiums against increases in factor requirements over a given year.

A major simplifying assumption was that the short-run supply curves (actually developed for 1972) would be characteristic of the short-run factor supply markets for the rest of the decade. The second assumption was that, except for operating effects, the *Census of Manufactures* breakdowns of the factors of production will also remain constant.

The supply curves were generally quite elastic. Supply curves for materials were more elastic than those of production labor, which in turn were more elastic than the skilled labor curves. Our supply curves for borrowed capital were actually stepwise curves indicating that above a certain annual increase in capital requirements the interest rate would jump from a lower to a higher level.

Our objectives in balancing our demand forecasts with our empirical supply curves were to indicate what price increases would result if direct cost increases created by supply constraints were passed onto the customers. In short, we measured a *cost push* and not directly a forecast of prices. This cost push reflects factor scarcity. The forecast of actual prices would have to include other important considerations besides factor scarcity: the effects of operating rates upon the fixed cost loads, the relative price elasticity to the quality of product and service performed, and the prediction of corporate policies on pricing in times of short- and over-supply.

We have analyzed the economic impact upon the different industry sectors in terms of the pollution abatement and closely-related businesses of the leading manufacturers. Since the gaseous control market is unique both in shape over time and in competitive membership, its analysis was separated from particulate control. As the companies involved in water pollution control equipment are equally involved in water treatment markets, we included forecasts of water treatment equipment demand in the calculation of year-to-year growth factors. We combined air and water instrumentation demand because of a substantial overlap of companies between those two markets and the probability that the overlap will increase in the future. In chemicals, we analyzed only the expected compliance schedule case since the three schedules for that industry were very similar. Again, we combined both water and wastewater treatment demand in analyzing the impact upon that industry.

B. RESULTS

In the particulate control equipment segment of the APC market, the potential cost push inflation (Table 2) is greater under the Federal Compliance Schedule (Case II) and the assumption (a) of present gaseous control technology. The Federal Compliance Schedule puts more pressure upon supply than the Expected Compliance Schedule (Case III). An assumption (b) of the development of adequate gaseous control technology reduces the demand for particulate control equipment and, consequently, the supply pressure on prices.

In the gaseous control equipment market, the inflation (Table 3) is greater under Case II and the assumption (b) of adequate gaseous control technology. With the latter assumption, gaseous control activity is allowed to progress faster, putting more pressure on costs and prices.

1. Price Effects.

The water pollution control equipment business (Table 4) was the only one in which the baseline demand schedule was of any significance. There, the baseline and expected compliance schedules resulted in only a 0.3% average inflation compared to 0.8% for the federal compliance schedule. The inflation effects for both the water pollution control equipment business and the water chemicals business (Table 5) were dampened considerably by the addition to the related demand for water treatment.

The results of these analyses which take into account factor supply elasticities and operating rate conditions are combined in a kind of composite supply curve for each industry as illustrated in Figures 4 and 5. These are not true supply curves in the sense of

TABLE 2

COMPARATIVE INFLATIONARY IMPACT OF CASES II AND III -- AIR POLLUTION CONTROL

PARTICULATE CONTROL EQUIPMENT

	Case II - Federal Compliance Schedule		Case III - Expected Compliance Schedule	
	(a) Present Gaseous Control Technology	(b) Adequate Gaseous Control Technology	(a) Present Gaseous Control Technology	(b) Adequate Gaseous Control Technology
	Cumulative Index	Cumulative Index	Cumulative Index	Cumulative Index
1972	1.0101	1.0018	1.0033	1.0027
1973	1.0437	1.0048	1.0060	1.0072
1974	1.1007	1.0245	1.0146	1.0171
1975	1.1443	1.0733	1.0213	1.0223
1976	1.1395	1.0699	1.0279	1.0260
1977	1.1258	1.0565	1.0309	1.0238
1978	1.1192	1.0500	1.0377	1.0213
1979	1.1115	1.0443	1.0472	1.0213
1980	1.1049	1.0413	1.0527	1.0213
Inflated Demand 1971-1980 (Millions 1972 Dollars)	$3794.3	$2262.4	$3337.8	$2212.2
÷ Base Demand 1971-1980 (Millions 1972 Dollars)	$3439.0	$2178.0	$3244.0	$2176.0
= Average Inflation	10.3%	3.9%	2.9%	1.7%

TABLE 3

COMPARATIVE INFLATIONARY IMPACT OF CASES II AND III -- AIR POLLUTION CONTROL GASEOUS CONTROL EQUIPMENT

	Case II - Federal Compliance Schedule		Case III - Expected Compliance Schedule	
	(a) Present Gaseous Control Technology	(b) Adequate Gaseous Control Technology	(a) Present Gaseous Control Technology	(b) Adequate Gaseous Control Technology
	Cumulative Index	Cumulative Index	Cumulative Index	Cumulative Index
1972	1.0094	1.0080	1.0044	1.0110
1973	1.0240	1.0395	1.0104	1.0222
1974	1.0691	1.0893	1.0176	1.0536
1975	1.1089	1.1363	1.0251	1.0730
1976	1.1552	1.1911	1.0420	1.0966
1977	1.1658	1.1990	1.0596	1.1267
1978	1.1530	1.1852	1.0847	1.1723
1979	1.1455	1.1772	1.0965	1.1793
1980	1.1380	1.1694	1.1167	1.1794
Inflated Demand 1971-1980 (Millions 1972 Dollars)	$1176.2	$2084.7	$1054.5	$1888.8
÷ Base Demand 1971-1980 (Millions 1972 Dollars)	$1051.0	$1799.0	$ 988.0	$1664.0
= Average Inflation	11.9%	15.9%	6.7%	13.5%

TABLE 4

COMPARATIVE INFLATIONARY IMPACT OF CASES I, II AND III

WATER POLLUTION CONTROL EQUIPMENT

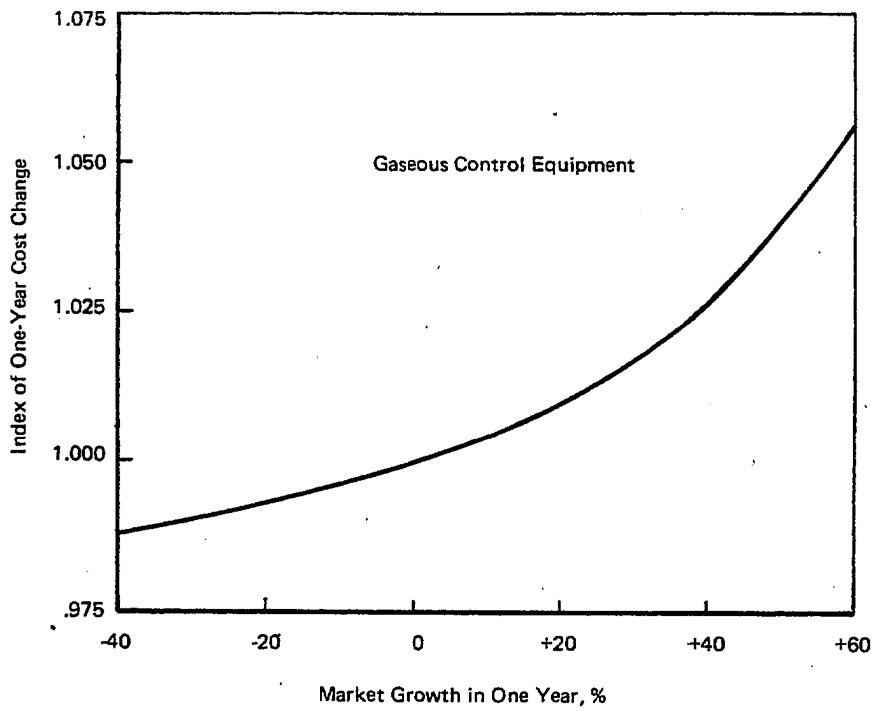
	Case I	Case II	Case III
	Baseline	Federal Compliance Schedule	Expected Compliance Schedule
	Cumulative Index	Cumulative Index	Cumulative Index
1972	1.0007	1.0013	1.0006
1973	1.0013	1.0026	1.0013
1974	1.0020	1.0046	1.0026
1975	1.0026	1.0090	1.0038
1976	1.0033	1.0131	1.0054
1977	1.0039	1.0141	1.0054
1978	1.0046	1.0100	1.0054
1979	1.0053	1.0087	1.0054
1980	1.0060	1.0087	1.0059
Inflated Demand 1971-1980 (Millions 1972 Dollars)	$1909.4	$3677.0	$3648.0
÷ Base Demand 1971-1980 (Millions 1972 Dollars)	$1903.0	$3655.4	$3636.0
= Average Inflation	0.3%	0.8%	0.3%

TABLE 5

COMPARATIVE INFLATIONARY.IMPACT OF CASES II AND III

INSTRUMENTATION AND SPECIALTY CHEMICALS

	Instrumentation		Specialty Chemicals
	Case II	Case III	Case III (and II)
	Federal Compliance Schedule	Expected Compliance Schedule	Expected and Federal Compliance Schedules
	Cumulative Index	Cumulative Index	Cumulative Index
1972	1.0073	1.0036	1.0003
1973	1.0294	1.0063	1.0006
1974	1.0494	1.0129	1.0009
1975	1.0699	1.0225	1.0012
1976	1.0599	1.0253	1.0016
1977	1.0554	1.0287	1.0020
1978	1.0472	1.0287	1.0031
1979	1.0353	1.0312	1.0038
1980	1.0284	1.0355	1.0045
Inflated Demand 1971-1980 (Millions 1972 Dollars)	$1175.3	$1144.0	$3466.0
÷ Base Demand 1971-1980 (Millions 1972 Dollars)	$1123.0	$1118.0	$3459.0
= Average Inflation	4.6%	2.3%	.2%



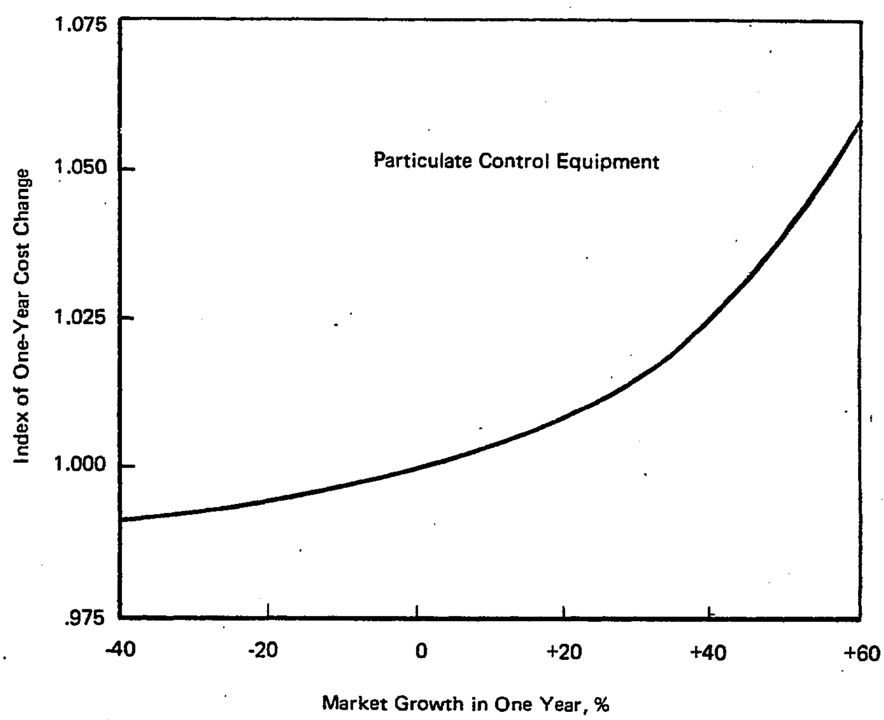
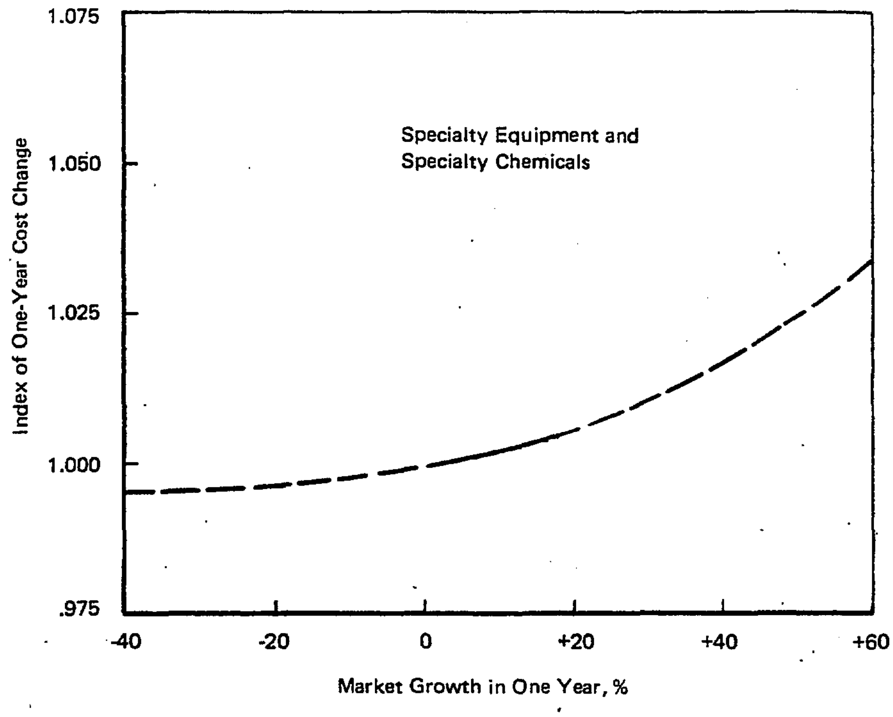


FIGURE 4 EFFECTIVE "SUPPLY" CURVES
Air Pollution Control



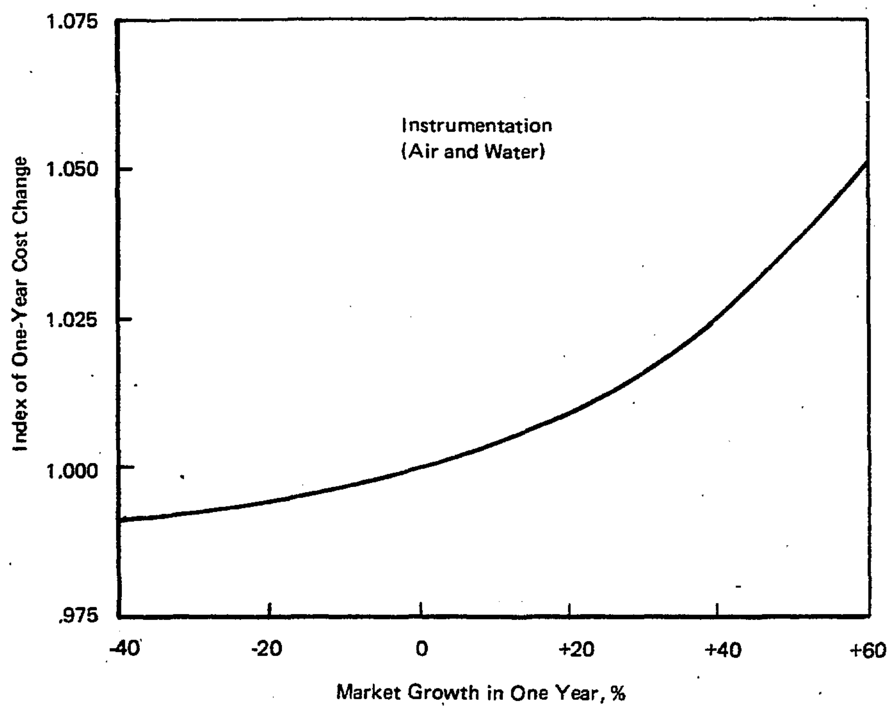


FIGURE 5 EFFECTIVE "SUPPLY" CURVES
Water Pollution Control

the ones we used as inputs to the analysis. They simply summarize a plot of the results of the price impact analysis in the different industries. In air pollution control (Figure 4), the resulting supply curves are the most elastic of the group, reflecting the higher growth rates, the more dramatic effects of federal deadlines, and somewhat greater input elasticities. These elasticities range from 20-25 (in the 0-20% growth range) to 10 (in the 20-40% range) to 5 (in the 40-60% range). The top of Figure 5 reflects the much higher elasticity (40, in the 0-20% range) in the range of growth rates developed in both water pollution control equipment and chemicals.

2. Employment Effects.

The lack of detailed studies of the manpower requirements in the pollution field for equipment suppliers and the smallness of our own sample of manufacturers' estimates of the breakdown of the types of manpower they utilize prevented us from statistically analyzing manpower requirements in detail. Based on average sales per employee ratios for leading companies in the business and the demand estimates we have developed, estimates of the gross manpower requirements for 1972, 1975, and 1980 are illustrated in Table 6.

In Case III, the total employment across the five industries is expected to increase from 35,000 people to 49,000 people (by 40%) from 1972-75 and to 75,000 people (210% of the 1972 level) by 1980. This compares to more than 210,000 employed in 1967 in the four-digit SIC industries encompassing these pollution abatement industries. Employment in Case II is projected to increase to 100,000 people in 1975 (up about 160% from 1972) but then decline to 27,000 people (less than current levels) by 1980 - within a group of four-digit SIC industries that employed over 210,000 in 1967.

It is clear that federal legislation has had a positive employment impact when you compare the estimate of 35,000 people in 1972 under expected compliance schedules to the estimated 21,000 people under baseline conditions (67% greater). By 1975, the expected compliance schedule corresponds to an employment almost exactly twice that of baseline conditions, and by 1980 is nearly two and one-half times as great.

TABLE 6

INDUSTRY PERSONNEL REQUIREMENTS, COMPARISON OF THREE CASES, 1972-80

Industry Category And $M Sales/ Employee Ratio	Case	1972 I	1972 II	1972 III	1975 I	1975 II	1975 III	1980 I	1980 II	1980 III
APC Equipment-Particulate*	Sales ($MM)	207	449	389	242	1,693	563	312	142	854
30.1	Employee	6,880	14,900	12,900	8,040	56,200	18,700	10,400	4,700	28,400
APC Equipment-Gaseous*	Sales	30	100	91	34	328	153	44	182	546
32.4	Employee	926	3,090	2,800	1,050	10,100	4,720	1,360	5,610	16,850
WPC Equipment-	Sales	159	318	298	183	531	399	236	136	366
32.5	Employee	4,890	9,780	9,170	5,630	16,300	12,300	7,260	4,180	11,300
Instrumentation	Sales	34	80	69	38	198	109	50	45	166
20.9	Employee	1,630	3,830	3,300	1,900	9,470	5,220	2,390	2,150	7,900
WPC-Spec.Chem.	Sales	282	289	289	318	339	336	392	419	418
41.0	Employee	6,880	7,050	7,050	7,760	8,270	8,200	9,560	10,200	10,200
Total Employees		21,200	38,650	35,220	24,280	100,340	49,140	30,970	26,840	74,650

*Corresponds to demand projections for APC equipment in situation (a) assuming continued technological difficulties in candidate SO_2 control technologies.

SOURCE: Arthur D. Little, Inc. estimates.

IV. RECOMMENDATIONS

A. DATA NEEDS

- Association surveys of the production capacity (physical plant) available to the pollution equipment industries with emphasis upon the definition of capacity and the complementary role of the broader metal fabrication industry.
- Cooperative sponsorship with the Department of Commerce of surveys of equipment shipments for air or water pollution abatement.
- Studies with greater focus upon the operating and maintenance (O&M) costs of pollution control.
- In future cost-of-control studies, the development of aggregate costs for an industry on the basis of a typical mix of approaches rather than on general application of one typical approach.
- In future cost-of-control studies, the development of general schemes for relating costs to levels of treatment.
- Collaboration with Department of Commerce to more clearly define the placement of pollution abatement equipment items within the next *Census of Manufactures.*

B. FURTHER ANALYSES

- Updating of the demand and impact analyses in this report as the implied costs of new standards become better known, i.e., for the New Source Performance Standards under the Clean Air Act of 1970 or the effluent limitation guidelines under the 1972 Amendments to the Federal Water Pollution Control Act.
- Study of manpower requirements, both in skills and numbers, of the pollution equipment industry.
- Development of a supply-warning system relating environmental standards, derivative demand, the health of the economy, the balance of trade, and system delays to the, production, financial, raw material, manpower, and technological resources of the pollution equipment and construction industries.

C. POLICY IMPLICATIONS

- The expectation of promised action has been a major cause of the present overcapacity in the pollution control industry. To the degree that standards and deadlines are, first, set realistically and, second, enforced an schedule, future overcapacity will be reduced.
- Traditional pollution equipment manufacturers are typically not strong in research and development (R&D) and potential new entrants are in need of time and direction in their R&D. Federally-sponsored R&D is thereby essential to the development of future control technologies.

- Recognizing that a healthy abatement industry is clearly secondary to the primary purpose of environmental legislation (i.e., to control pollution), it is nonetheless less inflationary, to consider the phasing of control programs with abatement industry capabilities. For example, from a supply standpoint, a policy which requires a mix of treatment activity across industries is preferable to one that requires one kind or level of treatment by all industries before moving on to another level.