A SURVEY OF THE AIR POLLUTION CONTROL INDUSTRY IN CALIFORNIA

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CALIFORNIA AIR RESOURCES BOARD

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EXECUTIVE SUMMARY

The purpose of the study was to identify and characterize firms in California that derive all or part of their revenue from manufacturing air pollution control equipment or providing related services. These firms constitute the California Air Pollution Control Industry (APCI). When control regulations are enacted by the Air Resources Board, costs are incurred by those firms that are required to install control equipment, but the APCI also experiences increased sales and revenues. The purpose of the study was to compile a data base that could be used to characterize the APCI and estimate its impact on the California economy. In essence, this report will allow the Air Resources Board to more fully assess the impacts of suggested air pollution control measures on the economy of California.

The economic impacts that can be associated with the APCI depends to a great extent upon the definition of the industry. A literature survey was conducted to determine how the industry had been defined by others. The most restrictive definitions included manufacturers of stationary control equipment and excluded auxiliary services and equipment while the least restrictive definitions included the total employment of all firms that had even a minor component of APCI activity. All of the published studies were concerned with the national APCI rather than California. As a part of the study, estimates of the California APCI were made based on the national studies. Depending on the

definition, the California APCI could sell as much as $2.23 billion or as little as $860 million and could employ as many as 44,600 or as few as 1,730 people. The present study uses a fairly restrictive definition of the APCI in order to permit manageable and direct measurement for California.

For purposes of this study, the manufacturers of the following kinds of equipment were included in the APCI for California: wet scrubbers, mechanical collectors, electrostatic precipitators, fabric filters, flue gas treatment systems, tank seals, afterburners, incinerators, absorption columns, spray towers, vapor recovery systems, low NO_x burners and combustion modification systems. Manufacturers of the following were included in the California APCI when the equipment was associated with an air pollution device: ducts, hoods, blowers, fans, measuring instrument, water equipment and fuel storage tanks. Suppliers of equipment associated with industrial clean rooms or intended for household use were specifically excluded from the study. Firms that provided the following services were included in the California APCI when the service was related to air pollution policy, planning, or control: consulting, design, equipment maintenance and repair, laboratory testing and field testing. Attorneys' services were specifically excluded. In addition, all manufacturing and services related to mobile sources were excluded from the study along with the activities of government and colleges and universities.

All APCI firms were contacted by telephone and mail to collect information on 1980 calendar year sales, services, employment, customers, purchases and major competitors. The first questionnaire mailings were accomplished between March 22 and April 9, 1982, and up to three follow-up calls were made in an effort to secure a completed questionnaire. The responses to the survey efforts are summarized below:

Potential firms identified	257
Firms reporting APCI activity	157
Firms reporting no APCI activity	59
Firms not responding at all	41

The survey responses indicated that the APCI is composed of essentially two types of firms -- manufacturing and services. Together these firms supplied an estimated 18 different types of equipment and services. While the majority of firms competed with other California firms, there still remained a significant amount of competition from the rest of the country. Competition from the rest of the world was insignificant. Firms in the industry have been in business an average of 15 years.

Based on the definition of the industry employed in this study, total California APCI employment was estimated to be 5,600 employees. The majority, 3,100, were employed by the manufacturing sector; the remainder, 2,500, were employed by the service sector. APCI employment represents 0.1 percent of the total California employment in manufacturing and services. Sales generated

by the APC industry were estimated at $903 million, with $143 million being sold to California end-users. The manufacturing sector produced and sold $703 million worth of equipment and services, with $90 million going to California end-users. Of the remaining $200 million in sales for the service sector, $53 million went to California end-users. APCI sales account for less than one percent of the total sales in the manufacturing and service sectors for California. The major customers in the industry are oil and gas extraction firms, petroleum refining (mostly in-State sales), utilities, and public administration. Most of the major purchases by the industry are from fabricated metal firms and measuring instrument producers. Of the firms' total capital expenditures, approximately 40 percent were directed to APC activities. The outlook for the industry is expected to be somewhat profitable.

The multiproduct, capital goods APCI is primarily an export industry. Almost 90 percent of California's APCI manufactured goods were sold in out-of-state markets. Similarly, 75 percent of APCI services were provided to customers in other states. As a basic or export industry, the California APCI would exhibit growth, development, and general economic activity as air pollution control efforts increase in other parts of the nation. This increased activity provides jobs and income for Californians which are primarily paid for by individuals, businesses, and governments of other states.

The export status of the industry underscores another idea, As long as air quality standards are established throughout the United States, California APCI firms will be able to play a vital role in supplying air pollution control equipment and services. While the impetus for developing an APCI may have been the result of California's leadership in establishing air quality standards, the continued health of the industry is much more dependent on the needs of the rest of the nation.

Although the primary focus of this study was the characterization of the APCI, a survey was also conducted of selected purchasers of air pollution control equipment. A group of 57 firms was identified from the records of the California Pollution Control Financing Authority. During the period from January 1978 to May 1982 these firms financed air pollution control projects amounting to $422,698,000. These purchasers indicated that only 28 percent of the borrowed funds were spent outside of California and about 5 percent were spent within the borrowing firms. The remaining 67 percent ($283,200,000) was spent in making purchases from the California APCI. The estimates of expenditures by purchasing firms are consistent with the sales estimates obtained from the APCI survey when allowances are made for uncertainties in determining exactly when the loan funds were spent and difficulties in defining purchases that were not financed by loans.

Indirect economic impacts were considered, and procedures were suggested for using ARB's Input/Output Model to evaluate

indirect impacts. The probable future sales of the APCI were assessed within the framework of future regulatory plans of California air pollution control agencies, and it was concluded that the demand will continue into the future. The specific goods and services will have to change in response to changing technologies.

In summary, the California APCI is a multiproduct, capital goods, export industry that contributes to the state's economy through employment and sales which are primarily supported by the rest of the nation. Although the California APCI services the demands that arise within the state, the industry's future is closely tied to the air pollution control needs of the nation.

ACKNOWLEDGEMENTS

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The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with the material reported herein is not to be construed as either an actual or implied endorsement of such products.

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CHAPTER 1

INTRODUCTION

As the public's awareness concerning the problem of environmental pollution grew and its impact on the health, safety, and welfare of individuals was disclosed, government and its responsible agencies responded by identifying measures from which the environmental problems could be managed. For example, the California Air Resources Board (CARB) has been given the legal mandate to coordinate the efforts of attaining and subsequently maintaining acceptable air quality standards. The resulting impacts of these governmental regulatory efforts have permeated all areas, especially in terms of the economic effects. As adjustments were made to this new economic environment, there began to emerge a cost-sensitive bias to the regulatory efforts. In order to more fully reflect the economic consequences of air pollution regulations, proper analytical methods can be used to consider the full range of impacts, i.e., costs and benefits.

Regulated firms emphasized the increased expenditures and adverse economic ramifications such cleaning up activities would have on the economic environment. These firms suggested that not only did negative impacts occur, but significant indirect impacts (i.e., "ripple effects") also resulted from those regulations. Regulatory agencies were asked to review their efforts

in light of those negative economic impacts and, in some cases, adjust the regulations accordingly. Unfortunately, this placed the regulatory agencies in a somewhat disadvantaged position.

To evaluate the total impact of a regulation, all benefits and costs could be identified and quantified. The traditional approach, which emphasizes the costs incurred by the regulated industries, fails to consider increases in sales and employment in the industries that manufacture the control equipment. In addition, design services and equipment maintenance may also be purchased from specialty suppliers. Each of these efforts represents an increase in economic activity to other involved sectors. The supplier of these goods and services is the air pollution control industry, a major cost component in the analysis of the cost issue. The activities of this industry are important to the economic impact issue and, therefore, must be analyzed in order to fully assess regulatory impacts. The air pollution control industry's existence can be traced to the concerns for better air quality. In the process of supplying the necessary air pollution control goods and services demanded by industry, the Air Pollution Control Industry (APCI) injects additional jobs and income into California's economic environment. This information will allow the Air Resources Board to consider more fully the total impacts of regulation on the California economy.

This research project represents the initial efforts in developing a clear picture of California's air pollution control industry. Essentially, the project was comprised of three phases:

Phase 1 -- Classification of the industry and compilation of a candidate list of firms.

Phase 2 -- Survey of candidate firms to collect information on sales and purchases.

Phase 3 -- Analysis of survey results and development of industry profiles

The procedures, results, and findings of each phase are contained in this report.

CHAPTER 2

CLASSIFICATION OF THE AIR POLLUTION CONTROL INDUSTRY

This research project represents the first attempt to specifically define and study the APCI in California. In general, the APCI may be broadly defined as that industry which provides any kind of goods and services related to air pollution control. However, great care is necessary to formulate a definition that will essentially meet the needs of all who wish to use the study results. Therefore, these needs must be considered in light of the ability to measure the APCI quantitatively. Thus, the classification of the APCI in California balances user needs with quantitative measurement requirements.

In order to develop a working definition of the APCI in California, the following questions were considered:

(1) How has the APCI been classified and measured previously?

(2) What kinds of goods and services are required to comply with existing regulations? Are these provided "in-house"* or obtained from outside suppliers?

(3) How is the APCI defined in the market place as judged by advertising in trade journals or the telephone yellow pages?

Each of these questions is discussed in this chapter. In light of this discussion, a working definition of the California APCI is presented.

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*The term "in-house" denotes goods or services that are provided by the regulated firm itself rather than being purchased from outside suppliers.

2.1 -- PREVIOUS APCI CLASSIFICATIONS AND MEASUREMENT

A survey of the literature revealed, as expected, that no studies specifically examining the California APCI had been published. There are, however, a few national studies which provide definitional insight into the APCI. In addition, these national studies provide some indication of the size of the APCI in California under certain assumptions.

2.1.1 -- Review of Classifications

In general, national studies of the APCI exhibit different definitions of the industry. Some studies use very restrictive definitions of the APCI normally focusing on specific equipment or technology. Alternatively, other studies use a very broad definition of the industry and include not only control equipment but all other equipment and personnel costs associated with activities that have even a minor air pollution control component. In some cases, industry measurements are made without reference to a specific definition.*

When restrictive measurements of the APCI are considered, two studies are prominent. First, the U.S. Department of Commerce performed a survey of manufacturers of certain air pollution control equipment.** The survey is directed to manufacturers of particulate emissions collectors, gaseous emissions control

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*Robert W. McIlvaine, "The Ever-Changing Air Pollution Control Market," Journal of the Air Pollution Control Association, 32:304-309 (1982), and Robert W. McIlvaine, "Market Trends for Air Pollution Control Equipment," Journal of the Air Pollution Control Association, 33:250-255 (1983).

**U.S. Department of Commerce, Bureau of the Census, Selected Industrial Air Pollution Equipment, 1980. (OMB No. 41-R2676).

devices and one category of industrial air pollution control equipment defined simply as "other." The survey is limited to tail gas cleanup and omits all controls based on process modifications or changes in operation and maintenance procedures. (A copy of the survey questionnaire is given in Appendix A). Second, under contract with the Environmental Protection Agency, Arthur D. Little, Inc., conducted a national study of the economic impacts of the pollution control industry*. One of the major sectors considered was the air pollution control sector. The A.D. Little definition of the air pollution control sector excluded mobile sources and the activity of companies that participated in related activities, e.g., consulting engineers, fabricators, etc. Definitionally, these studies limit the size of the APCI.

Alternatively, other studies provide very broad definitions of the APCI. A study performed for the Industrial Gas Cleaning Institute serves as an illustration.** This study defines the APCI so broadly that the total employment of a firm is automatically included in the industry regardless of the level of activity that can be associated with air pollution control. For example, the total employment of Bechtel Corporation is associated with APCI even though this represents an extremely small portion of their major activity which is the design and construction of

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*Arthur D. Little, Inc., "The Economic Effects of Environmental Regulations in the Pollution Control Industry," Report to the Environmental Protection Agency, September, 1978 (EPA Contract No. 68-01-4660).

**H & W Management Science Consultants, Employment in the Air Pollution Control Industry, Industrial Gas Cleaning Institute, February 1982.

power plants and refineries, etc. From a methodological point of view, this type of broad definition may not serve the needs of the present study.

Still other studies tend to classify the national pollution control industry without really providing a specific definition. For example, a Data Resources, Inc., study for EPA indicates that the industry is the pollution control equipment industry and all industries that operate and maintain pollution control equipment and facilities.* However, a definition which permits direct measurement is not provided by the study. Thus, such studies provide only limited insights into the methods that can be used to measure the industry's activity in California.

2.1.2 -- General Measurements of the California APCI

Although there are no specific measurements of the size of the California APCI, these past studies could be used to provide rough estimates of what could be expected for the State. Since these studies are national in scope and have various definitions of the industry, the resulting estimates must be viewed with caution. However, these rough estimates provide a range of values that might be expected for the California APCI.

Table 2.1 provides some rough estimates for the California APCI's employment that were derived for this study by making reasonable assumptions with respect to the percentage of the national totals that would be found in California. As the table

*Data Resources, Inc., "The Macroeconomic Impact of Federal Pollution Control Programs: 1981 Assessment," a Report to the Environmental Protection Agency, July 1981.

Table 2.1

ROUGH ESTIMATES OF THE
EMPLOYMENT IN THE CALIFORNIA APCI
BASED ON NATIONAL STUDIES

Study	Estimated Year	Estimated U.S. Pollution Control Employment	Estimated California APCI Employment
Industrual Gas Cleaning Institute	1982	313,105[a]	31,310[b]
Data Resources, Inc.	1970-1987	Δ 524,000[c]	Δ 31,400[d]
A.D. Little	1983	17,300[a]	1,730[b]
Council on Environmental Quality	1979	446,000[a,e]	44,600[b]
National Academy of Sciences	1974	677,900[c]	39,318[d]

[a]Exclusively air pollution control.

[b]Assumes California represents 10% of the U.S. employment.

[c]All types of pollution control.

[d]Assumes California represents 10% of the U.S. employment and air pollution control represents 60% of total pollution control.

[e]Employment figure derived by assuming $50,000 sales per employee.

Sources: H & W Management Science Consultants, Employment in the Air Pollution Control Industry, Industrial Gas Cleaning Institute, February 1982.

Data Resources, Inc., "The Macroeconomic Impact of Federal Pollution Control Programs: 1981 Assessment," a report to the Environmental Protection Agency, July 1981.

Council on Environmental Quality, Environmental Quality - 1980, December 1980.

A.D. Little, Inc., "The Economic Effects of Environmental Regulations in the Pollution Control Industry," a report to the Environmental Protection Agency, September 1978.

National Academy of Sciences, National Research Council, Manpower for Environmental Pollution Control, 1977.

indicates, estimates are given for various years. In addition, it should be noted that the estimated U.S. employment figures are not comparable from study to study since non-air pollution related activities are included in some of the figures. In one case, i.e., the Council on Environmental Quality study, national employment had to be derived based on total annual abatement costs due to Federal regulations and an assumption regarding sales per employee. Therefore, different sets of assumptions had to be made in order to derive a rough estimate for the employment of the California APCI.

As Table 2.1 indicates, the estimates of the California APCI vary substantially. The Industrial Gas Cleaning Institute estimates U.S. APCI employment at 313,105. Since California's population is roughly 10 percent of the nation's population and assuming this relationship holds for employment, the number of employees for the California APCI could be estimated at 31,310 using the Industrial Gas Cleaning Institute's national figures. The Data Resources study estimates the change in total pollution control employment from 1970 to 1987 at 524,000. Since this figure includes non-air pollution control employment, an adjustment is necessary. Assuming that air pollution control represents 60 percent of total pollution control activity* and that California represents 10 percent of the change in employment, the estimated increase in California APCI employment would be 31,400

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*Note the Council on Environmental Quality, Environmental Quality - 1980, December 1980, p. 424, estimates that air pollution abatement received 58 percent of total incremental outlays for pollution abatement.

from 1970 to 1987. The A.D. Little estimate for California would be 1,730 based on a very restrictive definition of the industry and the 10 percent assumption. The calculation using the Council on Environmental Quality data assumes that the $22.3 billion total abatement costs due to Federal regulations can be translated into employment based on $50,000 per employee* (i.e., 446,000 for the U.S. as a whole, and that California represents 10 percent of this employment figure). Finally, the California employment estimate based on the National Academy of Sciences study required assumptions identical to Data Resources' study but apply to total employment rather than the change in employment.

Employing national studies, rough estimates of California APCI sales can also be made. Table 2.2 provides these estimates. The $2.23 billion estimate attributed to the Council on Environmental Quality assumes that 10 percent of total U.S. incremental air pollution costs in response to Federal legislation can be attributed to the California APCI. All other sales figures simply multiply the estimated California APCI employment in Table 2.1 by the $50,000 sales per employee figure. As indicated in Table 2.2, California APCI sales could be expected to range from $86 million to $2.23 billion annually depending on which study is used.

In summary, the rough estimates of APCI employment and sales indicate that a significant level of activity can be attributed

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*Note that the average sales/employee ratio developed from groups of leading companies in pollution control is reported to be $50,000 per person in the aforementioned A.D. Little study.

Table 2.2

ROUGH ESTIMATES OF THE
SALES OF THE CALIFORNIA APCI
BASED ON NATIONAL STUDIES

Study	Estimated Year	Estimated Sales of California APCI (millions of $)
Industrial Gas Cleaning Institute	1982	$1,565[a]
A.D. Little	1983	86[a]
Council on Environmental Quality	1979	2,230[b]
National Academy of Sciences	1974	1,965[a]

[a]Sales figure represents estimated California APCI employment at $50,000 per employee.

[b]Sales figure represents 10 percent of total U.S. incremental air pollution abatement costs in response to Federal legislation.

Sources: H&W Management Science Consultants, Employment in the Air Pollution Control Industry, Industrial Gas Cleaning Institute, February 1982.

A.D. Little, Inc., "The Economic Effects of Environmental Regulations in the Pollution Control Industry," a report to the Environmental Protection Agency, September 1978.

National Academy of Sciences, National Research Council, Manpower for Environmental Pollution Control, 1977.

Council on Environmental Quality, Environmental Quality-1980, December 1980.

to the industry. The range of employment falls between 1,730 and 44,600. In addition, based on the DRI study, increases in California APCI employment can be expected through 1987. The rough sales estimates indicate that California APCI sales may be as large as $2.23 billion. Needless to say, these rough estimates should be viewed cautiously in light of the industry definitions used and the assumptions employed.

2.2 -- CLASSIFICATION FROM THE LEGISLATIVE VIEWPOINT

The APCI provides goods and services that are needed by controlled firms to enable them to comply with air pollution control regulations. By examining the regulations and listing the types of equipment required for compliance with each regulation, it is possible to identify most kinds of equipment and services that are required by California firms. By determining whether these purchases are made within the State of California or outside it, an important segment of the APCI can be defined. In the paragraphs that follow, this is done.

For the purpose of this report, it is convenient to construct a matrix of processes (or industries) that come under regulation and the types of control equipment that might be installed by each process (or industry). Such a matrix is shown in Table 2.3. The general categories for processes (industries) and for control technology were patterned after the same scheme used by Accurex in a report they recently prepared for the CARB.* In brief,

*D. Minucucci, M. Herther, L. Babb, and W. Kuby, "Assessment of Control Technology for Stationary Sources," report prepared by Accurex for California Air Resources Board, under contract No. A7-170-30, July 1979.

Table 2.3

INDUSTRIES
(Pollutants)*

Control Technology	Fuel Combustion					Petrol Refin., Prod., Mktg.						Organic Solvent		Chemical Processing						Metallurgical Operations					Minerals			Food and Agriculture			Wood Processing				Waste Burn.
	HC	NO	SO	PM	CO	HC	NO	SO	PM	CO	HS	HC	PM	HC	NO	SO	PM	CO	HS	HC	SO	PM	CO	HS	SO	PM	CO	HC	PM	HS	HC	SO	PM	HS	PM
TAIL GAS CLEANUP																																			
Wet Scrubber			XX	XX				XX	XX						XX	XX	XX				XX	XX				XX		XX	XX	XX			XX	XX	XX
Absorption Columns			XX														XX		XX					XX					XX				XX		
Vapor Recovery						XX						XX		XX														XX							
Mechanical Collector									XX								XX					XX							XX				XX		XX
Fabric Filter													XX			XX	XX					XX				XX			XX				XX		XX
Electrostatic Precip.				XX					XX													XX											XX		XX
Hoods, ducts, etc.												XX	XX				XX					XX													
Afterburner incinerator						XX			XX	XX	XX	XX		XX			XX	XX		XX			XX					XX	XX				XX	XX	XX
Flue Gas Treatment		XX	XX	XX				XX			XX				XX																				
Miscellaneous		XX	XX		XX	XX	XX	XX				XX	XX	XX	XX							XX				XX									
PROCESS MODS.		XX				XX	XX	XX		XX	XX	XX		XX				XX	XX	XX	XX	XX	XX		XX		XX				XX	XX		XX	
OPERATIONAL AND MAINTENANCE PROC.	XX			XX	XX	XX			XX	XX		XX		XX		XX	XX	XX				XX	XX			XX					XX				XX

*HC = Hydrocarbons
NO = Nitrogen oxides
SO = Sulfur oxides
PM = Particulate matter
HS = Hydrogen sulfide

Source: CIC Research, Inc.

the process (industry) categories are identical to the stationary source categories that are used for emission inventories --

- Fuel Combustion
- Petroleum Process, Storage and Transfer
- Organic Solvent Use
- Industrial Processes
  - Chemical
  - Metal Processes
  - Mineral Processes
  - Food and Agricultural
  - Wood and Paper
- Waste Burning

Mobile sources are not included in Table 2.3 because this study is limited to stationary sources.

Control technologies are grouped into three major categories: tail gas cleanup, process modifications and operational and maintenance procedures. The equipment categories given under the heading "Tail Gas Cleanup, " in Table 2.3 were chosen to be compatible with the categories used by CARB in their emissions inventory. Several categories were grouped together as shown below:

Equipment	CARB Control Device Codes*
Wet scrubbers	001, 002, 003
Mechanical collectors	004, 005, 006, 007, 008, 009
Electrostatic precipitators	010, 011, 012
Fabric filters	016, 107, 018
Afterburners, incinerators	119, 020, 021, 022
Flue gas treatment	039, 040, 041, 042, 043, 044, 045
Vapor recovery systems	047, 048
Absorption columns, spray towers	049, 050, 051, 052, 053
Ducts, hoods, blowers, fans	054

*See Appendix B for complete listing of CARB control device codes.

Table 2.3 lists all potentially applicable control technologies, including some controls that may not be in use in California; nevertheless, the information is useful for identifying the probable types of control equipment that are of interest in this study. In general, each equipment category (except miscellaneous) corresponds to a certain kind of hardware which is usually purchased from a specialized supplier.

For the other control categories -- process modifications and operational and maintenance procedures -- the relationship between hardware requirements and control technology is not clear-cut. Some process modifications may be accomplished entirely "in-house" by the regulated industry with very little equipment being purchased. Other process modifications may require the replacement of existing equipment with improved versions that are purchased from specialized vendors. For clarity, "in-house" control activities have been excluded from the Air Pollution Control Industry definition for this study, but firms that supply goods and services to enable regulated industries to modify processes or operations are included in the APCI.

For the discussions that follow, regulations are grouped into general categories rather than being listed by specific rule numbers for each APCI district in the State. As a rule, the same pollution control equipment is required for a given process, even though the polluting industries may be located in Air Pollution Control Districts with differently worded regulations.

2.2.1 -- Particulate Matter Control Regulations

Particulate matter emission regulations fall into three general categories: (1) opacity, (2) process weight, or (3) grain loading. Generally, all air pollution control districts have enacted opacity regulations and most have process weight regulations for combustion sources and grain loading regulations for non-combustion sources. Regardless of the form of the regulations, particulate control is accomplished by removing the particles from the gas stream by using a variety of devices. Wet scrubbers, mechanical collectors, electrostatic precipitators, and fabric filters are all used to remove particles. The most appropriate device is chosen after evaluating the flow rate and temperature of the air stream, the size and chemical composition of the particles, and other related parameters.

For the purposes of this study, it is not necessary to identify separate manufacturers for each type of particulate control device because many suppliers provide an assortment of devices. A survey of firms listed under the general heading of "industrial particulate control devices" will identify suppliers of wet scrubbers, mechanical collectors, fabric filters, electrostatic precipitators, and hoods. In addition, manufacturers of sophisticated flue gas treatment units for control of sulfur oxides also provide particulate control devices as required by particulate and sulfur oxide regulations. Since these units are primarily used at coal-fired power plants, this application is not important to the present study.

A SURVEY OF THE AIR POLLUTION CONTROL INDUSTRY IN CALIFORNIA

EXECUTIVE SUMMARY

Prepared for:

CALIFORNIA AIR RESOURCES BOARD

Under Contrct No. AB AO-137-32

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EXECUTIVE SUMMARY

The purpose of the study was to identify and characterize firms in California that derive all or part of their revenue from manufacturing air pollution control equipment or providing related services. These firms constitute the California Air Pollution Control Industry (APCI). When control regulations are enacted by the Air Resources Board, costs are incurred by those firms that are required to install control equipment, but the APCI also experiences increased sales and revenues. The purpose of the study was to compile a data base that could be used to characterize the APCI and estimate its impact on the California economy. In essence, this report will allow the Air Resources Board to more fully assess the impacts of suggested air pollution control measures on the economy of California.

The economic impacts that can be associated with the APCI depends to a great extent upon the definition of the industry. A literature survey was conducted to determine how the industry had been defined by others. The most restrictive definitions included manufacturers of stationary control equipment and excluded auxiliary services and equipment while the least restrictive definitions included the total employment of all firms that had even a minor component of APCI activity. All of the published studies were concerned with the national APCI rather than California. As a part of the study, estimates of the California APCI were made based on the national studies. Depending on the

definition, the California APCI could sell as much as $2.23 billion or as little as $860 million and could employ as many as 44,600 or as few as 1,730 people. The present study uses a fairly restrictive definition of the APCI in order to permit manageable and direct measurement for California.

For purposes of this study, the manufacturers of the following kinds of equipment were included in the APCI for California: wet scrubbers, mechanical collectors, electrostatic precipitators, fabric filters, flue gas treatment systems, tank seals, afterburners, incinerators, absorption columns, spray towers, vapor recovery systems, low NO_x burners and combustion modification systems. Manufacturers of the following were included in the California APCI when the equipment was associated with an air pollution device: ducts, hoods, blowers, fans, measuring instrument, water equipment and fuel storage tanks. Suppliers of equipment associated with industrial clean rooms or intended for household use were specifically excluded from the study. Firms that provided the following services were included in the California APCI when the service was related to air pollution policy, planning, or control: consulting, design, equipment maintenance and repair, laboratory testing and field testing. Attorneys' services were specifically excluded. In addition, all manufacturing and services related to mobile sources were excluded from the study along with the activities of government and colleges and universities.

All APCI firms were contacted by telephone and mail to collect information on 1980 calendar year sales, services, employment, customers, purchases and major competitors. The first questionnaire mailings were accomplished between March 22 and April 9, 1982, and up to three follow-up calls were made in an effort to secure a completed questionnaire. The responses to the survey efforts are summarized below:

Potential firms identified	257
Firms reporting APCI activity	157
Firms reporting no APCI activity	59
Firms not responding at all	41

The survey responses indicated that the APCI is composed of essentially two types of firms -- manufacturing and services. Together these firms supplied an estimated 18 different types of equipment and services. While the majority of firms competed with other California firms, there still remained a significant amount of competition from the rest of the country. Competition from the rest of the world was insignificant. Firms in the industry have been in business an average of 15 years.

Based on the definition of the industry employed in this study, total California APCI employment was estimated to be 5,600 employees. The majority, 3,100, were employed by the manufacturing sector; the remainder, 2,500, were employed by the service sector. APCI employment represents 0.1 percent of the total California employment in manufacturing and services. Sales generated

by the APC industry were estimated at $903 million, with $143 million being sold to California end-users. The manufacturing sector produced and sold $703 million worth of equipment and services, with $90 million going to California end-users. Of the remaining $200 million in sales for the service sector, $53 million went to California end-users. APCI sales account for less than one percent of the total sales in the manufacturing and service sectors for California. The major customers in the industry are oil and gas extraction firms, petroleum refining (mostly in-State sales), utilities, and public administration. Most of the major purchases by the industry are from fabricated metal firms and measuring instrument producers. Of the firms' total capital expenditures, approximately 40 percent were directed to APC activities. The outlook for the industry is expected to be somewhat profitable.

The multiproduct, capital goods APCI is primarily an export industry. Almost 90 percent of California's APCI manufactured goods were sold in out-of-state markets. Similarly, 75 percent of APCI services were provided to customers in other states. As a basic or export industry, the California APCI would exhibit growth, development, and general economic activity as air pollution control efforts increase in other parts of the nation. This increased activity provides jobs and income for Californians which are primarily paid for by individuals, businesses, and governments of other states.

The export status of the industry underscores another idea, As long as air quality standards are established throughout the United States, California APCI firms will be able to play a vital role in supplying air pollution control equipment and services. While the impetus for developing an APCI may have been the result of California's leadership in establishing air quality standards, the continued health of the industry is much more dependent on the needs of the rest of the nation.

Although the primary focus of this study was the characterization of the APCI, a survey was also conducted of selected purchasers of air pollution control equipment. A group of 57 firms was identified from the records of the California Pollution Control Financing Authority. During the period from January 1978 to May 1982 these firms financed air pollution control projects amounting to $422,698,000. These purchasers indicated that only 28 percent of the borrowed funds were spent outside of California and about 5 percent were spent within the borrowing firms. The remaining 67 percent ($283,200,000) was spent in making purchases from the California APCI. The estimates of expenditures by purchasing firms are consistent with the sales estimates obtained from the APCI survey when allowances are made for uncertainties in determining exactly when the loan funds were spent and difficulties in defining purchases that were not financed by loans.

Indirect economic impacts were considered, and procedures were suggested for using ARB's Input/Output Model to evaluate

indirect impacts. The probable future sales of the APCI were assessed within the framework of future regulatory plans of California air pollution control agencies, and it was concluded that the demand will continue into the future. The specific goods and services will have to change in response to changing technologies.

In summary, the California APCI is a multiproduct, capital goods, export industry that contributes to the state's economy through employment and sales which are primarily supported by the rest of the nation. Although the California APCI services the demands that arise within the state, the industry's future is closely tied to the air pollution control needs of the nation.

ACKNOWLEDGEMENTS

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Special recognition should be given to Malcolm Dole, Sylvia Champomier, Brandt Stevens, and Fereidun Feizollahi of the Air Resources Board research staff for their technical input and advice. In addition, the cooperation of the California Air Pollution Control Financing Authority staff, particularly, Bruce H. Gies and Dixie Swart, is also gratefully acknowledged.

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The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with the material reported herein is not to be construed as either an actual or implied endorsement of such products.

In addition to the particulate control devices, the regulated industry may require the services of a consultant to design and prepare bid specifications for the equipment. Certain auxiliary equipment, such as flow meters, transmissometers, water conditioners, etc., may need to be purchased from separate suppliers before the control device can be operated. Specialized maintenance services may be provided under contract to keep the device in working order. Suppliers of the above equipment and services were included in the master list of firms.

2.2.2 -- Sulfur Oxides Control Regulations

Sulfur oxides originate from the combustion of fuels containing sulfur and are also emitted by sulfuric acid plants. Control regulations sometimes limit the concentration of sulfur oxides emerging from a stack or, in other cases, limit the quantity of sulfur oxides on a process weight basis. Another method of control is to limit the stack gas composition. The regulated industry may sometimes have a choice between installing a scrubber on a stack and reducing the sulfur content of the fuel supplied to the stack.

When tail gas cleanup is the method of choice, the device is normally purchased from a specialized supplier, and the device will usually control both sulfur oxides and particulates. Consultant services and auxiliary equipment are usually required, and sometimes special chemicals must be purchased. In addition, solid waste disposal facilities may need to be expanded. When low sulfur fuel is burned, the regulated industry usually purchases the fuel from its normal supplier. The industry does not

purchase equipment to desulfurize fuel at the site; however, it might install a new tank for storing low sulfur fuel in addition to its normal fuel supply.

A few preliminary inquiries showed that it was not possible to consider suppliers of chemicals as a part of the APCI. They do not aggregate their sales information according to the end use of the chemicals, so they are unable to provide data on sales associated with air pollution control. It was also not feasible to determine whether additional jobs had been created at refineries as a result of the increased need for low sulfur fuels. Previous experience has shown CIC that hard data of this kind are simply not available. Manufacturers of fuel storage tanks and segregated ballast tanks were considered to be part of the APCI, but difficulty was experienced in correlating their sales data with pollution control regulations.

2.2.3 -- Hydrocarbon Control Regulations

Hydrocarbon control regulations tend to be industry specific. Some regulations require tail gas cleanup and others require process modifications or maintenance procedures. The regulations are discussed below according to the industry categories of Table 2.3.

2.2.3.1 -- Fuel Combustion. Hydrocarbons are only a minor problem in fuel combustion processes. High levels are generally an indication of inefficient operation and are routinely avoided in order to minimize fuel consumption. It has not been necessary to promulgate specific regulations for flue gas hydrocarbons because badly operated combustion sources usually emit particulates

in violation of opacity standards or emit CO in excess of permitted concentrations. When the opacity and CO violations are corrected, the hydrocarbon levels are also acceptable. The study did not find any industries that make devices which are installed specifically to reduce hydrocarbon emissions from fuel combustion. Combustion control devices will usually be associated with particulate matter, nitrogen oxides, or carbon monoxide control regulations.

2.2.3.2 -- Petroleum Refining, Production and Marketing. Hydrocarbon regulations for refineries have been in existence for many years and have gradually become more strict and comprehensive. These regulations do not require the refinery to purchase additional hardware but simply require that more attention be given to good housekeeping and maintenance practices. For the purposes of this study, it was assumed that this is accomplished in-house. If it is accomplished as part of a maintenance contract with an outside company, preliminary inquiries indicated that the increased level of maintenance would be small, difficult to isolate, and could be neglected in this study.

Refineries have long been required to equip their gasoline storage tanks with floating roofs. Several years ago the specifications for floating roofs were made more stringent in an effort to reduce leakage from storage tanks. For the purposes of this study, manufacturers of floating roof tanks and secondary seals to reduce leakage were identified and it was assumed that all this activity is related to air pollution control.

Oil production facilities originally were exempted from hydrocarbon regulations that were enacted for refineries. Currently, the refinery regulations are being extended to oil production operations when they are applicable. The same kinds of goods and services are required by refineries and oil production operations, so the industries that serve refineries will also serve oil producers. It was not possible to differentiate between services and goods provided to refiners and producers so for the purposes of this study they were lumped together.

Petroleum marketing operations are regulated at virtually every stage of the marketing chain where gasoline or other volatile liquid is moved from one container to another. For example, the following kinds of transfers have been considered for regulation:

- Large tanker to small tanker (lightering)
- Floating roof tank to tank truck or railcar
- Tank truck or railcar to storage tank (usually fixed roof)
- Storage tank to vehicle fuel tank

Most of these regulations require that some kind of hardware be purchased and installed. The hardware varies somewhat with the size of the storage tanks and the location of the transfer facility, but as a first approximation for this study, all devices were considered together. Companies that supply vapor balance systems, condensors, afterburners, nozzles, and absorbers were identified. Regulations also specify that tank trucks must be leakproof; therefore, a group of industries that provide leak testing and repair services was identified.

Some miscellaneous goods and services were added to the above. Large architectural and engineering firms that design refineries and oil production facilities were surveyed. Shipbuilders that provide segregated ballast tanks were also included.

2.2.3.3 -- Organic Solvent Use. Hydrocarbon emissions from organic solvent use are usually associated with surface coating operations. Other industrial sources are degreasing operations and drycleaning. Regulations generally fall into one of three categories: (1) limitations on the weight of solvent that may be discharged from a machine or piece of equipment in a given time period, (2) limitations on the amount of hydrocarbon that may be discharged for each liter of coating that is applied, and (3) prohibiting the sale of coating materials that contain more than a prescribed amount of solvent. Regulated industries may choose to comply by installing tail gas cleanup devices or by reformulating their coatings, or a combination of both.

The coatings regulations impact the industries that manufacture the coatings because they have had to develop new coatings to conform to the new regulations. In addition, the regulations may have a small impact on the industries that manufacture coating equipment because the new coatings may require different spray nozzles, drying ovens, or other modified equipment. For the purposes of this study, no attempt was made to assess the impact of regulations on the coatings manufacturing industry. The impact is believed to be small, possibly negative, and almost impossible to isolate clearly. Manufacturers of coating

equipment were surveyed, but it was difficult to identify any air pollution control segment of their business.

2.2.3.4 -- Chemical Processing and Metallurgical Operations. These industries are generally required to comply with regulations that have already been discussed under petroleum or organic solvent use. No unique kinds of equipment or services are required, and it is anticipated that the general survey covered these industrial categories adequately.

2.2.3.5 -- Food and Agriculture. Hydrocarbon emissions are a minor problem in certain agricultural industries and are unimportant in many other agricultural industries. Usually hydrocarbons are associated with an odor problem, so emissions are controlled to comply with odor regulations. Some type of tail gas cleanup device is commonly installed, and the type of device will depend on the chemical makeup of the hydrocarbon emissions. Afterburners, absorbers, and scrubbers are used, and many of these may be purchased from suppliers that provide similar equipment to the petroleum, solvent use, and chemical industries. In addition, there are some suppliers that specialize in solving odor problems, and their sales to industries that are classified as major air pollution sources were included in this study.

2.2.4 -- Nitrogen Oxides Control Regulations

Nitrogen oxides originate during fuel combustion and are also emitted by nitric acid plants. However, there is no extensive California industry that supplied pollution control equipment and services to nitric acid plants. There are many

fuel combustion operations, chiefly, furnaces and boilers, and regulations applying to these operations have been developed recently, or are still being developed. Generally, the regulations limit the emission rate of NO_x to some prescribed quantity per unit of power generated by the combustion device. Most of the regulations require that tail gas cleanup devices be installed or that burners be modified. Some NO_x control can be accomplished by process modifications without installing hardware. NO_x controls are different from other kinds of controls, and the firms that provide these goods and services are generally different from any of the firms discussed in earlier sections. Boiler manufacturers that sell low NO_x burners, staged combustion units, and other modified burners in sizes ranging from small oil field steam generators (50mm Btu/hr) to large utility boilers (greater than 500mm Btu/hr) were identified. In addition, suppliers of selective catalytic and noncatalytic reduction units for tail gas cleanup of large boilers were identified.

Model control regulations have been developed for NO_x from stationary internal combustion engines. Compliance will probably require installation of a catalyst system on the exhaust. Suppliers of these catalyst systems were contacted, but the regulations have not been enacted long enough by local APCDs for many purchases to have been made. Control regulations have also been proposed for NO_x from electric utility gas turbines. These regulations are to take effect in stages beginning in 1983, and water injection will probably be the technique chosen at that time.

Gas turbine manufacturers were contacted in an attempt to identify costs of these controls, but the effort proved to be premature. In addition, control regulations have recently been recommended for glass melting furnaces and cement kilns. These are to take effect in 1983 and 1984 and generally assume that compliance can be achieved by process modifications rather than hardware. If tail gas cleanup devices are used, they will be similar to those recommended for other types of NO_x sources. Therefore, no additional equipment suppliers needed to be surveyed to identify suppliers of goods and services to these industries.

2.2.5 -- Carbon Monoxide Control Regulations

Carbon monoxide emissions are almost always associated with combustion processes -- chiefly in internal combustion engines. Regulations usually limit the amount of CO that may be omitted per unit of fuel burned or power generated. In most instances, CO emissions are controlled by adjusting air and fuel ratios for the most efficient combustion. This can be accomplished with the conventional combustion control devices that are part of a modern boiler designed for efficient operation. In a few exceptional cases, such as carbon black manufacture and petroleum refining, CO is a by-product and is burned in a waste heat boiler or afterburner. No specialized devices or techniques are used for CO control. The survey of suppliers of hydrocarbon control devices will automatically include devices for CO as well.

2.2.6 -- Auxiliary Goods and Services

Air monitoring and continuous source monitoring may be required as part of compliance with many air pollution control regulations -- especially those that apply to new sources (those covered by NSPS). For purposes of this survey, manufacturers of monitoring instruments were considered as a separate industrial group. No attempt was made to ascertain whether instruments were purchased to meet regulatory requirements or whether they were used in other ways, because instrument suppliers do not know the exact application of each instrument they sell. Some of the instruments may be used to monitor mobile sources as well as stationary sources. Certain instruments can be associated with particular pollutants, but others such as flow meters, temperature measuring devices, wind speed and direction indicators, data recorders, etc., do not provide direct measures of specific pollutants. All air pollution instrumentation was aggregated into a single group in the initial survey. The survey responses were evaluated to determine whether information could be developed for subgroups, but as discussed in Chapter 4, no additional breakdown was possible.

Consulting firms provide services to design and build new industrial plants or modify existing plants. Part of this effort is expended in specifying appropriate devices for air pollution control. These firms were surveyed and asked to estimate what percentage of their total business deals with air pollution regulations and associated hardware.

Other consulting firms perform studies that deal with the general area of air pollution but are not concerned with the application of specific regulations to specific firms. These studies are usually funded by government agencies and frequently seek to assess the feasibility of a regulation or improve the methodology for quantifying and predicting the effects of air pollution. These consulting firms were surveyed as a group, but it was not possible to relate their activities to specific regulations. Consulting firms that specialize in preparing EIRs were not surveyed because the air pollutant component of most EIRs is so small that it cannot be readily separated from the major effort.

Attorney's services are required whenever industries file suits to challenge the legality of regulations or whenever control agencies go to court to enforce regulations. This activity was omitted in this study's definition of the APCI because it is not a direct and necessary consequence of all regulatory actions.

2.3 -- ADVERTISED GOODS AND SERVICES

A variety of advertising literature was consulted, and the types of goods and services were compared with those identified above in Section 2.2. (The sources of this literature are listed in the following chapter in Section 3.1.) All the advertised goods and services corresponded to those that had been identified by the exercise of Section 2.2, dealing with legislative requirements. The following kinds of goods and services were not commonly advertised in the air pollution literature:

- Sophisticated flue gas treatment devices
- Floating roof tanks and seals
- Vapor recovery systems
- Low NO_x burners

Large Architectural and Engineering firms that specialize in design of refineries and other industrial plants did not advertise the air pollution control services that they provide as part of the design and construction of every plant.

Many goods and services were advertised for use in industrial clean rooms, control of odors and removal of particulate matter from household atmospheres. All of these were excluded from the APCI, as defined for this study, because they are not required by state or local air pollution control regulations.

2.4 -- A WORKING CLASSIFICATION OF THE APCI

For the purposes of this study, California-based firms that supply the following types of equipment as discussed in Sections 2.2 and 2.3 were identified:

- Wet scrubbers
- Mechanical collectors
- Electrostatic precipitators
- Fabric filters
- Ducts, hoods, blowers, fans
- Flue gas treatment systems
- Tank seals, tank truck seals
- Afterburners, incinerators
- Absorption columns, spray towers

- Vapor recovery systems
- Low NO_x burners, combustion modifications

Suppliers of equipment associated with industrial clean rooms or intended for household use were specifically excluded from the study.

Also included in this study were firms that supply the following kinds of auxiliary goods and services:

- Measuring instruments
- Water treatment equipment
- Fuel storage tanks
- Consulting services to design control systems
- Maintenance and repair of control equipment
- Laboratory and field testing services
- Consulting services related to policy and planning

For reasons explained in Section 2.2, the following have been omitted from the study:

- Suppliers of chemicals for flue gas treatment
- Changes in employment at refineries related to low sulfur fuel or maintenance practices
- Companies that perform maintenance for oil producers, pipeline operators and refiners
- Reformulation of surface coatings
- Activities associated with preparation of EIRs
- Attorneys' services

In addition, the following were excluded because they are not normally hired by regulated firms to provide services that relate to compliance with regulations:

- Employees of Federal, State and local governments
- University and college faculty and students

Also, any activities related to mobile sources were excluded because the study is restricted to stationary sources.

CHAPTER 3

THE SURVEY OF THE AIR POLLUTION CONTROL INDUSTRY

The purpose of this study was to develop an economic profile of the APCI in California. For this purpose, answers to the following questions were sought:

1. How many APCI firms exist in California?
2. What kinds of goods and services do they provide?
3. What are their annual sales and employment?
4. Who are their major customers? Do they sell primarily to California customers?
5. What kinds of materials do they purchase? Are these purchases made primarily from California firms?

The information was compiled by conducting a mail survey of all APCI firms that could be identified. The methodology is described in this chapter.

3.1 -- SAMPLE FRAME

Specific firms that provide the goods and services identified in Chapter 2 were selected from a variety of published and unpublished sources. These are discussed in the paragraphs that follow.

3.1.1 -- Lists Compiled by Others

The base list was provided by Dr. Malcolm Dole of CARB who had assembled this material for a survey conducted six years

ago. This list was augmented and updated by consulting the following: (see Bibliography listings for publishers, etc.)

- Southern California Business Directory and Buyers Guide
- Thomas Register of Manufacturers
- Air Pollution Control Association Directory, 1980-81 and 1981-82
- Air Pollution Control Association Consultants Guide, December 1980
- Pollution Engineering, 1980 Environmental Yearbook
- Analytical Chemistry, 1981-82 Lab Guide
- Telephone Yellow Pages for San Diego, Los Angeles, Orange County, Riverside, San Bernardino, San Francisco, Oakland, and Sacramento

Current addresses and telephone numbers were assembled, and when information was available on product lines, this was also recorded. Every attempt was made to exclude firms that specialize in water, solid waste, or industrial clean rooms. Firms that provide equipment or services exclusively for households were not included. Sometimes it was not possible to determine a firm's product or service from published information. If the firm advertised under an "air pollution control" heading, it was included if no other information was available. California representatives of out-of-state companies were generally not included, but the parent companies were added to the list.

3.1.2 -- CARB Mailing Lists

Many groups in the Stationary Source Control Division and the Mobile Source Control Division of the CARB have assembled mailing lists that are used to distribute material relating to proposed regulations or revisions of existing regulations. These lists include

names of firms that would have to comply with the regulations as well as firms that would supply hardware or services required by the regulation. The following mailing lists were obtained:

Architectural Coating
Can and Coil Coating
General Metal and Appliance Coating
Printing Manufacturers
Marine Coatings
Floating Roof Tanks
Stage II Vapor Recovery Equipment Manufacturers
Maintenance of Oil Production and Refinery Equipment
Kern County Oil Production
Abrasives for Dry Unconfined Blasting
Coal-Fired Power Plant, Part I
Coal-Fired Power Plant, Part II
NO_x Control System Suppliers
Lightering
Pipeline Operators
Oil Well Vents
Pumps and Seals
Oil Production Companies
Refineries
Natural Gas Processing
Sulfur in Diesel
Gasoline Composition
Thermally Enhanced Oil Recovery
Commercial and Industrial Boilers

Most of the names on these lists were companies that would be required to comply with the proposed regulations; however, equipment manufacturers were listed for vapor recovery, NO_x control, coal-fired power plants, oilfield steam generators, and floating roof tanks. Manufacturers of coatings were also included but as discussed in Chapter 2, these were not added to the list.

Companies that perform maintenance for oil producers, pipeline operators, and refiners were also on the CARB mailing lists, but were not added to the list for reasons explained in Chapter 2.

3.1.3 -- Other Sources of Information

The larger air pollution control districts were contacted to determine whether they provided lists of firms to industries that needed assistance or equipment to comply with regulations. Ventura County was the only district that had such a list. This list was obtained and the appropriate names were added to the master list.

The "Business Briefs" section of each issue of the Journal of the Air Pollution Control Association was reviewed for 1980, 1981, and through July of 1982; all activities of California firms were noted. This source also provided information on large expenditures by California firms to purchase control equipment from out-of-state vendors. These out-of-state vendors were added to the master list and surveyed to find out whether they maintained branch offices in California.

Miscellaneous advertising literature such as Pollution Equipment News and the classified sections of the Journal of the Air Pollution Control Association and Environmental Science and Technology was reviewed periodically, and California companies were added to the list if they were not already there. In addition, the firms receiving the questionnaire were asked to list their major competitors. If these competitors were not already on the list, they were added to it.

3.1.4 -- Master List of APCI Firms

A compilation of 257 firms was developed as indicated in the paragraphs above (see Appendix C for names, addresses, and telephone numbers). To simplify the survey, the firms on the master list were assigned to one of the following categories based on the information on hand at the time:

- Manufacturers of Major Control Equipment
- Manufacturers of Auxiliary Equipment
- Consultants With Equipment Sidelines
- A & E Firms
- Consultants Without Equipment Sidelines
- Laboratories and Testing Services
- Others (distributors, specialized services)

The survey questionnaire (refer to Section 3.2) was accompanied by a cover letter individually prepared for each of the above categories.

3.2 -- METHODOLOGY

A questionnaire was designed to be mailed to each firm to collect information on 1980 product lines, employment, gross sales, air pollution control sales, customers, purchases and expectations of profitability in the future. A copy of the questionnaire is given in Appendix D along with copies of the various versions of the cover letter. Before the questionnaire was mailed, each firm was contacted by telephone. The telephone contact accomplished three things. First, the telephone call insured that the firm was still part of the California APCI.

Second, the telephone contact was used to confirm the firm's address and to locate a knowledgeable person concerning the firm's product lines, employment, customers, expenditures, sales, etc. Third, the telephone contact solicited participation in the survey. After the initial telephone contact, each firm was sent a cover letter, a numbered questionnaire, and a postage-paid return envelope. Twenty firms were used for a pre-test of the survey methodology. All methods expected to be used in the actual survey were employed in the pre-test, and two versions of Question 5 on gross sales were tested. The pre-test showed that the survey methods were satisfactory and that it was preferrable to ask for categories that corresponded to gross sales rather than ask for a specific amount.

The first questionnaire mailings were accomplished over a period of about three weeks, between March 22 and April 9, 1982. After this was completed, follow-up calls were made to all firms that had not returned questionnaires within three weeks of the mailing date. If the questionnaire had not been received, or if a different recipient was now considered appropriate, an additional questionnaire was mailed. For those who had received the questionnaire and were still working on it, no additional mailings were made. Up to three follow-up calls were made in an effort to secure a completed questionnaire.

A second questionnaire was designed to be telephone administered to the firms who failed to respond to the mail questionnaire, but were still in the active file. This questionnaire (see Appendix D) was brief and asked for readily available

information. Each firm was called and, where possible, a questionnaire was completed.

3.3 -- RESPONSES

As the completed questionnaires were received, each was edited and coded carefully. The actual coding process involved reviewing the questionnaire with respect to industries, control technologies, and pollutants, and the applicable equipment or service being provided by the respondent. Coded information was entered into the computer using a program that would automatically reject all entries that fall outside the range of values for each question based on all questionnaires. Rejected entries were checked against original questionnaires and re-entered. Subsequently, a team of data editors conducted a 100 percent validation of the questionnaires on an item-by-item basis to ensure that the computer data base matched the coded information exactly. Corrections were made as required. A small number of respondents replied that they provided no air pollution goods and services in spite of the fact that they were actually engaged in such activities. In such cases, the senior staff contacted the individuals at those firms that were actually performing the work (as opposed to the firm's controller or marketing manager) and attempted to obtain the desired information. In some cases, the information was supplied, but in other cases, the persons contacted were not permitted to give financial information.

Table 3.1 summarizes the results of the survey. Responses to the mail or telephone survey were secured from 216 of the 257

Table 3.1

DISTRIBUTION OF FIRMS CONTACTED
DURING APCI SURVEY BY
FIRMS' ACTIVITY RESPONSE

Firms' Response by Industrial Sector and Survey Method:		Number of Firms Responding
Manufacturing		103
Completed mail questionnaire	56	
Completed telephone questionnaire	47	
Service:		54
Completed mail questionnaire	41	
Completed telephone questionnaire	13	
Reported no APCI activity*		59
No response to survey		41
Total number of potential APCI firms identified		257

*All firms reporting no APCI activity responded to the mail questionnaire.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982.

firms on the master list; however, 59 of these firms responded that they did not provide goods and services for air pollution control. These firms are identified in the listing in Appendix C. In addition, Appendix E presents a question-by-question response rate for the two survey instruments. Many of them actually do have some APCI activities, but it is apparently such a small part of their total business that they do not perceive themselves as part of the APCI.

An initial attempt was made to group firms into the seven categories listed in Section 3.1 and to examine survey responses for each category. A study of the returned questionnaire showed that many firms had multiple activities and no clear cut distinctions could be made among the categories. Accordingly, firms were grouped into two major sectors:

- Manufacturing
- Service

The survey responses by sector are shown in Table 3.2.

Table 3.2

NUMBER OF FIRMS SURVEYED THAT
REPORTED APCI ACTIVITY

Sector	Number of Firms Responding: Mail Questionnaire	Number of Firms Responding: Telephone Questionnaire	Total
Manufacturing	56	47	103
Service	41	13	54
Total APCI	97	60	157

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982.

CHAPTER 4

AN ECONOMIC PROFILE OF THE AIR POLLUTION CONTROL INDUSTRY

In this chapter the results from the survey are analyzed and used to prepare economic profiles of the California Air Pollution Control Industry. The profile developed is a condensation of critical characteristics of the industry's basic economic structure. Also, the profile provides a quantitative assessment of the California Air Pollution Control Industry.

In evaluating the APCI profile, two factors should be considered. First, the developed profiles reflect the manner in which the California APCI was defined. Thus, should the APCI definitional constraints change, the resulting economic profile would be modified. Second, this study represents the first formal attempt at estimating the basic economic structure of the APCI in California.

In the following sections, a discussion of the profile characteristic selection process will be made along with the methodology used to develop quantitative estimates. Quantitative estimates of APCI firm characteristics are then provided. Finally, the California APCI is profiled.

4.1 -- PROFILE CHARACTERISTICS

From a methodological point of view, the construction of the APCI profile required two distinct processes: first, the

specific profile characteristics were selected, and, secondly, methods were developed to provide quantitative evaluation of each characteristic. These processes are discussed below.

4.1.1 -- Selection of Firm Characteristics to be Included in APCI Profile

First, the firm characteristics to be included in the APCI profile had to be selected. From a purely analytical viewpoint, the determination of what elements should be included when profiling an industry is virtually without constraint. The only consideration given is whether or not a particular variable adequately describes the economic make-up of the industry. Specifically, sales, employment, income, and purchasing information are desired when developing an economic profile. Unfortunately, the availability of this information is limited. Frequently a firm is reluctant to provide detailed information which the firm believes may reveal its cost or profit structure, but which is relevant and necessary to the profile. In addition, the sought-after information often may not be readily available to the firm and would require costly effort for the firms to obtain. Hence, the profile characteristics must be selected not only from an analytical point of view, but also with consideration to the information development costs to the firm and the sensitivity of the desired data.

The selected firm characteristics are summarized in a survey questionnaire. The questionnaire balances the researcher's

- percent of APC activity associated with California end users
- estimate of dollar value of APC sales in California
- sales inside and outside California
- allocation of sales by customer product line

- Purchases
  - allocation of major purchases by industry
  - percent of total purchases associated with sales of APC equipment or services
  - percent of capital expenditures geared to APC equipment or services for past three years
- Expectations
  - profitability of APCI over next five years

Overall, the APCI profile is comprised of five major categories: firm's business activity, employment, sales, purchases, and expectations.

4.1.2 -- Methodology for Deriving Profile Estimates

Having identified the specific set of profile characteristics to be examined, the next step was to compile the numerical values associated with each characterstic. The data sources for these computations were the results from the survey efforts. The primary survey effort, the mail survey, served as the base data source. An additional survey, the telephone survey, was conducted to determine if those firms who failed to respond to the mail survey differed, in a statistical sense, from those who returned the original questionnaire. This non-response issue is central to ensuring that a data set representative of the APCI industry was compiled.

percent of the firm's activity associated with the APCI, and, finally, the total number of firms involved. This average or aggregated method simply multiplies the average value of each variable together. The second method computes the desired estimate in a similar fashion, only on a question-by-question basis. Thus, returning to the above example, instead of using averages, this disaggregated method calculates the employment figure for each respondent separately and then sums the results to obtain the desired number.

Each of the above methods has certain advantages and disadvantages. The average method is easy to compute but is influenced by outliers because the arithmetic mean is used as the average. On the other hand, the second method is more difficult to compute, and if one component (question) of the chain is missing, the computation cannot be completed for that respondent.

A comparison of the two methods was made. Because the method using averages tended to result in over-estimates, the disaggregated method was employed in computing APCI profiles. In all cases, where the disaggregated method was employed, the response rate was large enough to assure an adequate number of complete chains.

A total of 257 firms were identified as being potential participants in the California APCI. Of the 216 firms responding to the mail or telephone surveys, 59 or 27 percent indicated that they were not part of the California APCI. In addition,

41 firms did not respond to either survey. These 41 firms were allocated as participants and non-participants in proportion to what was found to be true for responding firms. Thus, 11 firms (41 x 27%) were assumed to not be part of the California APCI, while 30 firms (41 x 73%) were considered part of the industry. Thus, for the sake of this study, the California APCI consists of an estimated 187 firms (see Table 4.1) of which 157 were identified through survey response.

4.2 -- ESTIMATES FOR PROFILE CHARACTERISTICS

From the beginning of the project, the results of the survey were meant to be reported at the highest level of disaggregation which was statistically sound. In order to determine this level, Standard Industrial Classification Codes (SIC) were used. A firm can be described in various SIC digit groups, i.e, two-digit, three-digit, four-digit, etc. As the digits increase, the level of detail regarding the firm also increases. During the course of analysis, it was discovered that the mail survey data base could only be reported at the two-digit level and still maintain statistically reliable estimates due primarily to modest sample size. This two-digit level disaggregates APCI firms into either the manufacturing sector or the service sector. Therefore, the following profile characteristics for 1980 business activity are presented for the manufacturing and service sectors as well as for the industry as a whole.

Table 4.1

ALLOCATION OF POTENTIAL APCI FIRMS
BY APCI PARTICIPATION*

Method Used to Determine APCI Participation	APCI Firms	Non-APCI Firms
Mail Survey Respondents	97	59
Telephone Survey Respondents	60	0
Allocation of firms that did not respond to any survey efforts.	30	11
Estimated Totals	187	70

*Total number of potential APCI firms equals 257

**A total of 41 firms did not respond to any survey efforts. It was assumed that these firms would have indicated either participation or non-participation within the APCI in the same proportion as firms who responded to the surveys. Under this assumption, 27 percent or 11 firms would have indicated that they were not a part of the APCI, while the remaining 30 would have indicated participation in the industry.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982.

4.2.1 -- Firms' Business Activity

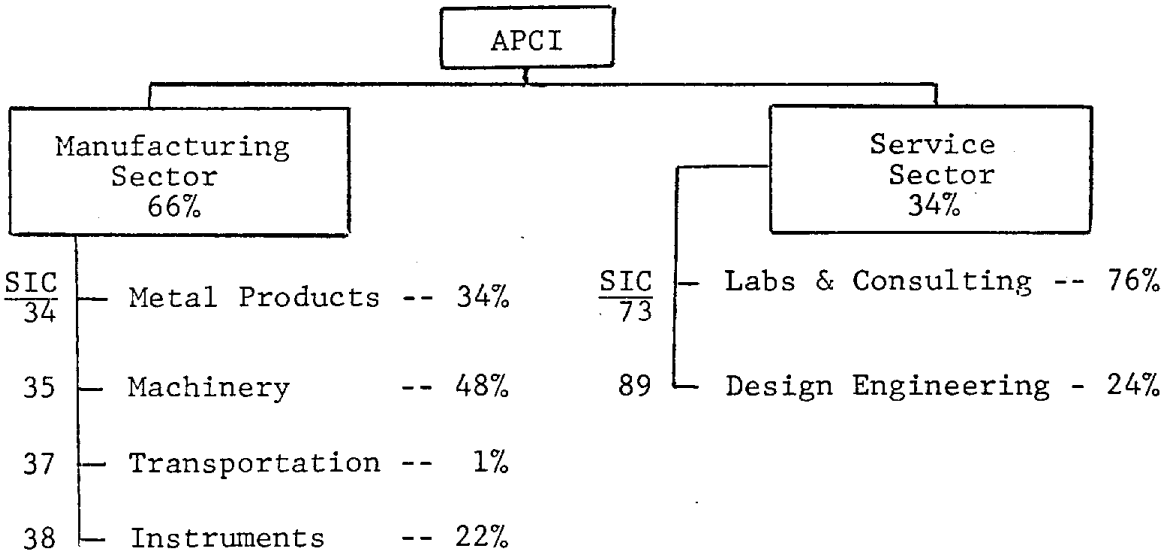
The California APCI was estimated to have 187 firms. Each of these firms supplied equipment or services to California end users. About 90 percent of these firms provided equipment or services to buyers outside the State. For the manufacturing sector, 87 percent of the APCI firms furnished goods and services to out-of-state firms, compared with 95 percent of the service sector.

The breakdown of the APCI industry by firm activity is contained in Figure 4.1. The number of manufacturing firms was almost twice that of service firms. Within the manufacturing sector, almost half of the firms fall in the machinery (SIC 35) category, while three-fourths of the service sector firms were involved in labs and consulting (SIC 73) activities.

Table 4.2 shows the general location of California APCI firms' competitors as seen from the firms' viewpoint. Not unexpectedly, the service sector viewed its competition as coming from within California, while the manufacturing sector perceived greater competition from out-of-state firms. It is interesting to note that little foreign competition is presently believed to exist. The primary competition for the manufacturing sector seemed to be located in the northeastern portions of the United States, e.g., Ohio, Pennsylvania, New York, New Jersey. On the other hand, the service sector's competitors were distributed over the U.S. with a slight edge going to the states of Texas and Massachusetts.

Figure 4.1

BREAKDOWN OF
AIR POLLUTION CONTROL INDUSTRY
BY FIRMS' BUSINESS ACTIVITY



Note: Sample size = 157 firms and percentage sums may not add to 100 percent due to multiple responses.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982, Question 2.

Table 4.2

APCI FIRMS' COMPETITORS:
IN CALIFORNIA VS. OUT OF CALIFORNIA

Sector/Industry	Percent in California	Percent Other U.S.	Percent Other Parts of World
Manufacturing	40%	58%	2%
Service	88	12	--
APCI	60	39	1

Note: Sample size = 69 firms.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982, Question 12.

A total of 18 different types of equipment or services were being produced by the APCI. Table 4.3 identifies the types of equipment or services and provides an estimate of the percentage of firms supplying the equipment or service. As the table indicates by the percentages shown, many firms provide more than one type of equipment or service. In addition, some firms engage in activities in both the manufacturing and service sectors. Table 4.3 also provides the average life of equipment based on the manufacturers' estimates.

Table 4.4 distributes the firms in the APCI by tenure in the industry. As the table indicates, the APCI is a relatively young industry. Almost three-quarters of the firms have been in the industry for 15 years or less, reflecting the increased regulatory actions which commenced in the late 1960s. In addition, the service sector appears to be somewhat younger than the manufacturing sector.

4.2.2 -- Employment

The distribution of firm size may be indicated by the number of employees. Table 4.5 shows the percentage of firms with specific employee groups. The data indicates that the majority of firms had employment of 10 or less. For the manufacturing sector, the conclusion could be misleading because the telephone survey contacted significantly larger size firms. For the reported means in the table, this bias was corrected. Unfortunately, the correction could not be applied to the distribution depicted in Table 4.5.

Table 4.3

MAJOR TYPES OF AIR POLLUTION CONTROL EQUIPMENT OR SERVICE PROVIDED BY APCI

Type of Equipment or Service	Percent of Firms*		Average Life of Equipment (Years)
	Manufacturing Sector	Service Sector	
Wet scrubbers	25%	-	17
Mechanical collectors	30	5%	16
Electrostatic precipitators	29	2	17
Fabric filters	27	-	19
Ducts, hoods, blowers, fans	20	-	15
Afterburners, incinerators	16	-	11
Flue gas treatment	9	5	20
Vapor recovery systems	9	2	14
Absorption columns, spray towers	5	-	15
Water treatment equipment	7	2	13
Tank seals, tank truck seals	12	-	14
Low NO_x burners, combustion modifications	9	5	11
Manufacturing instruments or sampling equipment	50	22	8
Maintenance and repair of control equipment	17	-	NA
Laboratory and field testing except automotive	2	44	NA
Automotive emission testing	2	5	NA
Consulting, re: engineering, control technology	12	44	NA
Consulting--policy and planning	-	88	NA

*Does not sum to 100 percent due to multiple responses.

NA = Not Applicable

Note: Sample size = 96 firms.

Source: CIC Research, Inc., "Survey of APCI Firms," 1982. Question 3.

Table 4.5

DISTRIBUTION OF FIRMS' CALIFORNIA EMPLOYEES
IN APCI ACTIVITY

Number of Employees	Manufacturing (Percent)	Service (Percent)	APCI (Percent)
0 - 10	77%	51%	66%
11 - 25	17	14	15
26 - 50	4	14	9
51 - 100	--	11	5
101 - 250	--	8	3
251 - 500	2	2	2
	100%	100%	100%
Mean	25 employees	39 employees	30 employees

Note: Sample size = 89 firms for APCI Total
Sample size = 52 firms for Manufacturing
Sample size = 37 firms for Service

Source: CIC Research, Inc., "A Survey of APCI Firs," 1982, [(Question 4 + Question 4a) x Question 4b x Question 7]

The mean number of employees in Table 4.5 is calculated by combining full-time employees with full-time equivalents of part-time employees and then adjusting for any differences from the telephone survey.* This full-time equivalent averaged not more than one full-time employee for both the manufacturing and service sector. Part-time employment averaged 11 employees for the service sector and four employees for the manufacturing sector. Approximately 75 percent of the firms' employees were based in California; this figure holds true for both the manufacturing and the service sectors.

Table 4.6 provides estimates of the total employment of firms associated with the APCI and the employment directly attributable to air pollution control activity. Firms that participate in the APCI employ approximately 53,100 individuals. Of the total 53,100 employees, 5,600 worked directly on goods and services for air pollution control activities. Of those 5,600, 3,100 employees were in the manufacturing sector, while 2,500 were associated with the service sector.

One note of caution concerning the employment figures: since the mean employee number for the manufacturing sector was adjusted to take into account the results of the telephone survey in this area and a similar adjustment could be made for the distributional relationship, the results for the manufacturing

*The mean employment figure from the mail survey equaled 14. The adjustment factor (refer to Table F.5 in Appendix F) equals 1.82. Therefore, the adjusted employment value equals 14 times 1.82, or 25. The service mean value was calculated in a similar manner, while the APCI mean figure is a weighted average of the two.

Table 4.6

ESTIMATED FULL-TIME EMPLOYMENT
IN APCI

Category	Manufacturing Sector		Service Sector		APCI
	Survey Total	Sector Total *	Survey Total	Sector Total	Industry Total
Total Employment for all firms	20,600 (215)**	26,400	20,400 (417)	26,700	53,100
APCI Employment	2,400 (25)	3,100	1,900 (39)	2,500	5,600

*In order to estimate total sector employment, the average firm employment was multiplied by the number of firms in that sector. For example, the manufacturing sector is comprised of 123 firms with an average of 25 employees. The resulting multiplication generated an estimated 3,100 employees for that sector. The service sector has an estimated 64 firms.

**Parentheses contain average employment figure per firm.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982.

sector (in a distributional sense) may be downwardly biased (see Table 4.5). This bias, however, does not affect any of the point estimates for employment.

4.2.3 -- Income

Table 4.7 presents the estimates of the personal income derived from employment directly attributable to the air pollution control activity. Using personal income per employee for the California manufacturing and service industries, the personal income derived from APCI manufacturing in 1980 is estimated to be $57 million, while the personal income from APCI services totaled $35 million for 1980. As Table 4.7 indicates, the California APCI accounted for $92 million in personal income for 1980.

4.2.4 -- Sales

Sales information is among the most sensitive data to obtain form a firm. To increase the response to sales information, the questionnaire asked for an interval sales figure only. In order to calculate the desired APCI sales figure, two additional bits of information were required. Each firm was asked to provide an estimate of the percent of the firm's total sales which was derived from APCI activity. In addition, the firm was asked to estimate the percentage of APCI activity that could be associated with California customers. From these variables, an APCI sales figure for California was estimated. At the conclusion of the sales questions on the questionnaire, each firm was asked to provide a dollar estimate of California APCI sales. This actual

Table 4.7

ESTIMATED APCI TOTAL PERSONAL INCOME - 1980

Sector	Personal Income per Employee*	Number of Employees	Estimated Total Personal Income (Millions)
Manufacturing	$18,283	3,100	$57
Service	$14,128	2,500	$35
APCI			$92

*Personal income per employee for manufacturing is calculated by dividing 1980 personal income for manufacturing by total 1980 manufacturing workers. An analogous calculation was made to derive the service sector figure.

Sources: California Statistical Abstract, 1980.
CIC Research, Inc., "A Survey of APCI Firms," 1982.

sales number should correspond to the sales estimate derived previously. A statistical comparison between the two sales variables was made and the results indicated that no significant difference existed, i.e., the answers from the two parts of the questionnaire were consistent.

The distribution of the APCI's California sales is shown in Table 4.8. In the manufacturing sector, each sales grouping is almost equally represented with almost 40 percent of the sales occurring in the $100,000 to $500,000 range. One-third of the service sector firms reported sales of $50,000 or less. For the total industry, annual sales per firm is estimated to be $756,000.

Table 4.9 contains the estimates for gross sales by California's APCI. Before reviewing these estimates one comment is in order concerning the calculations behind these numbers. First, the average sales figures for California APCI sales provided in the table are essentially derived from two variables. As mentioned above, two estimates of the firms' California APCI sales were available from the questionnaire. An average of the two sales variables was computed and used as the average sales figure for California APCI sales.* These average values are shown in Table 4.9.

As Table 4.9 indicates, the estimated gross sales of the APCI account for $2.7 billion annually when non-APCI-related goods and services are included. Of the $2.7 billion, $903 million can be directly attributable to air pollution control

*In the case of grouped sales data, i.e., Question #5., p. E.2., the average was calculated using a grouped means method.

Table 4.8

DISTRIBUTION OF APCI'S CALIFORNIA SALES

Sales Grouping (Thousands)	Manufacturing (Percent)	Service (Percent)	APCI (Percent)
Less than $50	14%	33%	22%
51 - 100	10	14	12
101 - 250	19	10	15
251 - 500	19	13	16
501 - 1,000	15	10	13
1,001 - 3,000	17	15	16
3,001 and over	6	5	6
Mean	$725,000	$815,000	$756,000

Note: Sample size = 90 firms for APCI total
Sample size = 51 firms for Manufacturing total
Sample size = 39 firms for Service total

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982, Question 5 x Question 6 x Question 7.

Table 4.9

ESTIMATED GROSS SALES BY APCI

	Manufacturing Sector		Service Sector		APCI
	Survey Total (Millions)	Sector Total (Millions)	Survey Total (Millions)	Sector Total (Millions)	Industry Total (Millions)
Total Gross Sales	$643 (12.1)*	$1,500	$ 765 (18.7)	$1,200	$2,700
Total APCI Sales	295 (5.6)	703	123 (3.1)	200	903
Total APCI Sales to California Firms	36 (.725)	90	32 (.815)	53	143
Total APCI Sales to Firms Outside California	259	613	91	147	760

*Parentheses contain average sales figure per firm.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982, Questions 5, 6, & 7.

activities. The manufacturing sector accounts for $703 million and the service sector accounts for $200 million.

The sales to California end users are estimated to be $143 million annually. The manufacturing sector sells approximately $90 million to other California firms for air pollution control. Similarly, the service sector sells $53 million annually. As Table 4.9 indicates, the manufacturing sector exports a larger percentage of its products than does the service sector, i.e., 87 percent and 74 percent, respectively. In this sense, the California APCI is a basic or export industry. Basic industries as defined here, produce goods locally, e.g., California, and market them primarily outside the state. Basic industries, as a whole, provide a primary source of payment for other goods and materials that are not produced in the local economy.

An interesting relationship between the size of a firm and the firm's air pollution control sales emerged when reviewing the distribution of these sales variables. For the most part, the proportion of the firm's total sales which are generated by air pollution control activity is inversely related to the size of the firm. Thus, the smaller the APCI firm, the larger the proportion of the firm's sales that can be attributed to air pollution control activity. In addition, the majority of APCI firms either obtain less than 25 percent or more than 75 percent of their total sales from air pollution control activity.

Table 4.10 illustrates how the APCI sales were distributed to customer product lines. The manufacturing sector had sales in 20 different product lines, while the service sector sold to 18 lines. Only major customer product lines are shown in Table 4.10. Almost 60 percent of the California APCI manufacturing sales were made to the petroleum refining and oil and gas extraction customers in California. When the manufacturing sector sold its products outside California, the bulk of these sales, i.e., 83 percent, were made to utilities and oil and gas extraction customers. For the service sector, the major customer both in and outside California appears to be the public sector.

It was recognized that an independent estimate of sales to the public sector might be developed from published information on expenditures by government agencies. This estimate could then be used as a check on the survey results. To this end, the published budgets of the Environmental Protection Agency, the National Institute of Health, the Department of Energy, the California Air Resources Board and the Energy Commission were examined to identify extramural expenditures for air pollution and for Federal agencies to determine the proportion of these funds that went to California firms. This proved to be an impossible task since air pollution expenditures were not specifically identified and breakdowns by state were not provided in the published summaries. The most useful information was gleaned from material obtained from the U.S. Small Business Administration's Innovation Research Program. The Small Business Innovation Act of 1982 requires that

Table 4.10

DISTRIBUTION OF APCI SALES BY MAJOR CUSTOMER'S PRODUCT LINE*

		Manufacturing -- APCI Sales** (Percent)		Service -- APCI Sales*** (Percent)	
SIC	Customer Product Line	Inside Calif.	Outside Calif.	Inside Calif.	Outside Calif.
13	Oil & Gas Extraction	17%	20%	14%	8%
28	Chemicals	7	2	3	16
29	Petroleum Refining	42	--	4	4
49	Utilities	8	63	22	5
90	Public Administration	6	2	39	51
99	Nonclassifiable	2	2	8	10

*Columns sum to 100 if all product lines included.

**Represents 40 manufacturing firms which responded to these questions in CIC's survey of APCI firms.

***Represents 25 service firms which responded to these questions in CIC's survey of APCI firms.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982. Questions 3, 5, 6, and 7.

Federal agencies with annual extramural research and development budgets in excess of $100 million set aside a certain percentage of the total for awards to small businesses. The various agency representatives who have the responsibility for administering the Innovation Research Program also have information on the total extramural research and development expenditures by each agency which they provide informally to small businesses such as CIC. Although it was not possible to obtain information by state and by subject area, a number of interesting facts emerged.

1. The extramural budget for NIH (which includes the National Heart and Lung Institute) is approximately $2.9 billion annually. If we allocate by population (refer to Chapter 2), we could estimate that $290 million goes to California. Almost all of these funds are allocated to universities and non-profit medical institutions. None of these grantees would be considered members of the APCI. In addition, an extremely small portion of the total agency budget is spent on air pollution research. It is evident that sales to NIH by the California APCI are negligible.

2. The extramural budget for DOE is approximately $2.4 billion annually. Since the agency funds high-technology research, California might get a larger share than would be indicated by an allocation based on population. DOE does not fund research in air pollution per se, and does not classify its technical research areas in a manner that will allow the air pollution component to be separated. It is likely that some sales are made by the California APCI to DOE but it is not possible to estimate the amount.

3. The extramural budget for EPA for 1981/82 was approximately $110 million and covered air, water, and hazardous wastes. A breakdown by type of pollution, and state was not available. Since California is a center of expertise in air pollution, it is likely that a disproportionately larger share of the funds were used to purchase services from California firms. If it is assumed that California receives twice the proportional

allocation (20%) and that 60 percent of the budget is spent on air pollution, we can estimate that EPA purchases from California firms are about $13.2 million. Some of these purchases are made from universities that are not included in the APCI, but is is believed that the majority of the purchases are made from consulting firms that are included in the APCI

Research and Development budgets from the Department of Transportation, the National Aeronautics and Space Administration, the U.S. Department of Agriculture, the National Science Foundation, and the Department of Defense were examined, but no identifiable air pollution components were discovered. Within the State of California, the Energy Commission has an extramural research budget that includes about $40,000 annually for research on biomass conversion and alcohol fuels. These funds are spent almost entirely within California but none of the work is directly related to compliance with air pollution control regulations for stationary sources. The CARB extramural research budget is about $5.4 million annually with approximately 25 percent of the funds going to non-university and non-government agencies. Most of the funds are spent in California. Therefore, APCI sales to the CARB can be estimated at about $1.35 million or perhaps a little more because some purchases are made from funds other than the extramural research budget.

If the APCI sales to Public Administration (from Table 4.10) are transformed to dollars by using information from Table 4.9, the following values are obtained:

Sales by Manufacturing APCI to California Public Administration:	$2.16 million
Sales by Manufacturing to Public Administration outside California:	$5.18 million

Sales by Service APCI to California Public Administration:	$12.4 million
Sales by Service APCI to Public Administration outside California:	$46.4 million

The survey respondents did not specify the particular government agencies that purchased their services except that they occasionally mentioned EPA and two respondents mentioned ARB. Usually they merely said "government." The sales to Public Administration by the manufacturing sector of the APCI probably represent equipment purchases by government agencies for their own use, and if this assumption is correct, these items would not be included in the extramural research budgets that were discussed above. The analysis of extramural budgets, therefore, does not provide any information to check the accuracy of the survey. The sales to Public Administration in California by the service sector of the APCI should include the CARB extramural research funds of about $1.35 million as well as unidentified additional amounts from other state and local agencies. The estimate of $12.4 million based on survey results is not unreasonable, but it is not possible to estimate its accuracy using the available data. The sales to Public Administration outside of California by the service sector of the APCI should include the EPA extramural research funds of about $13 million plus unidentified additional amounts from DOE and possibly from the military and other government agencies. The survey estimate of $46.4 million is not unreasonable but its accuracy cannot be evaluated.

4.2.5 -- Purchases

In order to develop a measure of the total economic impact of the APCI, both direct and indirect effects must be identified and measured. While the purpose of this study is limited to estimating the direct effects of APCI activity, the indirect effects cannot be entirely ignored. A valuable technique used to measure the indirect impacts in economic analysis is called Input-Output Modeling (refer to Appendix G for a more detailed discussion of I-O modeling). An important element in the I-O process is to quantify the purchasing activity of, in this case, the APCI firms. This purchasing information identifies those industries which are impacted by the APCI's activity. For example, APCI firms will be required to purchase additional materials, causing expansion by other firms as the industry expands. This chain of events, then filters throughout the economy. Hence, a look at purchasing activity of APCI firms provides insight in to the existence and magnitude of these indirect effects.

Unfortunately, information available from the survey does not allow for an independent dollar estimate of purchases. Instead, the presentation of the purchasing activities of the APCI will be summarized in percent terms. It is possible to derive a dollar estimate of the APCI purchases by exploiting the relationship between sales and purchases. A comparison of the percent of a firm's total purchases required for APCI activity and the percent of a firm's total sales derived from APCI activity were, in

the aggregate, very similar. For example, in the manufacturing sector, on the average, 62 percent of the firm's total purchases or total sales are associated with APCI activity. Thus, if required, a purchase dollar figure could be derived by exploiting the above relationship.

Table 4.11 provides an idea of what industries supply goods and services to the California APCI. Although the sample sizes are somewhat modest, Table 4.11 shows purchase information from both California firms and from all firms combined. For example, the California APCI service sector purchases 69 percent of its inputs from California measuring instrument firms.

Another area of interest when reviewing purchases is capital expenditure activity by the firm. During the years 1978, 1979, and 1980, capital expenditures within the APCI remained relatively constant. In the California APCI manufacturing sector, approximately 45 to 50 percent of an "average" firm's capital expenditure was directed at APCI activities. A slight increase in 1979 expenditures was observed in an analysis of the median values for this variable. About 35 percent of an "average" firm's capital expenditure was directed at APCI activities in the service sector. However, analysis of the medians revealed a slight increase in expenditures for 1980.

Table 4.12 summarizes these results and shows the three-year average for APC equipment capital expenditure as a percent of total capital expenditures. The aggregated distribution

Table 4.11

DISTRIBUTION OF APCI PURCHASES
BY SELECTED INDUSTRY*

Industry	SIC	Purchases From California Firms: Manufacturing** (Percent)	Purchases From California Firms: Service*** (Percent)
Fabricated Metals	34	26%	4%
Electrical Machinery	36	9	9
Measuring Instruments	38	2	69
Air Transportation	45	3	2
Nonclassifiable	99	30	4

Industry	SIC	Total Purchases From All Firms: Manufacturing** (Percent)	Total Purchases From All Firms: Service*** (Percent)
Fabricated Metals	34	34%	3%
Electrical Machinery	36	5	8
Measuring Instruments	38	1	64
Air Transportation	45	27	6
Nonclassifiable	99	9	7

*Columns would sum to 100% if all industries were included.

**28 manufacturing firms responded to this question in CIC's survey of APCI firms.

***18 service firms responded to this question in CIC's survey of APCI firms.

Source: CIC Research, Inc., "A Survey of APCI firms," 1982. Question 9.

Table 4.12

AVERAGE APC EQUIPMENT CAPITAL EXPENDITURE AS A PERCENT OF TOTAL CAPITAL EXPENDITURES*

Capital Expenditure Percent Category	Manufacturing Sector (Percent)	Service Sector (Percent)
	[40] **	[26] **
0 - 10%	25%	46%
11 - 20	18	8
21 - 30	8	12
31 - 50	12	4
51 - over	38	31
	101%***	101%***
Mean	48%	35%

* = Average computed using 1978, 1979, 1980 information.

** [ ] = Number of firms responding to this question.

*** Rounding error.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982, Question 13.

closely resembles a given year's distribution. It should be noted that larger firms tend to invest a small percentage of their total capital expenditures in the APCI activity because it is a relatively small percentage of their total business activity.

4.2.6 -- Expectations

Firms in the APCI did not expect to lose money over the next five years. Almost 80 percent of these firms in both the manufacturing and service sectors expected to realize a positive level of profit. Table 4.13 shows the breakdown by sector of the firms' profitability expectations.

There was one exception to the above pattern that deserves special mention. Envirotech Corporation of Menlo Park, a company with $200 million in sales of air quality control equipment in 1980, responded to the survey by saying that they were discontinuing their APCI activities. No explanation was given, but published information (annual report) indicated that this portion of the overall company business was operating at a loss.

4.2.7 -- Secondary Assessment of APCI's Financial Condition

Results from the APCI firm survey provided a brief indication of the industry's financial condition and outlook. Basically, the outcome of the survey revealed that the industry was in the midst of a cautious business environment. Respondents' attitudes concerning capital expenditures and expected profitability provided the basis for this conclusion.

Table 4.13

EXPECTATION OF PROFITABILITY OF APCI
OVER NEXT FIVE YEARS

Profitability Category	Manufacturing (Percent)	Service (Percent)
Very Profitable	15%	8%
Somewhat Profitable	68	70
Breakeven	13	16
Modest Losses	2	5
Significant Losses	2	0
	100%	99%*

*Rounding error.

Source: CIC Research, Inc., "A Survey of APCI Firms," 1982, Question 14.

In order to obtain sufficient information which would allow the appraisal of the industry's financial condition in terms of cyclicability, growth, and health, additional information sources must be uncovered. Unfortunately, information directly related to the California APCI and its financial make-up cannot be directly determined from published sources. For example, annual reports were collected for over 30 potential APCI firms during the course of the study. The APCI segment of the firm's activity could not be identified explicitly. The APCI activity was intermingled with the other activities of the firms, making it impossible to directly assess the cyclicability and growth of the APCI segment. In addition, in most cases where annual reports and other published information were available, the proportion of the firm's activity that could be associated with APCI was relatively small.

However, there is some information that sheds light on the APCI's growth and cyclicability. The Council on Environmental Quality has indicated that pollution control expenditures as a percentage of gross national product steadily increased from 1.6 percent in 1972, to over 2.0 percent in 1976.* Since air pollution control is a substantial portion of total pollution control, its share might have grown in a similar fashion. The A.D. Little study supports this argument by indicating that the overall growth rates associated with the air pollution control equipment business was in the order of 8 - 10 percent per year,

*Council on Environmental Quality, Environmental Quality, December 1978.

as of 1978.* The implication could be that the industry is steadily growing at the national level.

Alternative information indicates that the growth and stability implied for the APCI may not be justified. Based on industrial Gas Cleaning Institute data, Robert W. McIlvaine presents particulate control orders from 1971 to 1981.** Figure 4.2 graphically illustrates what happens to an index of these orders using 1971 as a base year. As the figure indicates, there have been substantial changes in particulate control orders over time. If the APCI in California follows this trend, it could not be considered a stable, steadily growing industry. Instead, it would appear that the industry responds to overall economic conditions rather dramatically.

4.3 -- A SUMMARY OF THE AIR POLLUTION CONTROL INDUSTRY PROFILE

The basic structure of the California APCI may be shown in a condensed format. As Table 4.14 indicates, the APCI is composed of essentially two type of firms -- manufacturing and services. Together, these firms supplied an estimated 18 different types of equipment or services. While the majority of the firms competed with other California firms, there still remained a significant amount of competition from the rest of the country.

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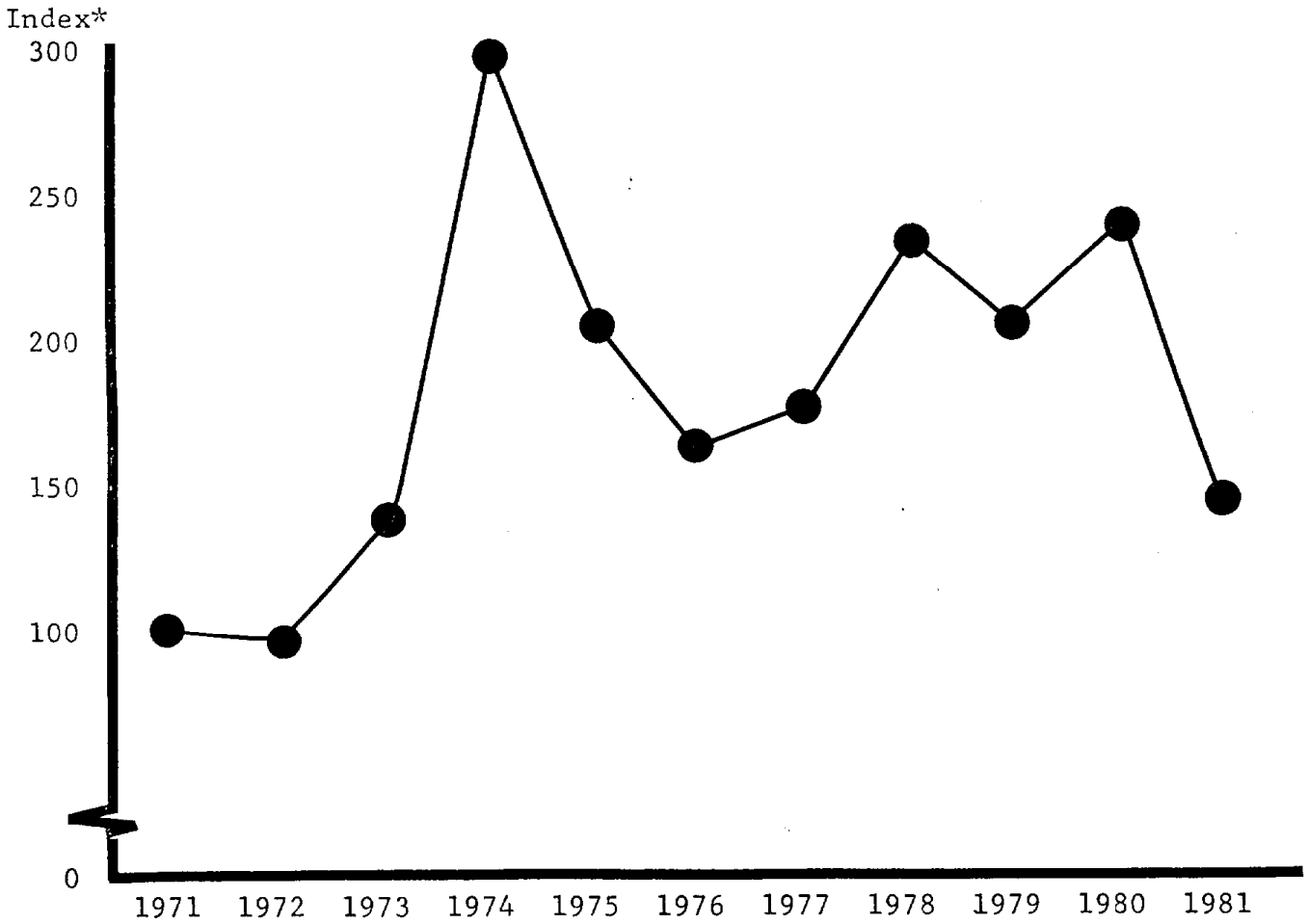
*A.D. Little, "The Economic Effects of Environmental Regulations on the Pollution Control Industry." a final report to the Environmental Protection Agency, September 1978.

**Robert W. McIlvaine, "Market Trends for Air Pollution Control Equipment," Journal of the Air Pollution Control Association, March 1983.

Figure 4.2
INDEX OF PARTICULATE CONTROL ORDERS
FROM 1971 - 1981**



* Base Year: 1971

** Particulate control orders include electrostatic precipitators, fabric filters, mechanical scrubbers and wet scrubbers.

Source: Robert W. McIlvaine, "Market Trends for Air Pollution Control Equipment," Journal of the Air Pollution Control Association, March 1983.

CIC Research, Inc.

Table 4.14

APCI PROFILE - THE INDUSTRY

Profile Characteristic	Estimate of Profile Characteristic
Industry's Business Activity	
• One digit SIC code	• 3 - Manufacturing 7 & 8 Service
• Equipment & services	• 18 different products
• General location of competitors	• 60 percent in California 39 percent in remainder of U.S.
• Length of time in APCI	• 15 years
Employment	
• Total APCI employment	• 5,600 employees
- Manufacturing sector	- 3,100 employees
- Service sector	- 2,500 employees
Sales	
• Total APCI sales	• $903 million
- Manufacturing sector	- $703 million
- Service sector	- $200 million
• Total California APCI sales	• $143 million
- Manufacturing sector	- $ 90 million
- Service sector	- $ 53 million

(continued)

Table 4.14 (cont'd)

Profile Characteristic	Estimate of Profile Characteristic
Sales (cont'd)	
• Major customers	• Oil & gas extraction (SIC 13) Petroleum refining (SIC 29) Utilities (SIC 49) Public administration (SIC 90)
Purchases	
• Major purchases from:	• Fabricated metals (SIC 34) Measuring instruments (SIC 38)
• APC capital expenditure	• 40 percent of total capital expenditure
Expectations	
• Profitability over next five years	• Somewhat profitable

Source: CIC Research, Inc., "A Survey of APCI Firms", 1982.

Competition from the rest of the world was insignificant. Firms in the industry have been around an average of 15 years.

Total APCI employment was estimated to be 5,600 employees. The majority, 3,100, were employed by the manufacturing sector; the remainder, 2,500, were employed by the service sector. Sales generated by the APC industry were estimated at $903 million, with $143 million being sold to California end-users. The manufacturing sector produced and sold $703 million worth of equipment and services, with $90 million going to California end users. Of the remaining $200 million in sales for the service sector, $53 million went to California end users. The major customers in the industry are oil and gas extraction firms, petroleum refining (mostly in-State sales), utilities, and public administration. Most of the major purchases by the industry are from fabricated metal firms and measuring instrument producers. Of the APCI firms' total capital expenditures, approximately 40 percent were directed to air pollution control activities. The outlook for the industry is expected to be somewhat profitable.

In order to illustrate the basic structure of the industry, separate profiles were developed for both the manufacturing and the service sectors. These profiles are presented in Table 4.15 and 4.16, respectively. The word "typical" is used only as a means of presenting the profile results in a descriptive fashion and should not be related to the "representative" firm (i.e., using the behavior of one firm which exhibits industry-wide characteristics to model the industry) employed in the economic literature.

Table 4.15

APCI PROFILE - A TYPICAL MANUFACTURING FIRM

Profile Characteristic	Estimate of Profile Characteristic
Firm's Business Activity	
• SIC code	• 35 - Machinery, except electrical
• Major equipment provided	• Manufacturing instruments or sampling equipment
• General location of competitors	• Throughout United States
• Length of time firm in APCI	• 16 years
Employment	
• Number of employees in APCI activity	• 25 employees
Sales	
• Average APCI sales	• $5.6 million
• Average APCI sales in California	• $725,000
• Major customer	• Petroleum refining (inside California) Utilities (outside California)
Purchases	
• Major purchase from:	• Fabricated metals (SIC 34)
• APC capital expenditures	• 48 percent of total capital expenditure
Expectation	
• Profitability	• Somewhat profitable

Source: CIC Research, Inc., "A Survey of APCI Firms", 1982.

Table 4.16

APCI PROFILE - A TYPICAL SERVICE SECTOR FIRM

Profile Characteristic	Estimate of Profile Characteristic
Firm's Business Activity	
• SIC code	• 73 - Business services, labs & consulting
• Major service provided	• Consulting - policy & planning
• General location of competitors	• Mostly in California
• Length of time firm in APCI	• 13 years
Employment	
• Number of employers in APCI activity	• 39 employees
Sales	
• Average APCI sales	• $3.1 Million
• Average APCI sales in California	• $815,000
• Major customer	• Public administration
Purchases	
• Major purchase from	• Measuring instruments (SIC 38)
• APC capital expenditures	• 35 percent of total capital expenditure
Expectations	
• Profitability	• Somewhat profitable

Source: CIC Research, Inc., "A Survey of APCI Firms", 1982.

The manufacturing sector's typical firm (see Table 4.15) was classified in the machinery group and manufactures instruments or sampling equipment. The firm competed with other firms throughout the United States and the firm has been in the APCI for about 16 years. Twenty-five people were employed by the typical firm for its APCI activities. The firm's total APCI sales were $5.6 million of which $725,000 was sold to California end-users. Petroleum refining firms were its major California customer while utilities were its major out-of-state customer. Major purchases were made from the fabricated retail industry, with 48 percent of its capital expenditure budget going to APCI activities. The typical firm expected the future to be somewhat profitable.

On the other hand, the service sector's typical firm (see Table 4.16) was classified in the labs and consulting group, and provided policy and planning consulting. Most of the firm's competition came from within California. This service firm has been in the industry for 13 years. A total of 39 people were employed by the firm for its APCI activities. The firm's total APCI sales were $3.1 million, of which $815,000 was sold to California end-users. Public administration is its major customer. Major purchases were made from measuring instrument firms, with 35 percent of its capital expenditure budget going to APCI activities. The firm expected the future to be somewhat profitable.