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Economic Impact of Implementing RACT Guidelines in the Non-Attainment Areas for Ozone in South Carolina

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FINAL REPORT

ECONOMIC IMPACT OF IMPLEMENTING RACT GUIDELINES IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

Task Order Number 6 Under:
Basic Ordering Agreement Number 68-02-2544

RESEARCH AND DEVELOPMENT SERVICES FOR ASSISTANCE TO STATES AND EPA CARRYING OUT REQUIREMENTS OF CLEAN AIR ACT AND APPLICABLE FEDERAL AND STATE REGULATIONS

Prepared for:

EPA

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From:

BOOZ, ALLEN & HAMILTON Inc.

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BOOZ ALLEN

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1. EXECUTIVE SUMMARY

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This chapter summarizes the major elements and most significant findings of the study to determine the economic impact of implementing Reasonably Available Control Technology (RACT) guidelines for volatile organic compounds for eight industrial categories in the nonattainment areas for ozone of South Carolina. Further discussion and data are presented in detail in the subsequent chapters of the report. This Executive Summary is divided into three sections:

- Objectives, Scope and Approach
- Nonattainment Area Aggregate Economic Impact for the eight RACT Guidelines
- Economic Implications of Each RACT Guideline.

1.1 OBJECTIVES, SCOPE AND APPROACH

1.1 OBJECTIVES, SCOPE AND APPROACH

The Clean Air Act Amendments of 1977 required the states to revise their State Implementation Plans (SIPs) to provide for the attainment and maintenance of national ambient air quality standards in areas designated as nonattainment. The Amendments require that each state submit the SIP revisions to the U.S. Environmental Protection Agency (EPA) by January 1, 1979. These proposed regulations should contain an oxidant plan submission for major urban areas to reflect the application of Reasonably Available Control Technology (RACT) to stationary sources for which the EPA has published guidelines. The Amendments also require that the states identify and analyze the air quality, health, welfare, economic, energy and social effects of the plan provisions.

1.1.1 Objectives

The major objective of the contract effort was to assist the states in the determination of the direct economic impact of selected segments of their SIPs for six states (Alabama, Georgia, Kentucky, North Carolina, South Carolina and Tennessee) of Region IV of the U.S. Environmental Protection Agency. These economic studies plus other studies will be used primarily to assist EPA and state decisions on achieving emission limitations.

1.1.2 Scope

The scope of this project for South Carolina was to determine the costs and direct impacts of control to achieve RACT guideline limitations in eight industrial categories. The impact was addressed for each industry category in the nonattainment counties for ozone so that the respective studies are applicable to individual regulations. Direct economic costs and benefits from the implementation of the RACT guidelines were identified and quantified. While secondary (energy, employment, etc.) impacts were addressed, they were not a major emphasis in the study. In summary, direct economic impact analysis of each industrial category was aggregated on an area (nonattainment counties for ozone) basis for the RACT categories studied.

In the five counties designated as nonattainment for ozone in South Carolina, the economic impact was analyzed for the implementation of RACT guidelines for the following eight industry categories:

- Surface coating of paper
- Surface coating of fabrics
- Solvent metal cleaning
- Bulk gasoline terminals
- Bulk gasoline plants
- Storage of petroleum liquids in fixed roof tanks
- Service stations--Stage I
- Use of cutback asphalt.

The major study guidelines in the determination of the economic impact of the RACT guidelines are discussed below.

- The emission limitations for each industrial category was studied at the emission level established by the RACT guidelines. These are presented in Exhibit 1-1, on the following page.

- Emissions sources included were the use of cutback asphalt and existing stationary point sources in the applicable industrial categories in the nonattainment areas for ozone with the following guidelines:

    - Surface coating of paper and fabrics with potential VOC emissions of:

        - 10 tons or more in the four urban nonattainment counties (Richland, Lexington, Berkeley and Charleston)

        - 100 tons or more in York county.

    - Bulk gasoline plants were studied for the four urban counties only, since emissions from bulk plants do not exceed 100 tons per year.

    - Bulk terminals were studied for the four urban counties only, since no bulk terminals had been identified in York county.

      Service stations were studied for the four urban counties only, because their emissions do not exceed 100 tons per year. Service stations with less than 2,000 gallon tank capacity will be exempt from the regulation.

Exhibit 1-1(1)

U.S. Environmental Protection Agency
LISTING OF EMISSION LIMITATIONS THAT
REPRESENT THE PRESUMPTIVE NORM TO BE
ACHIEVED THROUGH APPLICATION OF RACT
FOR SPECIFIC INDUSTRY CATEGORIES

Category	RACT Guideline Emission Limitations[a] Surface Coating Categories Based on Low Organic Solvents (lbs. solvent per gallon of coating, minus water)
Surface coating of:	
Paper	2.9
Fabrics and vinyl coating	
. Fabric	2.9
. Vinyl	3.8
Solvent metal cleaning	
. Cold cleaning	Provide cleaners with: cover; facility to drain clean parts; additional freeboard; chiller or carbon absorber. Follow suggested procedures to minimize carryouts.
. Conveyorized degreaser	Provide cleaners with: refrigerated chillers; or carbon adsorption system; drying tunnel or rotating basket; safety switches; covers. Follow suggested procedures to minimize carryout.
. Open top degreaser	Provide cleaner with: safety switches; powered cover; chiller; carbon absorber. Follow suggested procedures to minimize carryout.
Bulk gasoline terminals	Equipment such as vapor control system to prevent mass emissions of VOC from control equipment to exceed 80 milligrams per liter (4.7 grams per gallon) of gasoline loaded.
Bulk Gasoline Plants	Provide submerged filling and vapor balancing or equivalent control to reduce VOC emissions. Follow suggested procedures to minimize vapor losses.

Exhibit 1-1 (2)
U.S. Environmental Protection Agency

Category	RACT Guideline Emission Limitations[a]
Storage of petroleum liquids in fixed roof tanks	Provide single seal and internal floating roof to all fixed roof storage vessels with capacities greater than 150,000 liters (39,000 gal.) containing volatile petroleum liquids for which true vapor pressure is greater than 10.5 kilo pascals (1.52 psia)
Service stations (Stage I)	Provide submerged fill and vapor balance for any stationary storage tank located at a gasoline dispensing facility.
Use of cutback asphalt	The manufacture, mixing, storage, use or application may be approved where: long-life stockpile storage is necessary; the use or application at an ambient temperature less than $10^{\circ}C$ ($50^{\circ}F$) is necessary; or it is to be used solely as a penetrating prime coat

[a] Annotated description of RACT guidelines.

Source: Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, U.S. Environmental Protection Agency, EPA-90512-78-001, April 1978.

- Solvent metal cleaning was studied for the four urban counties only, assuming that no solvent metal cleaners with over 100 tons VOC emissions exist in York County.

- The use of cutback asphalt was studied for the 5 nonattainment counties.

. The following five volatile organic compounds were exempted:

  - Methane
  - Ethane
  - Trichlorotrifluorethane (Freon 113)
  - 1,1,1-trichloroethane (methyl chloroform).[1]

. The timing requirement for implementation of controls to meet RACT emission limitations was May 1, 1981.

. All cost figures are presented for a base year, 1977.

. Capital cost figures represent installed equipment cost including:

  - Engineering
  - Design
  - Materials
  - Equipment
  - Construction.

  The capital cost estimates do not account for costs such as:

  - Clean-up of equipment
  - Lost sales during equipment downtime
  - Equipment start-up and testing
  - Initial provisions (spare parts).

. Capital-related annual costs are estimated at 25 percent of the total capital cost per year (unless explicitly stated otherwise). The estimating procedure applied was built up from the following factors:

  - Depreciation--assuming straight-line over a ten-year life

  - Interest--10 percent

  - Taxes and insurance--4 percent

  - Maintenance--5 percent.

1 The exempt status of methyl chloroform under these guidelines may be subject to change.

The capital-related annual costs do not account for investment costs in terms of return or investment parameters (i.e., the "opportunity cost" of money is not included).

- Annual operating costs of compliance with the RACT guidelines were estimated for each of the control alternatives studied. The annual operating costs included were:

  - Direct labor
  - Raw material costs (or savings)
  - Energy
  - Product recovery cost (or savings)
  - Maintenance.

  Other types of costs, not included in this analysis, involve compliance costs, such as:

  - Demonstration of control equipment efficiency

  - Supervisory or management time

  - Cost of labor or downtime during installation and startup.

- The annualized cost is the total of direct operating costs (including product or raw material recovery) and the capital related annual costs.

- The costs of meeting the emission limitations presented within this report represent application of control techniques on a process-by-process basis. This analysis does not account for the "Alternative Emission Reduction (Bubble) Approach" recently presented by the EPA to the states for consideration in the development of State Implementation Plans.

  Under the "bubble" concept, facilities may reduce the economic burden by applying more cost-effective mixes of control techniques rather than by applying the process-by-process emission control technologies studied, as long as total environmental benefits are not reduced. To the extent that affected facilities in South Carolina with multiple process-related emission sources can apply these alternative abatement strategies and achieve the same emission reduction for less cost, the economic impact presented in this report is overstated.

1.1.3 Approach

The approach applied to the overall study was: a study team with technology and economic backgrounds utilized available secondary sources to estimate the emissions, statistics and costs for each RACT industrial category; then, the study team completed, calibrated and refined these estimates based on interviews with industry representatives in the state.

Because of the number of point sources and the data available in the state emission inventory, the methodology was specific for each RACT industrial category studied. However, the general methodology applied for two major classes of industrial categories was:

- Surface coating RACT industrial categories (fabrics and paper)--The potentially affected facilities and emissions were obtained primarily from the South Carolina Department of Health and Environmental Control and interviews. Therefore, the following general methodology was applied:

  - A list of potentially affected facilities was compiled by Booz, Allen from secondary reference sources.

  - Data from the South Carolina emission inventory were categorized and compiled for each RACT industrial category by the South Carolina Department of Health and Environmental Control.

  - Firms not listed in the emission inventory were identified. All of these facilities were then interviewed by the South Carolina Department of Health and Environmental Control when there was doubt concerning their inclusion.

  - Emissions, emission characteristics, control options and control costs were studied for relevant firms.

  - Interviews were conducted by Booz, Allen to determine emissions (when not available), applicable control options and potential control costs.

  - The study team then evaluated the control cost to meet the RACT requirements and the potential emission reduction.

Nonsurface coating RACT industrial categories (bulk gasoline plants, bulk gasoline terminals, cutback asphalt, service stations, fixed roof tanks and solvent metal cleaning)--Each category either represented an exhaustive list of potentially affected facilities or emissions data were not available (or categorized) for these types of sources. Therefore, the following generalized methodology was applied:

- Industry statistical data were collected from secondary reference sources.
- The South Carolina Department of Health and Environmental Control identified facilities which would be affected by the proposed regulation for bulk gasoline plants, terminals and fixed roof tanks.
- Emissions were estimated by applying relevant factors (e.g., emissions per facility or throughput) which have been determined by the EPA.
- Control options and estimated costs to meet the RACT guidelines were reviewed.
- Interviews were conducted to determine applicable associated control options and the cost of control.

1.1.4 Quality of Estimates

The quality of the estimates that are presented in this report can be judged by evaluating the basis for estimates of the individual study components. In each of the chapters that deal with the development of estimated compliance cost, the sources of information are fully documented.

In the determination of the economic impact for each industrial category studied, the estimated compliance cost is subject to variations due to inherent variations in procedures for estimating:

- Engineering costs
- The number of sources affected.

Engineering cost estimates, when performed for an individual modification with specific equipment sized at the desired capacity, are typically subject to variations of 25 percent. When engineering cost estimates are performed on technologies not commercially proven for a specific facility, the variations are much greater, many times over 100 percent.

Many of the RACT categories studied (such as solvent metal cleaning) represent an exhaustive list of potentially affected facilities that have not been previously identified or categorized. Therefore, the actual number of facilities affected by a given RACT industrial category had to be estimated from available data sources.

If a study with unlimited resources were performed, to estimate the specific cost to each individual facility affected within the state, the study would be subject to a 25 percent to 50 percent variation because of the inherent variability of engineering estimates and the uncertainty involved in the selection and demonstrated capabilities of the control alternatives. Furthermore, a study of this type would take years to perform.

Therefore, to put a perspective on the estimates presented in this report, the study team has categorically ranked by qualitative judgment the overall data quality of the major sources and, therefore, of the outcomes. These data quality estimates were ranked into three categories:

- "Hard data"--study inputs with variation of not more than $\pm$ 25 percent.
- "Extrapolated data"--study inputs with variation of $\pm$ 25 to $\pm$ 75 percent.
- "Rough data"--study inputs with variations of $\pm$ 50 to $\pm$ 150 percent.

Each of these data quality estimates is presented in the individual chapters. The overall ranking of the study inputs for each RACT industrial category was generally in the extrapolated data quality range.

1.2 NON-ATTAINMENT AREA AGGREGATE ECONOMIC IMPACT FOR THE EIGHT RACT GUIDELINES

1.2 STATEWIDE AGGREGATE ECONOMIC IMPACT FOR THE EIGHT RACT GUIDELINES

The implementation of RACT emission limitations for eight industrial categories in the five counties designated non-attainment for ozone in South Carolina involves an estimated $11.2 million capital cost and $2.1 million annualized cost per year. The net VOC emission reduction is estimated to be 7,146 tons annually from a 1977 baseline of 10,858 tons. Exhibit 1-2, on the following page, presents a quantitative summary of the emissions, estimated cost of control, cost indicators and cost effectiveness of implementing RACT guidelines for eight industrial categories.

- Approximately 1,500 facilities are potentially affected by the eight RACT guidelines in the nonattainment counties of South Carolina.
  - Ninety-four percent of the potentially affected facilities are represented by the solvent metal cleaning (700 facilities) and service station (700 facilities) industrial categories.
  - Less than 1 percent (5 facilities) of the potentially affected facilities are represented by the two surface coating industrial categories (paper and fabrics).
- In 1977, the estimated annual VOC emissions (including those already controlled) for the eight RACT industrial categories totalled approximately 10,858 tons.
  - Two surface coating categories represented 42 percent of the total VOC emissions.
  - Four gas marketing categories (tank truck loading terminals, bulk gas plants, fixed roof tanks and service stations) represented 40 percent of the total VOC emissions.
  - Solvent metal cleaning represented 12 percent of the total VOC emissions (from the eight RACT categories studied)
  - Use of cutback asphalt represented 6 percent of the total VOC emissions.

EXHIBIT 1-2
U.S. Environmental Protection Agency
SUMMARY OF IMPACT OF IMPLEMENTING RACT
GUIDELINES IN EIGHT INDUSTRIAL CATEGORIES -- SOUTH CAROLINA
(FIVE COUNTY AREA)

Industry Category	Emissions: Number of Facilities Potentially Affected	Emissions: 1977 VOC Emissions (tons/yr.)	Emissions: Estimated VOC Emissions After Implementing RACT (tons/yr.)	Emissions: Net VOC Emission Reductions (tons/yr.)	Cost of RACT Control: Capital Cost[a] ($ million)	Cost of RACT Control: Annualized Cost (credit) ($ million)	Cost Indicators: Annualized Cost as Percent of Value of Shipments[b] (percent)	Cost Indicators: Annualized Cost Per Unit Shipment (cost per unit)	Cost Effectiveness: Annualized Cost (credit) Per Ton of VOC Reduction ($ per tons/yr.)
Surface coating of paper	3	4,240	1,520	2,720	6.0	1.2	3.0	-	450
Surface coating of fabrics	2	260	50	210	0.9	0.25	3.5	-	1,150
Solvent metal cleaning	700	1,320	980	340	0.23	0.03	<0.01	NA	87
Tank truck gasoline loading terminals	5	872	87	785	1.4	0.10	0.09	$ 0.001/gal.	48
Bulk gasoline plants	40	676	178	498	0.55	0.15	0.7	0.003/gal.	297
Storage of petroleum liquids in fixed roof tanks	44	1,425	142	1,283	1.02	0.12	-	$0.001/gal.	92
Service Stations (Stage 1)	700	1,400	210	1,190	1.1	0.26	<.1	$0.001/gal.	222
Cutback Asphalt	--	665	545	120	0.02	--	--	--	--
TOTAL	1,494	10,858	3,712	7.146	11.21	2.11			

Note: Figures presented in this exhibit are rounded and approximated for comparison purposes.

a. Includes on time costs
b. Value of shipments represents the total value in the specific industry category for the industry segment being studied.

Source: Booz, Allen & Hamilton Inc.

- The net emission reduction achievable by implementing the eight RACT guidelines is estimated to be approximately 7,146 tons annually. The approximate percent of the total VOC emissions reduced by implementing RACT by industrial category group is:

  - Gas marketing categories--52 percent of VOC emission reduction

  - Surface coating categories--41 percent of VOC emission reduction

  - Solvent metal cleaning category--5 percent of VOC emission reduction

  - Use of cutback asphalt--2 percent of VOC emission reduction.

- The capital cost for the eight industrial categories to achieve the RACT guidelines is estimated to be $11.21 million. The four industrial categories dealing with petroleum marketing (bulk gasoline plants, bulk gasoline terminals, fixed roof tanks and service stations) account for approximately $4.1 million (or 36 percent of the total) of the estimated capital cost.

- The annualized cost of the eight RACT industrial categories to achieve the RACT guidelines is estimated to be $2.1 million. In terms of cost indicators, the annualized compliance cost per value of shipments will have the largest effect on the following industrial categories:

  - Paper coating--The annualized costs represent approximately 2.1 to 3.9 percent of the 1977 affected industry's value of shipments.

  - Fabric coating--The annualized compliance costs represent approximately 3.5 percent of the 1977 statewide value of shipments.

  - Bulk gasoline plants--The annualized compliance costs represent approximately 0.7 percent of the 1977 statewide value of shipments.

- Technology developments and delivery of equipment could present problems in achieving the 1982 timing requirements in some of the RACT guidelines.

  - Low solvent coating technology requires some further development for cost- or energy-effective implementation of the RACT guidelines in the following industrial categories:

    - .. Surface coating of papers
    - .. Surface coating of fabrics.

  - Equipment delivery and installation of control equipment were identified as potential problems on a nationwide basis in the following industrial categories:

    - .. Surface coating of paper and fabrics
    - .. Solvent metal degreasing.

- The implementation of the RACT guidelines is expected to create further concentration for some industrial sectors requiring major capital and annualized cost increases for compliance. RACT requirements may have the effect of being another contributing factor to the industry trends of high throughput facilities in the following RACT industrial categories:

  - Bulk gasoline plants
  - Service stations.

- The annualized cost of compliance for the four gasoline marketing categories is estimated to be approximately $0.63 million. Assuming a "direct-cost pass-through" for the affected facilities (the four urban nonattainment county areas) the annualized cost would represent a price increase of 0.18 cents per gallon. This cost analysis assumes that vapors collected at the service station are recovered eventually at bulk terminals and refineries. To the extent that some service stations having controls may purchase gasoline from bulk gasoline plants (outside the four-county nonattainment area) without vapor collection equipment, the product recovered may be overstated.

- The implementation of the RACT guidelines for the eight industrial categories is estimated to represent a net energy savings of 15,730 equivalent barrels of oil annually as shown in Exhibit 1-3, on the following page. Assuming a value of oil at $13 per barrel, this is an equivalent energy savings of $204,000 annually.

EXHIBIT 1-3
U.S. Environmental Protection Agency
ESTIMATED CHANGE IN ENERGY DEMAND RESULTING
FROM IMPLEMENTATION OF EIGHT RACT GUIDELINES IN NONATTAINMENT
COUNTIES OF SOUTH CAROLINA

Industry Category	Energy Demand Change Increased (Decrease) (Equivalent barrels of oil)	Energy Demand Change Cost/(Savings)[a] ($ million)
Surface coating of paper	8,000	0.104
Surface coating of fabrics	1,070	0.014
Solvent metal cleaning	Negligible	Negligible
Tank truck gasoline loading terminals	(5,360)	(0.070)
Bulk gasoline plants	(3,400)	(0.044)
Storage of petroleum liquids in fixed roof tanks	(8,000)	(0.104)
Service stations (Stage I)	(8,040)	(0.104)
Use of cutback asphalt	Negligible	Negligible
TOTAL	(15,730)	(0.204)

a. Based on the assumption that the cost of oil is $13 per barrel.

Source Booz, Allen & Hamilton, Inc.

- RACT compliance requirements for the two surface coating industrial categories (paper and fabrics) represent a net energy demand of approximately 9,070 equivalent barrels of oil annually.

- RACT compliance requirements for the four industrial categories dealing with petroleum marketing (service stations, bulk gasoline terminals, bulk gasoline plants and fixed roof tanks) represent a net energy savings of approximately 24,800 barrels of oil annually. However, the feasibility of control efficiency has not been totally demonstrated and these estimates are likely to overstate the achievable energy savings for bulk gasoline plants and service stations.

1.3 ECONOMIC IMPLICATIONS OF EACH RACT GUIDELINE

1.3 ECONOMIC IMPLICATIONS OF EACH RACT GUIDELINE

This section presents a summary of the economic impact for each of the eight RACT industrial categories studied. Following this section is a series of summary exhibits which highlight the study findings for each industrial category.

1.3.1 Surface Coating of Paper

This study covered three plants identified from the RACT requirements for paper coaters. Excluded from this study are facilities engaged in publishing, who may coat paper as a segment of the processing line. The study assumes that these facilities would fall under other RACT guidelines currently being developed, such as Graphic Arts. Further definition of the paper coating category should be established prior to enforcement.

The retrofit situations and installation costs for add-on controls are highly variable. Based on these variations, the estimated capital cost to the industry is between $5.1 million and $6.8 million, with an annualized cost of $1.0 million to $1.3 million (approximately 3 percent of the affected firm's value of shipments).

Assuming 35 percent heat recovery, the annual energy requirements are expected to increase by approximately 8,000 equivalent barrels of oil per year. Energy consumption may decrease if further efficient recovery of incineration heat is possible.

Incinerator equipment manufacturers have stated that there may be significant problems in meeting the anticipated demand for high heat recovery incinerators on a nationwide basis.

1.3.2 Surface Coating of Fabrics

There are two firms in the nonattainment areas of South Carolina identified as coaters of fabric and affected by the proposed RACT guidelines. These facilities will be required to invest an estimated $0.9 million in capital and approximately $0.25 million (approximately 3.5 percent of the affected firm's value of shipments) in annualized cost to meet RACT limitations.

No significant productivity, employment or market structure dislocations should be associated with the implementation of the RACT guideline.

Incinerator equipment manufacturers have stated that there may be significant problems in meeting the anticipated demand for high heat recovery incinerators on a nationwide basis.

Assuming a 25 percent heat recovery, about 1,070 barrels of additional fuel oil per year would be required to operate the control equipment.

1.3.3 Solvent Metal Cleaning

This category includes equipment to clean the surface for removing oil, dirt, grease and other foreign material by immersing the article in a vaporized or liquid organic solvent. The cleaning is done in one of three devices: a cold cleaner, an open top vapor degreaser, or a conveyorized degreaser. This type of cleaning is done by many firms in many different types of industries.

Implementation of the proposed RACT guidelines for the four county urban nonattainment area in South Carolina will affect an estimated 700 cleaning operations. The regulation is expected to have a negligible economic effect on industry because of the relatively minor changes required. For South Carolina, the 700 potentially affected cleaners represent a capital cost of $230,000 and an annualized cost of $30,000 (<0.01 percent of industry value of shipments).

Because of the large number of degreasers nationwide that require retrofit to meet RACT and the inability of manufacturers to provide equipment on such a large scale, it is doubtful if all degreasers nationwide can be retrofitted within the 1982 timeframe.

No major productivity, employment and market structure dislocations are expected to result from RACT implementation.

1.3.4 Tank Truck Gasoline Loading Terminals

There are five facilities identified in the nonattainment areas of the state of South Carolina as tank truck gasoline loading terminals and affected by the limitation requirements. Emission control of these facilities is expected to require a capital investment of $1.4 million. Product recovery of gasoline will be accrued to bulk terminal operations not only from bulk terminal emission control installations but also from the recovery of vapors from service stations and bulk gasoline plants. Based on this savings, the net annualized cost for implementation of RACT for bulk gasoline loading terminals is estimated to be $0.1 million.

No significant productivity, employment or market structure dislocations should be associated with implementing the RACT guidelines.

1.3.5 Bulk Gasoline Plants

Nationwide, this industry is characterized by many small plants. Of these plants, only a few percent are either new or modernized. The majority of the plants are over 20 years old. Most bulk plants are located in rural areas where implementation of RACT to stationary sources is not required in the state of South Carolina.

To meet the RACT requirements, 40 bulk gas plants in the nonattainment areas must be equipped with vapor balance and submerged fill systems. This recommended control system is not cost-effective for the bulk plant operator as most of the economic credit (for recovered vapors) would be accrued to a bulk terminal or refinery.

The estimated capital cost and annualized cost to meet compliance requirements for the 40 facilities represent $0.55 million and $0.15 million (approximately 0.7 percent of affected industry's value of shipments), respectively. For these facilities, the price of gasoline (assuming a "direct cost pass-through") would be increased $0.003 per gallon. Because of the competitiveness and low profit structure in the industry, further cost increases could force some marginal operations out of the business, thus further concentrating the market structure. In urban areas, the bulk gasoline plant markets have been declining because of competition from retailers and tank truck terminals, and should continue to decline regardless of the RACT guidelines.

1.3.6 Storage of Petroleum Liquids in Fixed Roof Tanks

There are an estimated 44 fixed roof tanks in the nonattainment areas of South Carolina which would have to be equipped with a internal floating roof to comply with the proposed RACT requirements. These VOC emissions (1977) for these tanks are estimated to be over 1,425 tons.

These tanks are primarily owned by major oil companies and bulk gasoline tank terminal companies. The capital cost to equip these tanks with a single seal floating roof is estimated to be $1.0 million. The estimated annualized cost is $0.12 million, which would represent a price increase (assuming "direct cost pass-through") of less than $0.001 per gallon of throughput.

No significant productivity, employment or market structure change should be associated with the implementation of the RACT guideline.

Implementation of the RACT guideline is estimated to represent a net energy savings of 8,000 equivalent barrels of oil annually (assuming 90 percent control efficiency).

1.3.7 Service Stations

There are approximately 700 gasoline dispensing facilities which are located in the four county urban nonattainment areas of South Carolina and which are expected to be affected by the Stage I RACT regulations. The implementation of submerged fill and vapor balancing at these stations is estimated to be $1.1 million in capital. The annualized cost is $0.26 million which represents an average cost increase of approximately $0.001 per gallon at the affected facilities; however, larger stations will experience a much smaller unit cost increase. The service stations could experience loss of business while vapor control systems are being installed.

Implementation of the RACT guidelines may accelerate the trend to high throughput stations because of the increasing overhead costs. However, the RACT guidelines should not cause major productivity and employment dislocations to the industry as a whole.

It is estimated that implementing RACT guidelines for service stations in the urban nonattainment counties of South Carolina will result in a net energy savings equivalent to 8,000 barrels of oil per year, assuming 95 percent recovery of gasoline. This assumed control efficiency has not been fully demonstrated. Only a small percent of the economic benefit from the recovered gasoline vapors will directly accrue to the service stations.

1.3.8 Use of Cutback Asphalt

South Carolina has already converted most of the paving applications to asphalt emulsions. The majority of cutback asphalt remaining in use are primarily for penetrating prime coat applications, which are exempt from the proposed limitations. Replacement of the solvent-based asphalt with asphalt emulsion for patchwork applications will cause no dislocation in employment or worker productivity. Capital and training cost investment is estimated at $20,000. No change in paving costs are expected from the implementation of the RACT guideline.

It is anticipated that sufficient lead time is available to assure an adequate supply of asphalt emulsion to meet the increased demand and provide training for municipal employees.

* * * *

A summary of the direct economic implications of implementing RACT in each of the eight industrial categories studied is presented in Exhibit 1-4 through 1-11, on the following pages.

EXHIBIT 1-4 (1)
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR PAPER COATERS IN
THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	Three plants in the state's non-attainment areas are expected to be affected by these regulations. However, if this category were to be interpreted to include all types of paper coating, including publishing, far more firms would be affected.
Indication of relative importance of the industrial sector to the state economy	The 1977 value of shipments of these three plants is estimated to be about $34 to $45 million. They are estimated to employ 572 people.
Current industry technology trends	Gravure coating replacing older systems.
1977 VOC emissions (actual)	Approximately 4,240 tons per year were identified from three plants affected. Of these 3,360 tons per year are applicable under RACT.
Industry preferred method of VOC control to meet RACT guidelines	Though low solvent use is increasing, progress is slow. Add-on control systems will probably be used.
Assumed method of control to meet RACT guidelines	Thermal incineration with primary heat recovery and carbon adsorption.
Affected Areas in Meeting RACT	**Discussion**
Capital investment	Estimated to be $5.1 million to $6.8 million depending on retrofit situations. This is likely to be more than 100 percent of normal expenditures for the affected paper coaters.
Annualized cost	$1.0 million to $1.3 million annually. This represents 2.1 to 3.9 percent of the value of shipments for the three firms directly affected.
Price	Assuming a "direct cost pass-through"-- 2.1 to 3.9 percent at the three affected firms.

Affected Areas in Meeting RACT	Discussion
Energy	Assuming 35 percent heat recovery from the incineration system, annual energy requirements are expected to increase by approximately 8,000 equivalent barrels of oil.
Productivity	No major impact.
Employment	No major impact.
Market structure	No major impact.
RACT timing requirements (1981)	RACT guideline needs clear definition for enforcement.
	Equipment deliverables and installation of incineration systems prior to 1981 are expected to present problems. Development of low solvent systems is likely to extend beyond 1981.
Problem areas	Retrofit situations and installation costs are highly variable.
	Type and cost of control depend on particular solvent systems used and reduction in air flow.
VOC emissions after control	Approximately 1,520 tons/year (36 percent of 1977 VOC emission level from three affected plants).
Cost effectiveness of control	\$396 - \$514 annualized cost/annual ton of VOC reduction.

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 1-3 (1)

U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR FABRIC COATERS IN
THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	Two plants in the state's non-attainment areas are expected to be affected by these regulations.
Indication of relative importance of industrial sector to the state economy	The 1977 value of shipments of these two plants is estimated to be about $7.1 million. They are estimated to employ 100 people in fabric coating operations.
Current industry technology trends	Newer plants are built with integrated coating and emission control systems; older plants are only marginally competitive now.
1977 VOC emissions (actual)	Current emissions are estimated at about 260 tons/year.
Industry preferred method of VOC control to meet RACT guidelines	Direct fired incineration
Assumed method of VOC control to meet RACT guidelines	Direct fired incineration with primary heat recovery.
Affected Areas in Meeting RACT	**Discussion**
Capital investment	Estimated to be $0.8 million to $1.1 million depending on retrofit situations.
Annualized cost	$210,000 to $280,000 annually.
Price	Assuming a "direct cost pass-through"-- 3 to 4 percent.
Energy	Assuming 35 percent heat recovery, annual energy requirements are expected to increase by approximately 1,070 equivalent barrels of oil.
Productivity	No major impact.
Employment	No major impact.
Market structure	No major impact.

EXHIBIT 1-5 (2)
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR FABRIC COATERS IN THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Affected Areas in Meeting RACT	Discussion
RACT timing requirements (1981)	RACT guideline needs clear definition prior to enforcement. Nationwide, equipment deliverables and installation of incineration systems prior to 1981 are expected to present problems. Development of low solvent systems is likely to extend beyond 1981.
Problem areas	Retrofit situations and installation costs are highly variable. Type and cost of control depend on particular solvent systems used and reduction in air flow.
VOC emissions after RACT control	Approximately 50 tons/year (19 percent of 1977 VOC emissions level from affected plants.
Cost effectiveness of RACT control	$1,004 to $1,327 annualized cost/annual ton of VOC reduction.

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 1-6
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR SOLVENT METAL DEGREASING
IN THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	About 700 plants in the four urban non-attainment counties
Indication of relative importance of industrial section to state economy	Value of shipments of firms in SIC groups affected for non-attainment counties is approximately $0.7 billion, about 20% of the county totals for these SIC groups
Current industry technology trends	Where technically feasible, firms are substituting exempt solvents
1977 VOC emissions (actual)	1,320 tons/year
Industry preferred method of VOC control to meet RACT guidelines	Substitution. Otherwise lowest cost option as specified by EPA will be used.
Assumed method of VOC control meet RACT guidelines	Equipment modifications as specified by the RACT guidelines

Affected Areas in Meeting RACT	Discussion
Capital investment	$0.23 million
Annualized cost	$0.03 million (less than 0.01 percent of the value of shipments of the effected firms)
Price	Metal cleaning is only a fraction of manufacturing costs; price effect expected to be less than 0.01 percent assuming a "direct cost passthrough"
Energy	Approximately 35 equivalent barrels of oil per year increase
Productivity	5-10 percent decrease for manually operated degreasers. Will not effect conveyorized cleaners.
Employment	No effect except a possible slight decrease in firms supplying metal degreasing solvents
Market structure	No change
RACT timing requirements (1981)	Equipment availability--only a few companies now supply the recommended control modifications
Problem areas	No significant problem areas seen.
VOC emission after RACT control	980 tons/year (74 percent of 1977 VOC emission level--however, this does not include emission controls for exempt solvents)
Cost-effectiveness of RACT control	$87 annualized cost per ton of emissions reduced

Source: Booz, Allen & Hamilton Inc.

Exhibit 1-7

U.S. Environmental Protection Agency

SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN SOUTH CAROLINA (NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	5
Indication of relative importance of industrial section to state economy	1977 sales were $114 million with annual throughput of 270 million gallons at the affected facilities
Current industry technology trends	New terminals are being designed with vapor recovery equipment
1977 VOC actual emissions	872 tons per year
Industry preferred method of VOC control to meet RACT guidelines	Submerge or bottom fill and vapor recovery

Affected Areas in Meeting RACT	Discussion
Capital investment	$1.4 million
Annualized cost	$0.1 million (approximately 0.09 percent of value of shipments)
Price	No major impact
Energy	Assuming full recovery of gasoline—net savings of 5,362 barrels annually from terminal emissions
Productivity	No major impact
Employment	No direct impact
Market structure	No direct impact
Problem area	Gasoline credit from vapors from bulk gasoline plants and gasoline service stations require uniform RACT requirements throughout the state
VOC emission after control	87 tons per year
Cost effectiveness of control	$48 annualized cost/annual ton of VOC reduction from terminals assuming gasoline credit from vapors returned from bulk gasoline plants and gasoline service stations

Source: Booz, Allen & Hamilton Inc.

Exhibit 1-8

U.S. Environmental Protection Agency

SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR AFFECTED BULK GASOLINE PLANTS IN THE STATE OF SOUTH CAROLINA (NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	40
Indication of relative importance of industrial section to state economy	1977 industry sales from affected bulk plants were $21.9 million. The estimated annual throughput was 52 million gallons.
Current industry technology trends	Only small percent of industry has new/modernized plants
1977 VOC actual emissions	676 tons per year
Industry preferred method of VOC control to meet RACT guidelines	Top submerge fill and vapor balancing

Affected Areas in Meeting RACT	Discussion
Capital investment (statewide)	$550,000
Annualized cost (statewide)	$148,000 (approximately 0.68 percent of value of shipments)
Price	Assuming a "direct cost passthrough" . Industry-wide—$0.0028 per gallon increase . Small operations—$0.005 per gallon increase
Energy	Assuming full recovery of gasoline—net savings of 3,400 barrels annually
Productivity	No major impact
Employment	No major impact; however, for plants closing, potential average of 4 jobs lost per plant closed
Market structure	Regulation could further concentrate a declining industry
Problem areas	Severe economic impact for some small bulk plant operations. Recovery efficiency of cost effective alternative has not been effectively demonstrated
VOC emission after RACT control	178 tons per year
Cost effectiveness of RACT control	$297 annualized cost/annual ton of VOC reduction

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 1-9
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR STORAGE OF PETROLEUM
LIQUID IN THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	
Number of potentially affected storage tanks	44
Indication of relative importance of industrial section	The annual throughput was an estimated 260 million gallons
Current industry technology trends	Internal floating roof tanks utilizing a double seal have been proven to be more cost effective
VOC emissions	1,425 tons per year
Preferred method of VOC control to meet RACT guidelines	Single seal and internal floating roof
Affected Areas in Meeting RACT	
Capital investment	$1.02 million
Annualized cost	$118,000
Price	Assuming a "direct cost" passthrough-less than 0.05 cents per gallon of throughput
Energy	Assuming 90 percent reduction of current VOC level, the net energy savings represent an estimated savings of 8,000 equivalent barrels of oil annually
Productivity	No major impact
Employment	No major impact
Market Structure	No major impact
Problem area	Potential availability of equipment to implement RACT standard
VOC emission after RACT control	142 tons per year
Cost effectiveness of RACT control	$92 annualized cost/annual ton of VOC reduction

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 1-10(1)
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS
OF IMPLEMENTING RACT FOR
GASOLINE DISPENSING FACILITIES
IN THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	700 in the four urban nonattainment counties
Indication of relative importance of industrial sector to county economy	4-county industry sales are $0.183 million with a yearly throughput of 0.362 billion gallons. Approximately 90 percent of the throughput (0.324 billion gallons) would be affected at the 700 facilities
Current industry technology trends	Number of stations has been declining and throughput per station has been increasing. By 1980, one-half of stations in U.S. are predicted to become totally self-service
1977 VOC emissions (actual)	1,396 tons per year from tank loading operation. The VOC emissions at the 700 affected facilities is estimated to be 1,250 tons per year.
Industry preferred method of VOC control to meet RACT guidelines	Submerged fill and vapor balance
Assumed method of control to meet RACT guidelines	Submerged fill and vapor balance

Affected Areas in Meeting RACT	Discussion
Capital investment	$1.1 million
Annualized cost	$0.263 million
Price	Assuming a "direct cost passthrough"--less than $0.00 per gallon of gasoline sold in the 4 counties
Energy	Assuming full recovery: 389,000 gallons/year (8,040 barrels of oil equivalent) saved[a]
Productivity	No major impact
Employment	No major impact

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a One gallon of gasoline has 125,000 BTU's. One barrel of oil equivalent has 6,050,000 BTU's.

Affected Areas in Meeting RACT	Discussion
Market structure	Compliance requirements may accelerate the industry trend towards high through-put stations (i.e., marginal operations may opt to shut down)
RACT timing requirements (1981)	Retrofitting service stations within time constraints may be difficult in a few instances
Prolem area	Older stations face higher retrofit costs--potential concerns are dislocations during installations
VOC emission after RACT control	210 tons per year from tank loading operation. 62 tons per year at the affected facilities
Cost effectiveness of RACT control	$222 annualized cost/annual ton of VOC reduction

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 1-11(1)
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS
OF IMPLEMENTING RACT FOR USE OF
CUTBACK ASPHALT IN THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Potentially affected use	In 1977, use of cutback asphalt was approximately 3,200 tons in the non-attainment counties
Indication of relative importance of industrial sector to statewide economy	1977 sales of cutback asphalt were estimated to be $0.3 million in the nonattainment counties
Current industry technology trends	Most of the use of cutback asphalt is for penetrating prime coat applications, which are exempt
1977 VOC emissions (actual)	665 tons annually; 120 of which are non-exempted
Industry preferred method of VOC control to meet RACT guidelines	Replace with asphalt emulsions
Assumed method of control to meet RACT guidelines	Replace with asphalt emulsions

Affected Areas in Meeting RACT	Discussion
Capital investment	$0.02 million
Annualized cost	No change in paving costs are expected
Price	No change in paving costs are expected
Energy	0[a]
Productivity	No major impact
Employment	No major impact

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a A saving of 1,160 barrels of oil equivalent accrues to manufacturer, no user. The total energy associated with manufacturing, processing and laying one gallon of cutback is approximately 50,200 BTUs/gallon. For emulsified asphalts, it is 2,830 BTUs/gallon. One barrel of oil equivalent is assumed to have 6.05 million BTUs, and one ton of cutback asphalt is assumed to have 256 gallons.

EXHIBIT 1-11(2)

Affected Areas in Meeting RACT	Discussion
RACT timing requirements (1981)	Long-range supply of asphalt emulsions are expected to be available
Problem area	Winter paving
VOC emission after RACT control	Net VOC emission reduction is estimated to be 120 tons annually
Cost effectiveness of RACT control	$176 annualized cost/annual ton of VOC reduction in the first year. In subsequent years, the cost is $0.

Source: Booz, Allen & Hamilton Inc.

2.0 INTRODUCTION AND OVERALL STUDY APPROACH

2.0 INTRODUCTION AND OVERALL STUDY APPROACH

This chapter presents an overview of the study's purpose, scope and methodology. It is divided into six sections:

- Background
- Summary of State Implementation Plan revisions and state's need for assistance
- Scope
- Approach
- Quality of estimates
- Definition of terms used.

Each of these sections is discussed below.

The approach and quality of estimates is discussed in detail in each of the respective chapters dealing with the specific industrial categories affected by the volatile organic compounds control regulations.

2.1 BACKGROUND

The Clean Air Act Amendments of 1977 required the states to revise their State Implementation Plans (SIPs) to provide for the attainment and maintenance of national ambient air quality standards in areas designated as nonattainment. The Amendments require that each state submit the SIP revisions to the U.S. Environmental Protection Agency (EPA) by January 1, 1979. These proposed regalations should contain an oxidant plan submission for major urban areas to reflect the application of Reasonably Available Control Technology (RACT) to stationary sources for which the EPA has published guidelines. The Amendments also require that the states identify and analyze the air quality, health, welfare, economic, energy and social effects of the plan provisions.

Under the direction of Region IV, the EPA contracted with Booz, Allen & Hamilton Inc. (Booz, Allen) to assist the states of Alabama, Georgia, Kentucky, North Carolina, South Carolina and Tennessee in analyzing the economic, energy and social impacts of the SIP revisions proposed by these states. The assignment was initiated on September 28, 1978, and, as a first step, the proposed SIP revisions and the type of assistance desired by each state were reviewed.

After a review with each of the states and EPA Region IV representatives, a work scope was defined that would include in the study an analysis of the direct economic and energy impacts for those industrial segments most likely to have a significant impact at the statewide level. For the most part this included industrial categories that had more than a few facilities potentially affected. The next section discusses those specific industrial categories included in this work scope.

2.2 SUMMARY OF PROPOSED SIP REVISIONS IN SOUTH CAROLINA AND THE STATE'S NEED FOR CONTRACTOR SUPPORT

South Carolina has proposed statewide regulations to reduce volatile organic compound (VOC) emissions by implementing the Reasonably Available Control Technology (RACT) guidelines developed by the EPA for existing stationary sources. The state has also proposed regulations to control particulates emissions.

The state officials were interviewed to determine their need for support in analyzing the economic impact of the SIP revisions. The analysis of implementing the RACT guidelines for reducing VOC emissions was expressed as the fundamental concern. Specifically, the state needed assistance in the analysis of eight of the fifteen industrial categories for which the EPA has published RACT guidelines. These eight RACT industrial categories are described in the next section. The other seven industrial categories (surface coating of cans, coils, automobiles, metal furniture, magnet wire and large appliances and miscellaneous refinery sources) were excluded from this study because a very limited number of sources were affected by the proposed regulation in those categories. Although the cost impact in those categories excluded might be significant for an individual firm studied, it is unlikely that the economic or energy impact at the macrolevel (statewide) would be significant.

2.3 SCOPE

The primary objective of this study is to determine the costs and impact of compliance with the proposed SIC revisions for six states in EPA, Region IV. The study will emphasize the analysis of direct economic costs and benefits of the proposed SIP revisions. Secondary (social and energy) impacts will also be addressed but are not the major study emphasis.

In South Carolina, the economic impact will be analyzed for the implementation of RACT guidelines to reduce VOC from the following eight industry categories:

- Surface coating of paper
- Surface coating of fabrics
- Solvent metal cleaning
- Bulk gasoline terminals
- Bulk gasoline plants
- Storage of petroleum liquids in fixed-roof tanks
- Service stations—Stage I
- Use of cutback asphalt.

The major study guidelines in the determination of the economic impact of the RACT guidelines are discussed below.

- The emission limitations for each industrial category will be studied at the control level established by the RACT guidelines. These are presented in Exhibit 2-1, on the following page.

- All costs and emission data were presented for 1977.

- Emissions sources included were the use of cutback asphalt statewide and existing stationary point sources in the applicable industrial categories in the non-attainment areas for ozone with the following potential VOC emission rates:

  - 10 tons or more in the four urban non-attainment counties (Richland, Lexington, Berkeley, and Charleston)

  - 100 tons or more in York county

Exhibit 2-1(1)
U.S. Environmental Protection Agency
LISTING OF EMISSION LIMITATIONS THAT REPRESENT THE PRESUMPTIVE NORM TO BE ACHIEVED THROUGH APPLICATION OF RACT FOR SPECIFIC INDUSTRY CATEGORIES

Category	RACT Guideline Emission Limitations[a]
	Surface Coating Categories Based on Low Organic Solvents (lbs. solvent) per gallon of coating, minus water)
Surface coating of:	
Paper	2.9
Fabrics and vinyl coating	
. Fabric	2.9
. Vinyl	3.8
Solvent metal cleaning	
. Cold cleaning	Provide cleaners with: cover, facility to drain clean parts; additional freeboard; chiller or carbon absorber. Follow suggested procedures to minimize carryouts.
. Conveyorized degreaser	Provide cleaners with: refrigerated chillers; or carbon adsorption system; drying tunnel or rotating basket; safety switches; covers. Follow suggested procedures to minimize carryout.
. Open top degreaser	Provide cleaner with: safety switches; powered cover; chiller; carbon absorber. Follow suggested procedures to minimize carryout.
Bulk gasoline terminals	Equipment such as vapor control system to prevent mass emissions of VOC from control equipment to exceed 80 milligrams per liter (4.7 grams per gallon) of gasoline loaded.
Bulk Gasoline Plants	Provide submerged filling and vapor balancing or equivalent control to reduce VOC emissions. Follow suggested procedures to minimize vapor losses.

Exhibit 2-1(2)

Category	RACT Guideline Emission Limitations[a]
Storage of petroleum liquids in fixed roof tanks	Provide single seal and internal floating roof to all fixed roof storage vessels with capacities greater than 150,000 liters (39,000 gal.) containing volatile petroleum liquids for which true vapor pressure is greater than 10.5 kilo pascals (1.52 psia)
Service stations (Stage I)	Provide submerged fill and vapor balance for any stationary storage tank located at a gasoline dispensing facility.
Use of cutback asphalt	The manufacture, mixing, storage, use or application may be approved where: long-life stockpile storage is necessary; the use or application at an ambient temperature less than 10°C (50°F) is necessary; or it is to be used solely as a penetrating prime coat

[a] Annotated description of RACT guidelines.

Source: Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, U.S. Environmental Protection Agency, EPA-90512-78-001, April 1978.

- The following volatile organic compounds were exempted:
  - Methane
  - Ethane
  - Trichlorotrifluorethane (Freon 113)
  - 1,1,1-trichloroethane (methyl chloroform).[1]
- The timing requirement for implementation of controls to meet RACT emission limitations was May 1, 1981.

Additional study guidelines for specific industry categories include the following:

- Bulk gasoline plants will be studied for the four urban counties only since emissions from bulk plants do not exceed 100 tons per year
- Bulk terminals will be studied for the four urban counties only since no bulk terminals have been identified in York county
- Service stations will be studied for the four urban counties only because their emissions do not exceed 100 tons per year. Service stations with less than 2,000 gallon tank capacity will be exempt from the regulation
- Solvent metal cleaning will be studied for the four urban counties only assuming that no solvent metal cleaners with over 100 tons VOC emissions exist in York County
- The use of cutback asphalt will be studied statewide.

2.4 APPROACH

This section describes the overall approach and methodology applied in this assignment. In general, the approach varied for each state and also for each industrial category studied. This section specifically describes the overall approach that was applied for the State of South Carolina. The methodology applied to determine the economic impact for each industrial category in South Carolina is described in further detail in the first section of each chapter dealing with the specific industry category.

There are five parts to this section to describe the approach for determining estimates of:

- Industry statistics
- VOC emissions
- Process descriptions
- Cost of controlling VOC emissions
- Comparison of direct costs with selected direct economic indicators

2.4.1 Industry Statistics

The assembly of economic and statistical data for each industrial category was an important element in establishing the data base that was used for projection and evaluation of the emissions impact. Some of the major variables for each industrial category were:

- Number of manufacturers
- Number of employees
- Value of shipments
- Number of units manufactured
- Capital expenditures
- Energy consumption
- Productivity indices

- Current economics (financial) status
- Industry concentration
- Business patterns (small vs. large; downstream integration)
- Age distribution of facilities
- Future trends and developments.

Some of the industrial categories studied cover a large number of potentially affected facilities. For these categories, industry statistical data were collected by applying a categorical approach rather than by attempting to identify all the individual firms likely to be affected. The industrial categories studied by this approach included:

- Solvent metal cleaning
- Gasoline service stations
- Use of cutback asphalt.

For these industrial categories, secondary data sources and nonconfidential Booz, Allen files served as the primary resources for the data base. Industry and association interviews were then conducted to complete, refine and validate the industry statistical data base.

For the remaining industrial categories studied, a more deliberate approach was applied:

- For the surface coating categories, a list of the facilities potentially affected by the RACT guidelines was provided by the South Carolina Department of Health and Environmental Control. This list was refined by a review of secondary data sources and telephone interviews performed by the Booz, Allen study team.
- For bulk gasoline plants and terminals and fixed-roof tanks, the list of potentially affected facilities was compiled by the South Carolina Department of Health and Environmental Control.
- Industry category statistical data were compiled using secondary sources such as:

- Department of Commerce
- Census of Manufacturers
- Trade associations
- Bureau of Labor Statistics
- National Technical Information Services.

The industry statistical data were refined by two mechanisms:

- Assessing the statistical data for reasonableness in comparison to the list of potentially affected facilities

- Using industry and association interviews for completion and validation.

2.4.2 VOC Emissions

Emissions data were provided by the state and were refined by the Booz, Allen study team using different approaches depending upon the availability and completeness of data on the potentially affected facilities.

- For bulk gasoline plants and terminals and fixed-roof tanks, emissions were estimated by using facility characteristics data provided by the state and emission factors developed by U.S. EPA.

- For the surface coating industry categories, emissions were estimated by using data provided by the South Carolina Department of Health and Environmental Control and data obtained through telephone interviews with affected industries.

- For the other categories to be studied, the emissions were estimated by applying relevant factors (VOC emissions per facility, throughput, etc.) that had been developed by EPA studies. Although this categorical approach cannot be validated to the degree of a point source by point source approach, the emissions can be reasonably estimated for the five nonattainment counties because of the large number of sources in each RACT industrial category. Emissions were estimated by this approach for the following RACT industrial categories:

    - Solvent metal cleaning
    - Service stations
    - Cutback asphalt.

The emission estimates for each of the eight RACT industrial categories studied were refined during industry interviews.

2.4.3 Process Descriptions

For each of the industrial categories, the basic technology and emission data were reviewed and summarized concisely for subsequent evaluation of engineering alternatives. In this task, the RACT documents that had been prepared for each industrial category and other air pollution control engineering studies served as the basis for defining technological practice. Additional alternatives of control that met the requirements of the RACT guidelines were identified from literature search. The most likely control alternatives were assessed and evaluated by:

- Technical staff at Booz, Allen
- Interviews with industry representatives
- Interviews with EPA representatives
- Interviews with equipment manufacturers.

2.4.4 Cost of Controlling VOC Emissions

The cost of control to meet the requirements of the RACT guidelines had been presented in the RACT documents, other technical EPA studies and trade journal technical documents and by industry representatives. The approach applied in developing capital and annualized cost estimates was to:

- Utilize available secondary source information as the primary data source
- Validate the control alternatives industry is likely to apply
- Calibrate these cost estimates provided in technical documents.

It was not within the purpose or the scope of this project to provide detailed engineering costs to estimate the cost of compliance.

Cost data presented within the body of the report were standardized in the following manner:

- All cost figures are presented for a base year, 1977.

- Capital cost figures represent installed equipment cost including:

  - Engineering
  - Design
  - Materials
  - Equipment
  - Construction.

  The capital cost estimates do not account for costs such as:

  - Clean-up of equipment
  - Lost sales during equipment downtime
  - Equipment start-up and testing
  - Initial provisions (spare parts).

- Capital related annual costs are estimated at 25 percent of the total capital cost per year (unless explicitly stated otherwise). The estimated procedure applied was built up from the following factors:

  - Depreciation--assuming straight-line over a ten-year life

  - Interest—10 percent

  - Taxes and insurance—4 percent

  - Maintenance—5 percent

  The capital-related annual costs do not account for investment costs in terms of return or investment parameters (i.e., the "opportunity cost" of money is not included).

- Annualized costs of compliance with RACT guidelines were estimated for each of the control alternatives studied. The annual operating costs included were:

  - Direct labor
  - Raw material costs (or savings)
  - Energy
  - Product recovery cost (or savings)
  - Maintenance.

Other types of costs, not included in this analysis, involve compliance costs, such as:

- Demonstration of control equipment efficiency
- Supervisory or management time
- Cost of labor or downtime during installation and startup.

. The annualized cost is the total of direct operating costs (including product or raw material recovery) and the capital related annual costs.

2.4.5 Comparison of Direct Cost with Selected Direct Economic Indicators

In each of the industrial categories studied, after the costs (or savings) of compliance had been determined, these costs were compared with selected economic indicators. This comparison was performed to gain a perspective on the compliance costs rather than to estimate price changes or other secondary effects of the regulation. Presented below are typical comparisons of direct costs with indicators that are presented in this study.

. Annualized cost in relation to current price—To gain a perspective on the compliance cost in relation to current prices of the manufactured items at the potentially affected facilities, the annualized cost is presented in terms of a price increase assuming a direct pass-through of costs to the marketplace.

  - This analysis was based on the average cost change (including those facilities that may have little or no economic impact associated with meeting the proposed standards) divided by the average unit price of goods manufactured.
  - For this reason as well as many others (that might be addressed in a rigorous input-output study to estimate eventual price increase), this analysis should not be interpreted as forecast of price changes due to the proposed standards.

- Annualized costs as a percent of current value of shipment—The annualized costs applied are for all those facilities potentially affected divided by the estimated value of shipments for the statewide industrial category (i.e., including those facilities which currently may meet the proposed standard). This approach tends to understate the effect to those specific firms requiring additional expenses to meet the proposed standard. Therefore, when available, the compliance cost is also presented as a percent of the value of shipments for only those firms not currently meeting the proposed regulation.

- Capital investment as a percent of current annual capital appropriations—Estimated capital investment for the potentially affected facilities in the five nonattainment counties divided by the estimated capital appropriations for the industry affected as a whole in the state (including those facilities that may not require any capital investment to meet the proposed standard).

2.5 QUALITY OF ESTIMATES

The quality of the estimates that are presented in this report can be judged by evaluating the basis for estimates of the individual study components. In each of the chapters that deal with the development of estimated compliance cost, the sources of information are fully documented. In addition, the study team has categorically ranked the overall data quality of the major sources and, therefore, of the outcomes. These data quality estimates were ranked into three categories:

- High quality ("hard data")—study inputs with variation of not more than ± 25 percent
- Medium quality ("extrapolated data")—study inputs with variation of ± 25 to 75 percent
- Low quality ("rough data")—study inputs with variation of ± 50 to 150 percent.

Each of these data quality estimates is presented in the individual chapters. The overall quality ranking of the study inputs for each RACT industrial category was generally in the medium quality range.

2.6 DEFINITIONS OF TERMS

Listed below are definitions of terms that are used in the body of the report:

- Capture system--the equipment (including hoods, ducts, fans, etc.) used to contain, capture, or transport a pollutant to a control device.
- Coating applicator--an apparatus used to apply a surface coating.
- Coating line--one or more apparatuses or operations which include a coating applicator, flash-off area and oven, wherein a surface coating is applied, dried and/or cured.
- Control device--equipment (incinerator, adsorber or the like) used to destroy or remove air pollutant(s) prior to discharge to the ambient air.
- Continuous vapor control system--a vapor control system that treats vapors displaced from tanks during filling on a demand basis without intermediate accumulation.
- Direct cost pass-through--the relationship of the direct annualized compliance cost (increase or decrease) to meet the RACT limitations in terms of units produced (costs per unit value of manufactured goods.)
- Emission--the release or discharge, whether directly or indirectly, of any air pollutant into the ambient air from any source.
- Facility--any building, structure, installation, activity or combination thereof which contains a stationary source of air contaminants.
- Flashoff area--the space between the application area and the oven.
- Hydrocarbon--any organic compound of carbon and hydrogen only.

- Incinerator--a combustion apparatus designed for high temperature operation in which solid, semisolid, liquid or gaseous combustible wastes are ignited and burned efficiently and from which the solid and gaseous residues contain little or no combustible material.

- Intermittent vapor control system--a vapor control system that employs an intermediate vapor holder to accumulate vapors displaced from tanks during filling. The control device treats the accumulated vapors only during automatically controlled cycles.

- Loading rack--an aggregation or combination of gasoline loading equipment arranged so that all loading outlets in the combination can be connected to a tank truck or trailer parked in a specified loading space.

- Organic material--a chemical compound of carbon excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate.

- Oven--a chamber within which heat is used to bake, cure, polymerize and/or dry a surface coating.

- Prime coat--the first film of coating applied in a two-coat operation.

- Reasonably available control technology (RACT)--the lowest emission limit as defined by EPA that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. It may require technology that has been applied to similar, but not necessarily identical, source categories.

- Reid vapor pressure--the absolute vapor pressure of volatile crude oil and volatile nonviscous petroleum liquids, except liquified petroleum gases, as determined by American Society for Testing and Materials, Part 17, 1973, D-323-72 (Reapproved 1977).

- Shutdown--the cessation of operation of a facility or emission control equipment.

- Solvent--organic material which is liquid at standard conditions and which is used as a dissolver, viscosity reducer or cleaning agent.

- Standard conditions--a temperature of 20°C (68°F) and pressure of 760 millimeters of mercury (29.92 inches of mercury).

- Startup--the setting in operation of a source or emission control equipment.

- Stationary source--any article, machine, process equipment or other contrivance from which air pollutants emanate or are emitted, either directly or indirectly, from a fixed location.

- Topcoat--the final film of coating applied in a multiple coat operation.

- True vapor pressure--the equilibrium partial pressure exerted by a petroleum liquid as determined in accordance with methods described in American Petroleum Institute Bulletin 2517, "Evaporation Loss from Floating Roof Tanks," 1962.

- Equivalent barrel of oil--energy demand is converted into barrels of oil at the conversion rate of 6,000,000 BTU per barrel of oil.

- Vapor collection system--a vapor transport system which uses direct displacement by the liquid loaded to force vapors from the tank into a vapor control system.

- Vapor control system--a system that prevents release to the atmosphere of at least 90 percent by weight of organic compounds in the vapors displaced from a tank during the transfer of gasoline.

- Volatile organic compound (VOC)--any compound of carbon that has a vapor pressure greater than 0.1 millimeters of mercury at standard conditions excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate.

5.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR PLANTS SURFACE COATING PAPER IN THE NONATTAINMENT AREAS FOR OZONE IN SOUTH CAROLINA

5.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR PLANTS SURFACE COATING PAPER IN THE NONATTAINMENT AREAS FOR OZONE IN SOUTH CAROLINA

This chapter presents a detailed analysis of the impact of implementing RACT for plants in five nonattainment counties in South Carolina (Charleston, Berkeley, York, Lexington, and Richland) which are engaged in the surface coating of paper. This is meant to include protective or decorative coatings put on paper, pressure-sensitive tapes regardless of substrate, related web coating processes on plastic film and decorative coatings on metal foil, but does not include conventional printing processes which apply inks.

This analysis includes those paper coaters in the nonattainment area with potential emissions over 10 tons per year.

The chapter is divided into five sections:

- Specific methodology and quality of estimates
- Industry statistics
- The technical situation in the industry
- Cost and VOC reduction benefit evaluations for the most likely RACT alternatives
- Direct economic impacts.

Each section presents detailed data and findings based on analyses of the RACT guidelines; previous studies of paper coating; interviews with paper coaters, coating equipment and materials manufacturers; and a review of pertinent published literature.

5.1 SPECIFIC METHODOLOGY AND QUALITY OF ESTIMATES

This section describes the methodology for determining estimates of:

- Industry statistics
- VOC emissions
- Processes for controlling VOC emissions
- Cost of controlling VOC emissions
- Economic impacts

for plants engaged in the surface coating of paper. The quality of these estimates is discussed in the last part of this section.

5.1.1 Industry Statistics

Paper coating is practiced in a number of industries. Among products that are coated using organic solvents are: adhesive tapes; adhesive labels; decorated, coated and glazed paper; book covers; office copier paper; carbon paper; typewriter ribbons; photographic film; paper cartons; and paper drums. The firms coating paper are classified in a number of groupings in the U.S. Department of Commerce's Standard Industrial Classification system. The major coaters may be found in the following 16 SIC groups:

SIC	Description
2611	Pulp mills
2621	Paper mills, except building paper mills
2631	Paperboard mills
2641	Paper coating and glazing
2643	Bags, except textile bags
2645	Diecut paper and paperboard and cardboard
2649	Paper converting, n.e.c.
2651	Folding paperboard boxes
3291	Abrasive products
3292	Asbestos products
3293	Gaskets, packing and sealing devices
3497	Metal foil and leaf
3679	Electronic components, n.e.c.
3842	Orthopedic, prosthetic and surgical appliances and supplies
3861	Photographic equipment and supplies
3955	Carbon paper and inked ribbons

This list does not include plants listed in the SIC category 2700 (Printing, Publishing and Allied Industries), where paper coating other than printing may also be a part of the overall processing of the printed product.

Statistics concerning these industries were obtained from a number of sources. All data where possible were converted to the base year 1977 for the state using scaling factors developed from U.S. Department of Commerce data as presented in County Business Patterns. The primary sources of economic data were the 1972 Census of Manufactures and 1976 Annual Survey of Manufactures. The South Carolina Industrial Directory (1978) and industry oriented annuals such as Lockwoods' Directory ,Davidson's Blue Book and the Thomas Register of American Manufacturers were used to identify some of the individual companies engaged in paper conversion (i.e., coating of paper in roll form for sale to other manufacturers) and to identify other paper coating firms in the state.

5.1.2 VOC Emissions

The actual firms expected to be affected by the proposed regulations were identified from this tentative list by crosschecking the firms with the South Carolina Bureau of Air Quality Control source emissions inventories and the state annual survey file.

The South Carolina survey files, which at the time the data were gathered were more up to date than the emissions inventories, were used as a basis for estimation of the total VOC emissions to be expected in the five non-attainment counties. This procedure is believed to account for the majority of the emissions in the five nonattainment counties and for all of the large single sources.

5.1.3 Processes for Controlling VOC Emissions

Processes for controlling VOC emissions from sources included in the paper coating category are described in Control of Volatile Organic Emissions From Existing Stationary Sources, Volume II (EPA-450/2-77-008). The feasibility of applying the various control methods to paper coating discussed in this document was reviewed with coating firms, coating suppliers, coating equipment manufacturers and industry associations. These methods include both coating reformulation and the use of control devices, such as incinerators and carbon adsorbers.

Because of the wide variety of coating processes and coating materials in use, most methods of control will find some applicability. The situations where emissions are likely to be controlled by reformulation and by control devices were estimated based on a review of the literature and on information obtained from an interview with one of the South Carolina coaters.

5.1.4 Cost of Control and Estimated Reduction of VOC Emissions

The overall costs of control of VOC emissions in accord with the proposed regulations were determined from:

- Generalized cost formulas based on estimated emissions and judgment as to the type of control to be used
- A development of capital, operating and energy requirements for the facilities that will be affected, based on the generalized cost correlations
- Aggregation of the findings for each plant affected.

The generalized cost correlations used are to be found in:

- Control of Volatile Organic Emissions From Stationary Sources, Volume I (EPA-450/2-76-028)
- Air Pollution Control Engineering and Cost Study of General Surface Coating Industry, Second Interim Report, Springborn Laboratories.

Additional cost data were supplied by equipment and material suppliers and published literature sources. Major coaters in South Carolina, as well as in other states, were consulted to determine industry views on acceptable control methods and, in some cases, to confirm the cost estimating formulas.

5.1.5 Economic Impacts

The projected effect of RACT implementation on price is based on an indicator which is the incremental cost related to the total sales or cost of the product produced. The procedure is described below:

- Relate incremental costs to the part of the statewide production that is affected by the regulation (firms not now meeting RACT) and clearly define these terms.

- Where data is available, show the range of ratios for individual locations.

- Where the industry has been segmented, show the range of cost ratios for applicable industry segments.

The cost per unit of production is an indicator of potential price effect rather than a prediction of the price effect to be expected.

The economic impacts were determined by analyzing the lead time requirements to implement RACT, assessing the feasibility of instituting RACT controls in terms of capital and equipment availability, comparing the direct costs of RACT control to various economic indicators and assessing the secondary effects on market structure, employment and productivity as a result of implementing RACT controls in the state.

5.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, cost and economic impact of implementing RACT controls on the surface coating of paper in South Carolina. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (data that are published for the base year), "B" indicates data that were extrapolated from hard data and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analysis of previous studies and best engineering judgment. Exhibit 5-1, on the following page, rates each study output listed and the overall quality of the data.

EXHIBIT 5-1
U.S. Environmental Protection Agency
DATA QUALITY--SURFACE COATING OF PAPER

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics		X	
Emissions			X
Cost of emissions control		X	
Economic impact			X
Overall quality of data		X	

Source: Booz, Allen & Hamilton Inc.

5.2 INDUSTRY STATISTICS

Industry characteristics, statistics and trends for paper coating in South Carolina are presented in this section. This information forms the basis for assessing the total impact of implementing RACT for control of VOC emissions in the state and for the affect upon individual firms.

5.2.1 Size of the Industry

The 1978 South Carolina Industrial Directory and Lockwoods' Directory report a total of 76 firms in 16 SIC categories in South Carolina where paper coating, as defined in proposed RACT guidelines, is the main business of the firm or may be a part of its manufacturing activity. The number of firms and other relevant statistics in each SIC grouping are summarized in Exhibit 5-2.

Total value of shipments for these firms is estimated to be about $973 million, with a total of about 20,000 employees. New capital expenditures are estimated to be about $98 million annually, based on the most recent (1976) Annual Survey of Manufactures.

Of the total 76 firms, five have been identified as actual paper coaters. (These are listed in Exhibit 5-5 in Section 5.3.5.) Of these, Bird & Son, Inc. is not covered under the proposed standard because it uses an exempt coating process and Bowater Carolina Corporation meets the proposed standard because all coating materials are water-based. The remaining three firms, which are potential emitters under the proposed standard[1], are expected to be impacted directly by the proposed standard. (See discussion in Section 2.4). The total annual value of shipments of these three firms is estimated at $34 million to $45 million based on an average of $60,000 to $80,000 of shipments per employee which is characteristic of firms in SIC 2641, paper coating.

For all five firms, the annual value of shipments is estimated at $102 million to $136 million.

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[1] A potential emitter is a plant which would exceed state emission limits if operated at rated capacity for 24 hours per day seven days a week.

EXHIBIT 5-2

U.S. Environmental Protection Agency
1977 INDUSTRY STATISTICS—SURFACE
COATING OF PAPER SIC GROUPS IN SOUTH CAROLINA

SIC Code	Description	Number of Plants	Total Number of Employees	Total Payroll ($1,000,000)	Estimated Value of Shipments[a] ($1,000,000)	Estimated New Expenditures[a] ($1,000,000)
2611	Pulp mills	2	893	16.1	1.22	23.0
2621	Paper mills, except building paper mills	2	54	.912	5.17	.477
2631	Paperboard mills	6	3331	57.0	194	46.8
2641	Paper coating and glazing	6	858	9.84	69.7	2.17
2643	Bags, except textile bags	6	1909	22.5	132	3 81
2645	Diecut paper and paperboard and cardboard	3	56	.688	3.97	.116
2649	Paper converting, n.e.c.	4	271	3.30	15.9	.325
2651	Folding paperboard boxes	3	229	3.06	13.1	.398
3291	Abrasive products	1	11	.152	.663	.0215
3292	Asbestos products	1	184	2.32	11.3	.241
3293	Gaskets, packing and sealing devices	6	1403	16.7	53.8	1.97
3497	Metal foil and leaf[b]	-	-	-	-	-
3679	Electronic components, n.e.c	22	6846	85.5	298	12.7
3842	Orthopedic, prosthetic and surgical appliances and supplies	13	3827	43.8	168	5.95
3861	Photographic equipment and supplies	1	70	1 23	6.00	.244
3955	Carbon paper and inked ribbons[b]	-	-	-	-	-
Total		76	19942	263.102	972.823	98.2225

a. Estimated by using ratios of (value of shipment/total employment) and (capital expenditures/ total employment) for each SIC group as published in 1976 Annual Survey of Manufacture where value of shipments or expenditures are not tabulated for the state.

b. None listed.

Source: Booz, Allen & Hamilton Inc.: 1976 County Business Patterns, and 1976 Annual Survey of Manufactures, U.S. Department of Commerce and the 1977 So[illegible] [illegible]ar[illegible] a[illegible] [illegible]tr[illegible] [illegible]ir[illegible] [illegible]ry.

5.2.2. Comparison of the Industry to the State Economy

A comparison of the value of shipments of the 65 plants in the 16 SIC categories listed in Section 5.1.1 with the total state manufacturing economy ($16.6 billion) indicates that these plants represent about 5.9 percent of the total value of manufacturing shipments in South Carolina. These 65 firms employ about 5.4 percent of the 371,000 manufacturing employees in the state. The five firms having paper coating operations represent 0.61 to 0.82 percent of the total value of manufacturing shipments in South Carolina and employ about 0.46 percent of all manufacturing employees.

The three directly impacted firms represent 0.20 to 0.27 percent of the total value of manufacturing shipments in South Carolina and employ about 0.15 percent of all manufacturing employees.

Because several of the firms manufacture other goods in addition to coated paper, the figures cited above probably represent an upper limit.

5.2.3 Historical and Future Patterns of the Industry

The nationwide value of shipments in the industries expected to be affected by the proposed paper coating regulations, in general, exceed the growth rate of the economy. As summarized in Exhibit 5-3, the value of shipments increased in every category between 1972 and 1976, with an average annual growth rate of about 12.1 percent over the period. Compared to an average inflationary rate of 6 to 8 percent, this is equivalent to a real growth rate of 4 to 6 percent. In some individual categories, growth rates were even greater. Paper production increased by an uncorrected average annual growth rate of 16.5 percent; metal and foil by 16 percent; paper coating and glazing by about 12 percent, only slightly less than the average. It is expected that the growth rate will continue at these rates for the near future.

EXHIBIT 5-3
U.S. Environmental Protection Agency
HISTORICAL TRENDS IN VALUE OF SHIPMENTS OF
U.S. PLANTS ENGAGED IN PAPER COATING ($ millions)

SIC Code	1972	1973	1974	1975	1976
2611	710	849	1,525	1,630	2,055
2621	6,385	7,514	9,942	9,650	11,768
2631	4,153	4,862	6,516	6,055	6,724
2641	1,954	2,284	2,645	2,626	3,074
2643	1,886	2,183	2,867	2,980	3,379
2645	676	747	923	943	1,027
2649	631	833	1,079	1,090	1,288
2651	1,487	1,644	1,890	1,952	2,223
3291	888	1,067	1,235	1,222	1,433
3292	763	823	963	900	988
3293	665	723	835	843	1,020
3499	702	753	973	1,065	1,267
3679	3,060	3,430	3,210	3,450	4,120
3842	1,450	1,620	1,800	2,090	2,240
3861	5,624	6,435	7,490	7,627	8,844
3955	237	268	309	285	294
Total	31,271	36,035	42,400	44,408	51,744

Source: 1976 Annual Survey of Manufactures, U.S. Department of Commerce.

5.3 TECHNICAL SITUATION IN THE INDUSTRY

This section briefly describes the general process and materials used in the surface coating of paper and similar products proposed to be included under the RACT Surface Coating of Paper regulations. The technology is fully described in the RACT documents.[1] The products include a myriad of consumer and industry oriented items, such as pressure-sensitive tapes, adhesive labels, book covers, milk cartons, flexible packaging materials and photographic film. Although many of these products are also printed in one manner or another, the emissions from printing inks are not included in the RACT regulations pertaining to paper coating; only the emissions specifically issuing from the coating operation are included. An estimate of these emissions for the state is also presented in this section.

5.3.1 General Coating Process Description

In organic solvent paper coating, resins are dissolved in an organic solvent mixture and this solution is applied to a web (continuous roll) of paper. As the coated web is dried, the solvent evaporates and the coating cures.

Most organic solventborne coating is done by paper converting companies that buy paper from the mills and apply coatings to produce a final product. The paper mills themselves sometimes apply coatings, but these are usually waterborne coatings consisting of a pigment (such as clay) and a binder (such as starch or casein). However, much additional coating is done by firms only as part of the manufacturing process.

Solvent emissions from an individual coating facility will vary with the size and number of coating lines. A plant may have one or as many as 20 coating lines. Uncontrolled emissions from a single line may vary from 50 pounds per hour to 1,000 pounds per hour, depending on the line size. The amount of solvent emitted also depends on the number of hours the line operates each day.

Exhibit 5-4 gives typical emission data from various paper coating applications.

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[1] Control of Volatile Organic Emissions From Existing Stationary Sources, Volume II, EPA-450/2-77-008

EXHIBIT 5-4
U.S. Environmental Protection Agency
EMISSION DATA FROM TYPICAL PAPER COATING PLANTS

Number of coating lines	Solvent Usage (lb./day)	Solvent Emissions (lb.day)	Control Efficiency (%)[a]	Control Device
2	10,000	10,000	-	None
5	15,000	15,000	-	None
8	9,000	9,000	-	None
2	1,200	1,200	-	None
10	24,000	950	96	Carbon adsorption
20	55,000	41,000	90	Carbon adsorption (not all lines controlled)
3	5,000	1,500	90	Carbon adsorption
3	21,000	840	96	Carbon adsorption
1	10,500	500	96	Afterburner

a. Neglecting emissions that are not captured in the hooding system.

Source: Control of Volatile Organic Emissions Existing From Stationary Sources, Vol. II, EPA-450/2-77-008.

5.3.2 Nature of Coating Materials Used

The formulations usually used in organic solventborne paper coatings may be divided into the following classes: film-forming materials, plasticizers, pigments and solvents. Dozens of organic solvents are used. The major ones are: toluene, xylene, methyl ethyl ketone, isopropyl alcohol, methanol, acetone and ethanol.

Although a single solvent is frequently used, often a solvent mixture is necessary to obtain the optimum drying rate. Too rapid drying results in bubbles and an "orange peel" effect in the coating; whereas, slow drying coatings require more time in the ovens or slower production rates. Variations in the solvent mixture also affect the solvent qualities of the mix.

The main classes of film formers used in conventional paper coating are cellulose derivatives and vinyl resins. The most commonly used cellulose derivative, nitrocellulose has been used for paper coating decorative paper, book covers and similar items since the 1920s. It is relatively easy to formulate and handle, and it dries quickly, allowing lower oven temperatures than vinyl coatings. The most common vinyl resin is the copolymer of vinyl chloride and vinyl acetate. These vinyl copolymers are superior to nitrocellulose in toughness, flexibility and abrasion resistance. They also show good resistance to acids, alkalies, alcohols and greases. Vinyl coatings tend to retain solvent, however, so that comparatively high temperatures are needed. In general, nitrocellulose is most applicable to the decorative paper field, whereas vinyl copolymers are used for functional papers, such as some packaging materials.

In the production of pressure-sensitive tapes and labels, adhesives and silicone release agents are applied using an organic solvent carrier. The adhesive layer is usually natural or synthetic rubber, acrylic or silicone. Because of their low cost, natural and synthetic rubber compounds are the main film formers used for adhesives in pressure-sensitive tapes and labels, although acrylic and silicone adhesives offer performance advantages for certain applications. In most cases, tapes and labels also involve the use of release agents applied to a label carrier or the backside of tape to allow release. The agents are usually silicone compounds applied in a dilute solvent solution.

5.3.3 Current VOC Emissions

This section presents the estimated VOC emissions from paper coating operations in South Carolina for the year 1977. A summary of applicable emissions for the paper coating RACT category is presented in Exhibit 5-5. Plants listed are believed to represent the major single sources of emissions in the five nonattainment counties and in total represent the major portion of paper coating emissions.

Applicable current emissions from paper coating in South Carolina are approximately 3,360 tons per year. This figure is based on plant-by-plant data in State of South Carolina files on companies expected to be affected by the regulations.

5.3.4 RACT Guidelines

The RACT guidelines for control of VOC emissions from the surface coating of paper require that emission discharges of VOCs be limited to 2.9 pounds per gallon of coating material delivered to the coating applicator.

The recommended methods of achieving this requirement are:

- The application of low solvent content coatings; or
- Incineration, provided that 90 percent of the nonmethane VOCs (measured as combustible carbon) which enter the incinerator are oxidized to carbon dioxide and water; or
- A system demonstrated to have control efficiency equivalent to or greater than provided by either of the above methods.

In the following section are discussed several methods of low solvent and solventless systems, which have been demonstrated to be applicable to some paper coating products, and the two principal add-on systems, incineration and carbon adsorption, generally used for emission control. This information has been extracted principally from the previously cited EPA report, Control of Volatile Organic Emissions from Existing Stationary Sources, Volume II (EPA-450/2-77-008), which should be consulted for a more thorough discussion. In some instances, additional information was obtained from coaters, coating material suppliers and control equipment manufacturers.

EXHIBIT 5-5

U.S. Environmental Protection Agency
COMPANY ESTIMATES OF PAPER COATING EMISSIONS
AS REPORTED TO BOOZ, ALLEN & HAMILTON

Company Name Location	SIC Code	Employees	Applicable Paper Coating Emissions Without Control (tons per year)	Current Control Method[b]	Applicable Paper Coating Emissions With Current Controls (tons per year)
Amstar Corporation Charleston (Charleston)	2643	102	207	none	207
Anchor Continental Co. Columbia (Richland)	2641 3842	400	8000	Carbon adsorption	4047[f]
Bird & Son, Inc. Charleston (Charleston)	2952	250	ab	none	-
Bowater Carolina Corp. Catawba (York)	2641	878	none[c]	none	none
Carolina Gravure Lexington (Lexington)	3861	70	30	none	30
Totals		1700[d]	8237		4284[e]

[a] Not reported.

[b] This firm uses an exempt coating process.

[c] This firm uses water-based coating materials exlusively.

[d] The three firms directly impacted by the proposed regulation employ 572 people.

[e] The three firms directly impacted by the regulation emit 3,357 tons per year.

[f] Applicable emissions under RACT guidelines are 3,120 tons per year.

5.3.5 Low Solvent and Solventless Coatings

In Exhibit 5-6, on the following page, are listed several types of coating materials which have found utility in paper coating, and an estimate of expected solvent reduction.

5.3.5.1 Waterborne Coatings

Waterborne coatings have long been used in coating paper to improve printability and gloss. However, newer coatings have been developed in which a synthetic insoluble polymer is carried in water as a colloidal dispersion or an emulsion. This is a two-phase system in which water is the continuous phase and the polymer resin is the dispersed phase. When the water is evaporated and the coating cured, the polymer forms a film that has properties similar to those obtained from organic-solvent-based coatings.

5.3.5.2 Plastisols and Organisols

Plastisols are a colloidal dispersion of synthetic resin in a plasticizer. When the plasticizer is heated, the resin particles are solvated by the plasticizer so that they fuse together to form a continuous film. Plastisols usually contain little or no solvent, but sometimes the addition of a filler or pigment will change the viscosity so that organic solvents must be added to obtain desirable flow characteristics. When the volatile content of a plastisol exceeds 5 percent of the total weight, it is referred to as an organisol.

Although organic solvents are not evaporated from plastisols, some of the plasticizer may volatilize in the oven. This plasticizer will condense when emitted from the exhaust stack to form a visible emission.

5.3.5.3 Hot Melt Coatings

Hot melt coatings contain no solvent; the polymer resins are applied in a molten state to the paper surfaces. All the materials deposited on the paper remain as part of the coating. Because the hot melt cools to a solid coating soon after it is applied, a drying oven is not needed to evaporate solvent or to cure the coating. Energy that would have been used to heat an oven and to heat makeup air to replace oven exhaust is therefore saved.

EXHIBIT 5-6
U.S. Environmental Protection Agency
ACHIEVABLE SOLVENT REDUCTIONS USING LOW
SOLVENT COATINGS IN PAPER COATING INDUSTRY

Type of Low Solvent-Coating	Reduction Achievable (%)[a]
Waterborne coatings	80-99
Plastisols	95-99
Hot melts	99+
Extrusion coatings	99+
Pressure-sensitive adhesives	
Waterborne	80-99
Hot melts	99
Prepolymer	99
Silicone release agents	
100 percent nonvolatile coatings	99+
Waterborne emulsions	80-99

[a] Based on comparison with a conventional coating containing 35 percent solids by volume and 65 percent organic solvent by volume.

Source: Control of Volatile Organic Emissions From Existing Stationary Sources, Volume II, EPA-450/2-77-008.

One disadvantage with hot melt coatings is that materials that char or burn when heated cannot be applied by hot melt. Other materials will slowly degrade when they are held at the necessary elevated temperatures.

5.3.5.4 Extrusion Coatings

A type of hot melt coating, plastic extrusion coating is a solventless system in which a molten thermoplastic sheet is discharged from a slotted die onto a substrate of paper, paperboard or synthetic material. The moving substrate and molten plastic are combined in a nip between a rubber roll and a chill roll. A screw-type extruder extrudes the coating at a temperature sometimes as high as 600°F. Low and medium density polyethylene are used for extrusion coating more than any other types of resins.

5.3.5.5 Pressure-Sensitive Adhesive Coatings

Waterborne adhesives have the advantage that they can be applied with conventional coating equipment. Waterborne emulsions, which can be applied less expensively than can solventborne rubber-based adhesives, are already in use for pressure-sensitive labels. A problem with waterborne adhesives is that they tend to cause the paper substrate to curl and wrinkle.

Prepolymer adhesive coatings are applied as a liquid composed of monomers containing no solvent. The monomers are polymerized by either heat or radiation. These prepolymer systems show promise, but they are presently in a developmental stage only.

5.3.5.6 Silicone Release Coatings

Silicone release coatings, usually solventborne, are sometimes used for pressure-sensitive, adhesive-coated products. Two low-solvent alternatives are currently on the market. The first is a 100 percent nonvolatile coating which is usually heat cured, but may be radiation cured. The second system is a water emulsion coating which is lower in cost than the prepolymer coating. However, because of wrinkling and other application problems the waterborne coating may be of limited value.

Some silicone coating materials which are under development use single solvent systems that can be readily recovered by carbon adsorption. Current coatings are troublesome since some silicone is carried into the adsorber where it clogs the carbon pores to reduce adsorption efficiency.

5.3.6 Incineration

Catalytic and direct thermal incineration processes convert hydrocarbons to carbon dioxide and water at high temperatures. Incineration is widely accepted as a reliable means of reducing hydrocarbon emissions by 90 percent or more.

Generally, the major disadvantage of this approach is the increased energy required to raise the exhaust gas temperatures above 1,200°F for direct incineration and 700°F for catalytic incineration. Another problem is the generation of nitrogen oxides in direct fired incinerators because of the exposure of air to high-temperature flames.

The increased energy consumption can, in some cases, be reduced or eliminated by heat exchange of the exhaust gases with fresh emissions (primary heat recovery) or by use of the hot incinerator exhaust gases in process applications (secondary heat recovery). Typical use of secondary heat recovery is for oven heat in drying or baking ovens. In fact, with efficient primary exchange and secondary heat recovery, total fuel consumption of an incinerator-oven system can be less than that for the oven before the incinerator is added. The heat required to sustain the system comes from the combustion of the volatile organic compounds in the exhausts.

Paper coaters who use coating machinery for a multiplicity of processes have commented that catalytic incineration would probably not be used because of the possibility of catalyst poisoning. Direct incineration would be used.

5.3.7 Carbon Adsorption

Carbon adsorption has been used since the 1930s for collecting solvents emitted from paper coating operations. Most operational systems on paper coating lines were installed because they were profitable. Pollution control has usually been a minor concern.

Carbon adsorption is most adaptable to single solvent processes. Many coaters using carbon adsorption have reformulated their coatings so that only one solvent is required. Toluene, a widely used solvent for paper coating, is readily captured in carbon adsorption systems.

The greatest obstacle to the economical use of carbon adsorption is that, in some cases, reusing recovered solvents may be difficult. In many coating formulations, a mixture of several solvents is needed to attain the desired solvency and evaporation rates. Also if different coating lines within the plant use different solvents and are all ducted to one carbon adsorption system, then there may be difficulty reusing the collected solvent mixture. In some cases, such as in the preparation of photographic films or thermographic recording paper, extremely high purity solvents are necessary to maintain product performance and even distillation may be insufficient to produce the quality of recovered solvent needed. For most other coating formulations, distillation is adequate.

Another problem with carbon adsorption is the potential of generating explosive conditions in the adsorber because of the localized increases in combustible organic material concentrations. Ignition apparently can be caused by static electricity in systems where dry air at high flow rates is treated. Several explosions of absorbers have been reported in paper coating and other plants.

Also, adsorption of solvents containing water soluble compounds (such as alcohols, ketones or esters) can present a secondary pollution problem in the water effluent, where steam is used for regeneration. Additional treatment of the condensed steam with its content of dissolved organics would be required, increasing the complexity of the solvent recovery system and its cost.

5.4 COST AND VOC REDUCTION BENEFIT EVALUATIONS FOR THE MOST LIKELY RACT ALTERNATIVES

This section discusses the projected costs of control for paper coating in the state based on the emissions as discussed in Section 5.3.3 of this report. Where possible, the validity of the costs were confirmed with coating firms and equipment manufacturers.

When possible, coaters in South Carolina have already switched to water-based or low solvent systems. One, Bowater Carolina Corporation is using water-based coating materials exclusively. Another firm which is preparing for a major expansion, will only add coating systems which meet the proposed requirements. Of the three firms using the current high solvent systems Anchor Continental will probably use carbon adsorption controls and Carolina Gravure and Amstar will probably use incineration with primary heat recovery. These estimates are based, in part, on interviews with the firms.

5.4.1 Costs of Alternative Control Systems

Carbon adsorption and incineration system costs were taken directly from EPA-450/2-76-028. The cost estimates for both systems are based on the assumption that exhaust air flow rates can be reduced sufficiently to attain low explosion limit (LEL) levels of 25 percent. This is possible with well-designed ovens where excess air can be reduced or where product characteristics allow. Lower LEL levels require higher air flow and thus result in higher control costs.

Several paper coaters indicate that achieving 25 percent of LEL may not be possible with some coating lines, particularly older ones, or with certain types of coatings. Coating drying rate is a function of air flow rate, temperature and vapor concentration in the air. If air flow rates are to be reduced, drying temperatures or drying times must be increased. Because of the heat sensitivity of some coatings, temperature increases may not be possible. Increase in drying time will necessitate either longer ovens or reduced production rates. Several coaters of heat sensitive products indicated that, to achieve special characteristics, they could not increase emission concentrations above 5 to 6 percent of LEL and could not use oven temperatures above 140°F. Plants manufacturing conventional coated products, however, can decrease air flow rates sufficiently to increase VOC concentrations in the exhausts to 40-50 percent of LEL with only moderate increases in temperatures or changes in production rates. It has been assumed, for cost estimation purposes, that a 25 percent LEL can be attained on the average.

Incinerator costs are a function of equipment size, which varies generally with air flow rate. In most plants, it is impractical to manifold exhausts so that all exhausts could be treated in one add-on emission control system. Also, it would be difficult to use secondary heat recovery on ovens where the incinerator is remote from the oven.

The major problem in estimating total installed costs of control systems is the added cost of installation. The estimates were made on the assumption of a moderately difficult retrofitted system. In specific situations, some coaters have found actual installed costs to be three to five times those presented in the EPA document referred to earlier.

5.4.2 Estimated Statewide Costs

The total emissions considered to be applicable under RACT, as discussed in Section 5.3.4 of this report, are about 3,360 tons per year for the three directly impacted firms. These firms have evaluated alternative control methods and would probably select an incineration system or carbon adsorption system.

Total costs of compliance are based on 3,120 tons per year of emissions being reduced by incineration and 240 tons per year of emissions being reduced by carbon adsorption. It is reported that one major manufacturer already has plans to control a higher portion of its emissions and may be able to meet the RACT limitations. Therefore, the costs of compliance included in this section would be overstated if no controls beyond those planned are required at this facility.

The air flow rates for each of the affected firms were determined on the assumption of a 25 percent approach to LEL, other assumptions summarized in Exhibit 5-7 and each firm's current estimated emissions. These air flow rates were then used to estimate costs from EPA-450/2-76-028.

By applying these cost estimating procedures, the capital costs for add-on incineration were estimated to be $1.98 million, with annualized costs of $852,000. Both are adjusted for inflationary increases from mid-1975 (base period for EPA-450/2-76-028 data) to mid-1977.

EXHIBIT 5-7
U.S Environmental Protection Agency
SUMMARY OF ASSUMPTIONS USED IN COST ESTIMATE

Assumptions

240 tons of emissions are controlled by incineration with primary and secondary heat recovery; 3,120 tons by carbon adsorption with recovered solvent credited at fuel prices.

25 percent LEL is equal to 4,250 ppm of methyl ethyl ketone by volume.

Air flow can be reduced to reach 25 percent LEL

The price of a 15,000 SCFM carbon adsorption system was used as an average. No costs are added for distillation or additional waste disposal. Incineration system costs were taken directly from EPA-450/2-76-028.

3,360 tons of emissions are treated per year over an operating period of 2,080 hours per year.

Other assumptions regarding incinerator and adsorber prices, as estimated in Control of Volatile Organic Emissions from Existing Stationary Sources, Vol. I: Control Methods for Surface-Coating Operations, EPA-450/2-76-028, are valid.

Source: Booz, Allen & Hamilton Inc.

However, discussions with equipment manufacturers and coaters and review of published information indicated that these capital costs are probably three to four times lower than those experienced in recent retrofit situations. This issue is also addressed in EPA-450/2-76-028 which indicated that baseline capital costs could be 1.5 to 3 times higher because of various retrofit difficulties.

Therefore, assuming a 3 to 4 multiplier for capital costs which includes an adjustment for inflationary increases from mid-1975 to mid-1977, it is estimated that actual capital costs in the five nonattainment counties are more likely to range from $5.12 million to $6.82 million with corresponding annualized costs of $.964 million to $1.33 million.

5.4.3 Estimated Emission Reduction

Assuming that 90 percent of all solvents used in coating operations can be collected by properly designed hoods and ovens, emissions could be reduced by about 2,722 tons per year. This is based on a 90 percent capture and 90 percent destruction of emissions in an incinerator (an overall reduction in emissions of 81 percent).

5.5 DIRECT ECONOMIC IMPACTS

This section presents the direct economic implications of the RACT guidelines for surface coating of paper on a statewide basis. The analysis includes the availability of equipment and capital; feasibility of the control technology; and impact on economic indicators, such as value of shipments, unit price (assuming full cost pass-through), state economic variables and capital investment.

5.5.1 RACT Timing

Current proposed guidelines for paper coating suggest several compliance deadlines for alternative methods of compliance.[1] Generally, for add-on systems, they call for installation of equipment and demonstration by mid-1980 or late 1980; for low solvent systems, by late 1980 or mid-1981, depending upon the degree of research and development needed. Major coaters, material suppliers and equipment manufacturers believe these deadlines to be unattainable.

- Normally, large incinerator and carbon adsorption systems will require about a year or more from receipt of purchase order to install and start up the system. Engineering may require three months or more, fabrication three to six months and installation and startup as long as three months.

- Only a few companies manufacture incineration systems with proven high heat recovery. The cumulative effect of equipment requirements by all firms in the U.S. needing control devices could severely impede the ability of these firms to supply equipment. In some cases, the most efficient devices are only now undergoing initial trials, and no production capacity has been developed.

In general, it appears that if add-on control systems are used, deadlines may have to be extended based on national demand.

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1 Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Source Categories, EPA-905/278001.

5.5.2 Technical Feasibility Issues

Though low solvent or solventless materials are used in many paper coating operations at present, many types of solvent-based systems currently have no satisfactory replacement. In many cases, the alternative materials do not meet the product quality standards demanded by the coaters and their customers. Additional development is needed and will require the combined efforts of both the coaters (who must maintain finished product quality) and the coating material suppliers. While the time required to develop the low solvent materials is difficult to estimate, it is unlikely that new coatings can be commercialized by 1981. Ideally, the new coating materials should be adaptable to existing coating equipment to minimize additional capital investment.

As discussed above, both incineration and carbon adsorption are not completely satisfactory add-on control systems. Incineration requires large volumes of additional fuel if good heat recovery is not accomplished; carbon adsorption is not usable on many coating systems because of the multiplicity of compounds used in solvent mixtures.

5.5.3 Comparison of Direct Cost with Selected Direct Economic Indicators

The net increase in annualized costs to coaters was estimated at $.964 million to $1.33 million. These additional costs are projected to represent 0.7 to 1.3 percent of the total annual value of shipments of the five firms coating paper in South Carolina and 2.1 to 3.9 percent of the shipments of the three firms directly impacted by the proposed regulations. Assuming a "direct passthrough" of these costs, prices at the three firms can be expected to increase by 2.1 to 3.9 percent.

The above estimates of price increase are based on a comparison of the cost of control with the total value of shipments by the affected firms. Since only a part of some of these firms' business represents paper coating operations impacted by the regulations, the price increase for the affected products would be higher. Such price increases would make these firms less competitive with firms not affected by similar regulations elsewhere.

The major economic impact in terms of cost to most individual companies will be the large capital expenditures required for add-on devices, rather than increased annualized costs. For most companies, these costs would exceed their current level of capital expenditures for plant improvement and expansion. A large pressure-sensitive paper coater in another state, for instance, has estimated that a capital investment of about $2 million would be needed to meet proposed guidelines. His current annual capital expenditure program is normally in the range of $1.5 million.

Another typical case is an out-of-state firm which manufactures various types of recording paper. Although with additional development, some of its coating solutions could be replaced with low solvent or waterborne ones, incineration or carbon adsorption would be the only method of complying with the regulation as now proposed. Based on projected costs for either of these add-on control systems, the firm is seriously considering terminating or moving operations. Similar financial difficulties are foreseen for marginally profitable firms which have limited capital access or for which the added annual costs of compliance are prohibitive.

5.5.4 Selected Secondary Economic Impacts

This section discusses the secondary impact of implementing RACT on employment, market structure and productivity.

Employment is not expected to be affected. Employment would be reduced if marginally profitable facilities closed, but the present indication from the industry is that plant closures will not occur.

No significant effect on overall productivity is foreseen, except for a small change resulting from the need for add-on control system operating and maintenance personnel. This may be compensated for by small increases in productivity in firms that gain business from those who close rather than meet the RACT requirements.

5.5.5 Impact of Compliance Upon Energy Consumption

Based on the assumption that 240 tons of affected emissions would be controlled by installation of direct fire incinerators with primary heat recovery (at 35 percent effeciency) and 3,120 tons by carbon adsorption, energy consumption is expected to increase by an amount equal to approximately 8,000 barrels of oil annually. This is equivalent to approximately 64 million cubic feet of natural gas annually. The estimate is based further on the assumption that oven exhausts are about 300°F, that about 8 pounds of steam are used per pound of solvent recovered and that a barrel of oil is equivalent to 6.0 x 10^6 BTUs. This increased requirement is considered to be negligible compared to current state consumption.

*   *   *   *

Exhibit 5-8 summarizes the conclusions reached in this study and the implications of the estimated costs of compliance for paper coaters.

EXHIBIT 5-8(1)

U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR PAPER COATERS IN
THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	Three plants in the state's non-attainment areas are expected to be affected by these regulations. However, if this category were to be interpreted to include all types of paper coating, including publishing, far more firms would be affected.
Indication of relative importance of the industrial sector to the state economy	The 1977 value of shipments of these three plants is estimated to be about \$34 to \$45 million. They are estimated to employ 572 people.
Current industry technology trends	Gravure coating replacing older systems.
1977 VOC emissions (actual)	Approximately 4,240 tons per year were identified from three plants affected. Of these 3,360 tons per year are applicable under RACT.
Industry preferred method of VOC control to meet RACT guidelines	Though low solvent use is increasing, progress is slow. Add-on control systems will probably be used.
Assumed method of control to meet RACT guidelines	Thermal incineration with primary heat recovery and carbon adsorption.

Affected Areas in Meeting RACT	Discussion
Capital investment	Estimated to be \$5.1 million to \$6.8 million depending on retrofit situations. This is likely to be more than 100 percent of normal expenditures for the affected paper coaters.
Annualized cost	\$1.0 million to \$1.3 million annually. This represents 2.1 to 3.9 percent of the value of shipments for the three firms directly affected.
Price	Assuming a "direct cost pass-through"-- 2.1 to 3.9 percent at the three affected firms.

EXHIBIT 5-8(2)
U.S. Environmental Protection Agency

Affected Areas in Meeting RACT	Discussion
Energy	Assuming 35 percent heat recovery from the incineration system, annual energy requirements are expected to increase by approximately 8,000 equivalent barrels of oil.
Productivity	No major impact.
Employment	No major impact.
Market structure	No major impact.
RACT timing requirements (1981)	RACT guideline needs clear definition for enforcement.
	Equipment deliverables and installation of incineration systems prior to 1981 are expected to present problems. Development of low solvent systems is likely to extend beyond 1981.
Problem areas	Retrofit situations and installation costs are highly variable.
	Type and cost of control depend on particular solvent systems used and reduction in air flow.
VOC emissions after control	Approximately 1,520 tons/year (36 percent of 1977 VOC emission level from three affected plants).
Cost effectiveness of control	\$396 - \$514 annualized cost/annual ton of VOC reduction.

Source: Booz, Allen & Hamilton Inc.

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Private conversations with:

A. R. Moore and Dr. Sereal of Anchor Continental
George Dusty of Bird & Son, Inc.
Robert Gregory of Bowater Carolina Corporation
Robert Van Amberg of Davol
Mr. Baldwin of Westvaco

6.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR PLANTS SURFACE COATING FABRICS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

6.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR PLANTS SURFACE COATING FABRICS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

This chapter presents a detailed analysis of the impact of implementing RACT for plants in the non-attainment areas of the State of South Carolina which are engaged in the surface coating of fabrics and vinyls. This RACT category is meant to include the roll, knife or rotogravure coating and oven drying of textile fabrics (to impart strength, stability, appearance or other properties), or of vinyl coated fabrics or vinyl sheets. It includes printing on vinyl coated fabrics or vinyl sheets to modify appearance but not printing on textile fabrics for decorative or other purposes. It does not, however, include the coating of fabric substrates with vinyl plastic polymers which are usually applied as melts or plastisols that result in only minor amounts of emissions. The chapter is divided into six sections:

- Specific methodology and quality of estimates
- Industry statistics
- The technical situation in the industry
- Alternative control methods
- Cost and VOC reduction benefit evaluations for the most likely RACT alternatives
- Direct economic impacts.

Each section presents detailed data and findings based on analyses of the RACT guidelines, previous studies of fabric coating, interviews with fabric and vinyl coaters, coating equipment and materials manufacturers, add-on control equipment manufacturers, and a review of pertinent published literature.

6.1 SPECIFIC METHODOLOGY AND QUALITY OF ESTIMATES

This section describes the methodology for determining estimates of:

- Industry statistics
- VOC emissions
- Processes for controlling VOC emissions
- Economic impacts

for plants in the state engaged in the surface coating of fabrics and vinyls. The quality of these estimates is discussed in the last part of this section.

6.1.1 Industry Statistics

The coating of fabrics is used to produce a large variety of common consumer and industrial products. Typical products are raincoats, upholstery, wall covering, tablecloths, window shades, gasketing, diaphragms, lifeboats and bookcovers. In most cases the finished product is manufactured by firms who purchase the coated fabric from a manufacturer whose principal activity is fabric coating. However, there are a number of vertically integrated firms (the major automobile manufacturers are typical) which both coat fabrics and manufacture finished goods from them. Other exceptions are firms which both manufacture fabrics and coat them. Thus firms which coat fabrics or vinyl coated fabrics or sheeting can be found in a number of Standard Industrial Classification categories; these are listed below:

SIC	Description
2211	Broad woven fabric mills, cotton
2221	Broad woven fabric mills, man-made and silk
2241	Narrow fabrics and other, small wares mills
2258	Warp knit fabric mills
2261	Finishers of broad woven fabrics of cotton
2262	Finishers of broad woven fabrics of man-made fiber and silk
2269	Finishers of textiles, n.e.c.*
2295	Coated fabrics, not rubberized
2297	Nonwoven fabrics
3069	Fabricated rubber products, n.e.c.*
3079	Miscellaneous plastics products
3291	Abrasive products
3293	Caskets, packing, sealing devices

*not elsewhere classified

General statistics concerning the firms included in these SIC groupings were obtained from the most recent Census of Manufactures, County Business Patterns and other economic summaries published by the U.S. Department of Commerce.

Data on industrywide shipments of coated fabrics were obtained from the Textile Economics Bureau (New York, New York). Identification of individual candidate firms which might be affected by the proposed regulation was made by review of industry directories:

- Davidson's Textile Blue Book
- Rubber Red Book
- Modern Plastic Encyclopedia
- Thomas Register of American Manufacturers
- South Carolina Directory of Manufacturers
- Membership list of the Canvas Products Association.

A list of establishments expected to be affected by the proposed fabric coating RACT regulations in the state was prepared and cross checked with a list of potentially affected firms supplied by the State Bureau of Air Quality Control. Approximately fifteen firms were interviewed by telephone and three firms were identified which have fabric coating operations. These firms were further interviewed by telephone by the study team to verify their emissions and type of coating operations. Only two firms which are identified in Section 6.2 were found to be affected by the proposed regulations. The other firm, Uniroyal, Inc., had potential emissions sufficiently low not to be affected.

6.1.2 VOC Emissions

The South Carolina Bureau of Air Quality Control's emission inventory and information obtained during telephone interviews with the affected firms were used as a basis for estimation of the total VOC emissions from the fabric coating plants identified. These are believed to represent 90 percent or more of the emissions in this RACT category. Emissions from fabric coating plants not identifed in the non-attainment areas, if they exist, are expected to be small and negligible.

6.1.3 Processes for Controlling VOC Emissions

Processes for controlling VOC emissions from fabric coating processes are described in Control of Volatile Organic Emissions from Existing Stationary Sources, Volume II (EPA-450/2-77-008). The feasibility of applying the various control methods to fabric coating discussed in this document was reviewed with coating firms, coating suppliers, coating equipment manufacturers and industry associations. These methods include both coating reformulation and the use of control devices, such as incinerators and carbon adsorbers.

Because of the wide variety of coating processes and coating materials in use, most methods of control will find some applicability. The situations where emissions are likely to be controlled by reformulation and by control devices were estimated based on a review of the literature and on information obtained from the interviews described above.

6.1.4 Cost of Control and Estimated Reduction of VOC Emissions

The overall costs of control of VOC emissions to meet the proposed regulations were determined from:

- Generalized cost formulae based on reported emissions and judgment as to the type of control to be used
- A development of capital, operating and energy requirements for the facilities that will be affected, based on the generalized cost formulae
- Aggregation of the findings for each plant affected.

The generalized cost formulae used are to be found in:

- Control of Volatile Organic Emissions from Stationary Sources, Volume I (EPA 450/2-76-028)
- Air Pollution Control Engineering and Cost Study of General Surface Coating Industry, Second Interim Report, Springborn Laboratories.

Additional cost data were supplied by equipment and material suppliers and published literature sources. Major coaters in

South Carolina, as well as in other states, were consulted to determine industry views on acceptable control methods and, in some cases, to confirm the cost estimating formulae.

6.1.5 Economic Impacts

The economic impacts were determined by: analyzing the lead time requirements to implement RACT; assessing the feasibility of instituting RACT controls in terms of capital availability and equipment availability; comparing the direct costs of RACT control to various state economic indicators; and assessing the secondary effects on market structure, employment and productivity as a result of implementing RACT controls in the state.

6.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, cost and economic impact of implementing RACT controls on the surface coating of fabrics in the state. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (data that are available for the base year), "B" indicates data that were extrapolated from hard data and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analysis of previous studies and best engineering judgement. Exhibit 6-1, on the following page, rates each study output listed and the overall quality of the data.

EXHIBIT 6-1
U.S. Environmental Protection Agency
DATA QUALITY--SURFACE COATING OF FABRICS

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics	X		
Emissions[a]	X		
Cost of emissions control			X
Economic impact			X
Overall quality of data			X

[a] Emission data obtained from South Carolina state emission inventory and from data supplied by the potentially affected manufacturers.

Source: Booz, Allen & Hamilton Inc.

6.2 INDUSTRY STATISTICS

Industry characteristics, statistics, and trends for fabric coating are presented in this section. This information forms the basis for assessing the total impact of implementing RACT for control of VOC emissions in this category upon the state economy and upon the individual firms concerned.

6.2.1 Size of the Industry

The Bureau of Census, in 1976 County Business Patterns, reported a total of about 38 plants in SIC categories in which plants coating fabrics in the non-attainment counties in South Carolina would be expected to be tabulated. Pertinent data concerning these plants are summarized in Exhibit 6-2, on the following page. As mentioned earlier based on a review of industrial directories and other published information, only three plants were found in which fabric coating, as defined in the proposed "fabric coating" regulation, is being used. Two of these are likely to be affected by the proposed regulations and are listed in Exhibit 6-3, following Exhibit 6-2.*

As shown, these two affected firms are estimated to employ a total of about 100 people in the fabric coating operations. The total annual value of shipments of the two firms is estimated at $7.1 million based on an average of $71,000 per employee, which is characteristic of firms in SIC 2295, fabric coating.

6.2.2 Comparison of the Industry to the State Economy

A comparison of the value of shipments of these plants with the state economy indicates that these plants represent a small percentage of the total value of shipments by manufacturing plants and employ about 0.2 percent of the manufacturing workers in the non-attainment counties.

6.2.3 Historical and Future Patterns of the Industry

The fabric coating industry in the U.S., except for the general economic slump in 1975, has shown a gradual but steady growth in sales and shipments over the last

* The third firm has a very small fabric coating operation that employs only two persons.

EXHIBIT 6-2
U.S. Environmental Protection Agency
INDUSTRY STATISTICS FOR PLANTS IN SIC CATEGORIES
WHERE FABRIC COATING MAY BE USED IN SOUTH CAROLINA

SIC	Name	Number of Firms	Number of Employees	Estimated Value of Shipments ($Million)	Estimated New Expenditures ($Million)
2211	Broad woven fabrics mills, cotton	11	4,555	160	5.3
2221	Broad woven fabric mills, man-made and silk	8	2,477	93	3.9
2241	Narrow fabrics and other, small wares mills	6	702	23	0.4
2258	Warp knit fabric mills	-	-	-	-
2261	Finishers of broad woven fabrics of cotton	4	1,619	54	1.6
2262	Finishers of broad woven fabrics of man-made fiber and silk	1	1,500	90	3.4
2269	Finishers of textiles, n.e.c.	-	-	-	-
2295	Coated fabrics, not rubberized	1	25	2	0.04
2297	Nonwoven fabrics	1	375	23	1.4
3069	Fabricated rubber products, n.e.c.	4	610	26	1
3079	Miscellaneous plastics products	10	747	31	1.8
3291	Abrasive products	-	-	-	-
3293	Gaskets, packing, sealing devices	1	425	16	0.6
		38[a]	13,035	515	19.5

[a] Several firms listed under more than one SIC code.

Source: 1976 Annual Survey of Manufactures, U.S. Department of Commerce.

Exhibit 6-3
U.S. Environmental Protection Agency
FIRMS EXPECTED TO BE AFFECTED BY THE
FABRIC COATING RACT REGULATIONS IN THE
NONATTAINMENT COUNTIES IN SOUTH
CAROLINA

Firm	Location	Total Employees	Employees in Fabric Coating	Activity
Raybestos Manhattan, Inc.	Charleston	850	65	Rubber Products, Rubber Coating
Rock Hill Printing and Finishing	Rock Hill	3,000	35	Various Coated Fabrics, Cotton and Synthetics Finishing

Source: Booz, Allen & Hamilton Inc.

several years as demonstrated by Exhibits 6-4 and 6-5, on the following pages. The largest growth in terms of dollar value of shipments was for vinyl coated fabrics which increased by $215.5 million in shipments from 1972 to 1976, compared with an increase of $301 million for all coated fabrics. Pyroxylin (cellulose nitrate) coatings, because of their low cost and ease of application, still continue to occupy a steady though proportionately smaller share of the market. Natural and artificial rubber coated fabrics, because of unique properties not obtainable with plastic materials, also maintain a substantial (about 10 percent) share of the coated fabric market. Vinyl and urethane coatings, however, are replacing a larger share of both markets.

EXHIBIT 6-4
U.S. Environmental Protection Agency
U.S. ANNUAL VALUE OF SHIPMENTS OF COATED FABRICS
($ millions)

Item	1972	1973	1974	1975	1976
Pyroxylin-Coated Fabrics	876.5	693.7	728.7	681.5	817.4
Pyroxylin-Coated Fabrics	26.3	27.3	34.5	28.0	32.5
Vinyl Coated Fabrics	601.9	693.7	728.7	681.5	817.4
Other Coated Fabrics	154.1	188.0	212.6	202.7	213.8
Coated Fabrics, not rubberized	26.3	27.4	(13.6)[a]	(1.4)[a]	(33.8)[a]
Rubber Coated Fabrics	67.9	73.6[b]	83.5[b]	72.0[b]	80.0[b]
TOTAL	876.5	1,011.9	1,156.5	985.6	1,177.5

Notes:

a. Values obtained by difference from gross shipments of all coted fabrics, not rubberized.

b. Booz, Allen estimate based on shipments of "Other Rubber Goods, N.E.C.", SIC Code 30698

Source: 1976 Annual Survey of Manufactures

EXHIBIT 6-5
U.S. Environmental Protection Agency
U.S. ANNUAL SHIPMENTS OF BACKING MATERIALS FOR COATED FABRICS
(in millions of pounds)

	1972	1973	1974	1975	1976
Transportation Fabric, all fibers[a]	95.4	100.9	64.6	65.3	81.5
Coated and Protective Fabrics[b]	133.7	149.3	167.5	137.8	177.6
TOTAL	229.1	250.2	232.2	203.1	259.1

Notes:

a. Transportation fabric includes auto seat upholstery and slipcovers, sidewall, headlining and sheeting. The cotton poundage include the knit and woven fabric used as the backing for vinyl sheeting. The item includes convertible auto tops & replacements thereof, as well as upholstery used in other kinds of transportation, such as airplanes, railroad & subway cars, buses, etc. It does not include seat padding, transportation rugs, window channeling flocking, tassels, trim, etc., or the textile glass fiber used in reinforced plastic seating for subways, buses, etc.

b. Coated and protective fabrics includes parachutes, deceleration chutes and tow targets; awning; beach, garden & tractor umbrellas; inflatable dunnage and cushions, air-supported structures and automotive air-spring diaphragms; boat and pool covers; tarpaulin covers for athletic fields, etc.; also, the substrates used for vinyl sheeting. The cotton poundage include awnings, boat covers, tarpaulins and tents. Not included here are the cotton poundages used for vinyl substrates. Such poundages are tabulated with their appropriate end use, i.e., transportation upholstery, upholstery etc. Does not include man-made fiber surfaces for recreational fields.

Source: Textile Economics Bureau, *Technicon*, November 1977

6.3 TECHNICAL SITUATION IN THE INDUSTRY

This section describes the principal materials and processes used in fabric and vinyl coating and various methods which are considered to be reasonably available control technology to meet proposed regulations. The proposed RACT guidelines for fabric coating and an estimate of the total VOC emission reduction possible if the guidelines are implemented in the state are also presented.

6.3.1 General Coating Process Description

Fabrics are coated primarily to render them resistant to penetration by various fluids or gases, improve abrasion resistance or modify the appearance or texture. Typical examples are materials used in shower curtains; rubber life rafts; balloons; drapery material; synthetic leathers for shoes, upholstery or luggage; table cloths; and outdoor clothing. The base fabrics can be asbestos fiber cloth, burlap and pile, cotton drill, duck canvas, glass fabrics, knit cotton or rayon, nonwoven fabrics or nylon sheeting. In the case of coating of vinyls, the substrate is a flexible vinyl sheet or cloth-supported vinyl on which a coating is applied to enhance the appearance or durability of the vinyl surface.

Typical coating materials are rubber compounds, vinyl resins of various types, polyesters, polyurethanes, nitrocellulose resins, oleo resins, phenolic resins, epoxy resins and polyethylene. Various techniques are used for applying these coatings as melts, plastisols, latexes, solutions or other forms. The proposed guidelines are primarily concerned with coatings applied as solutions, where large volumes of volatile organic materials can be emitted. Descriptions of the processes for coating with coating materials dissolved in organic solvents may be found in the EPA guideline series Control of Volatile Organic Emissions from Stationary Sources Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles and Light Duty Trucks, EPA-450/2-77-008, May 1977.

6.3.2 Emissions and Current Controls

The reported and potential VOC emissions from the two plants likely to be affected by RACT guidelines in the state are summarized in Exhibit 6-6 on the following page.

EXHIBIT 6-6
U.S. Environmental Protection Agency
REPORTED AND POTENTIAL EMISSIONS

Firm	Location	Estimated Actual Emissions (2000 hrs/yr)	Estimated Potential Emissions (8736 hrs/yr)
Raybestos-Manhattan, Inc.	Charleston	160 tpy	700 tpy
Rock Hill Printing and Finishing	Rock Hill	100 tpy	435 tpy

Source: Booz, Allen & Hamilton Inc.

The total estimated VOC emissions from fabric coating lines in these plants were 260 tons in 1977. No controls are now used by these plants.

6.3.3 RACT Guidelines

The RACT guidelines for control of VOC emissions from fabric coating require that emissions from coating lines be limited to a level of 2.9 pounds per gallon of coating for coating of fabric substrates and 3.8 pounds per gallon for coating of vinyl substrates. Both limits are based upon the use of an add-on device which recovers or destroys 81 percent of the VOC introduced in the coating. This the U.S. EPA considers to be achievable by capture of 90 percent of the VOC emissions and destruction of these emissions in an add-on device such as an incinerator. In some cases use of alternative low solvent or solventless coatings can also be used to meet these limits.

6.4 ALTERNATIVE CONTROL METHODS

In this section are briefly discussed methods of low solvent and solventless systems which have been demonstrated to be applicable to some fabric coating products, and the two principal add-on systems, incineration and carbon adsorption, generally used for emission control. This information has been extracted principally from the previously cited EPA report, Control of Volatile Organic Emissions from Existing Sources, Volumes I and II, which should be consulted for a more thorough discussion. In some instances, additional comment was obtained from coaters, coating material suppliers and control equipment manufacturers.

6.4.1 Low Solvent and Solventless Coatings

Organic emissions can be reduced 80 to 100 percent through use of coatings which inherently have low levels of organic solvents. Both high-solids and waterborne coatings are used. The actual reduction achievable depends on the organic solvent contents of the original coating and the new one. Using a coating which has a low organic solvent content may preclude the need for an emission control device. Often the coating equipment and procedures need not be changed when a plant converts to coatings low in organic solvent.

Although a number of companies have converted to low solvent coating, either in part or in total, one may not presume them to be universally applicable. Each coating line is somewhat unique and many coated fabrics have different specifications.

None of the plants identified were aware of suitable alternative coatings currently available which would meet the quality and performance standards required in all of their products. Some firms in the U.S. have over the last several years converted to waterborne coatings on some products and believe that if sufficient time were allowed for research and development a majority of their coatings could be replaced by low solvent ones. There may be some coatings which could not be replaced.

6.4.2 Incineration

Catalytic and direct thermal incineration processes convert hydrocarbons to carbon dioxide and water at high temperatures. Incineration is widely accepted as a reliable means of reducing hydrocarbon emissions by 90 percent or more.

Generally, the major disadvantage of this approach is the increased energy required to raise the exhaust gas temperatures over 1,200°F for direct incineration and 700°F for catalytic incineration. Natural gas is the most commonly used fuel though propane, fuel oils, or other fluid hydrocarbons can be employed. Fuel oil is not generally acceptable because of the sulfur oxides generated in combustion or the presence of catalyst poisons in the oil. Another problem is the generation of nitrogen oxides in direct fired incinerators resulting from the exposure of air to high-temperature flames.

The increased energy consumption can, in some cases, be reduced or eliminated by heat exchange of the exhaust gases with fresh emissions (primary heat recovery) or by use of the hot exhaust gases in process applications (secondary heat recovery). Typical use of secondary heat recovery is for oven heat in drying or curing ovens. In fact, with efficient primary exchange and secondary heat recovery, total fuel consumption of an incinerator-oven system can be less than that for the oven before the incinerator is added. The heat required to sustain the system comes from combustion of volatile organic compounds in the exhausts.

Both catalytic and direct fired systems are capable of high heat recovery efficiency if several conditions occur:

- VOC concentrations are or can be increased to 8-10 percent or more of their LEL (lower explosion limit).

- Oven temperatures are sufficently high to enable use of the sensible heat in the exhaust gases after primary heat exchange. Usually, oven temperatures above 140°F are sufficient to allow 85 percent or more overall heat recovery.

- Where catalytic incinerators are used, no compounds must be present in the gases treated which could poison or blind the catalyst.

In most coating operations, drying and curing temperatures are 250°F or higher. By reduction of air flow to reach exhaust levels of 8-10 percent or higher and proper design of the heat recovery system, it may be possible to achieve overall heat recoveries of 85 percent or greater.

6.4.3 Carbon Adsorption

Carbon adsorption has been used since the 1930s for collecting solvents emitted from coating operations. Most operational systems on coating lines were installed because they were profitable. Pollution control has usually been a minor concern. Carbon adsorption systems on coating lines range in size from a few thousand to tens of thousands of cubic feet per minute. Exhausts from several coating lines are often manifolded together to permit one carbon adsorption unit to serve several coating lines.

The greatest obstacle to the economical use of carbon adsorption is that, in some cases, reusing solvent may be difficult. In many coating formulations, a mixture of several solvents is needed to attain the desired solvency and evaporation rates. If this solvent mixture is recovered, it sometimes cannot be reused in formulating new batches of coatings. Also if different coating lines within the plant use different solvents and are all ducted to one carbon adsorption system, then there may be difficulty reusing the collected solvent mixture. In this case, solvents must be separated by distillation.

However, in some cases azeotropic, constant boiling, mixtures can occur which can be separated only by specialized techniques. Most coating firms would not have the skills necessary for the complex distillation and separation procedures needed. For small adsorption systems, the additional separation expenses would probably exceed the cost of fresh solvent.

Also, adsorption of solvents containing water soluble compounds (such as alcohols, ketones or esters) can present a secondary pollution problem where steam is used for bed regeneration. Additional treatment of the condensed steam with its content of dissolved organics would be required, increasing the complexity of the solvent recovery system and its cost.

6.5 COST AND VOC REDUCTION BENEFIT EVALUATIONS FOR THE MOST LIKELY RACT ALTERNATIVES

This section discusses the projected costs of control for fabric coating in the non-attainment areas of the state based on the emissions as discussed in Section 6.3.4 of this report. Where possible, the validity of the costs was confirmed with coating firms and equipment manufacturers.

The coaters interviewed in South Carolina indicated incineration as the most likely control method to comply with RACT guidelines.

6.5.1 Costs of Alternative Control Systems

Exhibit 6-7, on the following page, summarizes costs for a typical incineration system as developed by EPA sources. These costs are based on the assumption that exhaust flow rates can be reduced sufficiently to obtain LEL levels of 25 percent. This is possible with well-designed capture systems where intake air flows can be reduced or where product characteristics allow. Lower LEL levels require higher air flow and thus result in higher control costs.

Incinerator costs are a function of equipment size, which varies generally with air flow rate. In the two affected plants it would be practical to manifold exhausts so that all exhausts could be treated in one add-on emission control system. Also, it would be difficult to use secondary heat recovery on ovens where the incinerator is remote from the oven.

The major problem in estimating total installed costs of control systems is the added cost of installation. The estimates in Exhibit 6-7 were made based on the assumption of an easily retrofitted system. In specific situations, some coaters have found actual installed costs to be three to five times those summarized in Exhibit 6-7.

6.5.2 Estimated Statewide Costs

The total emissions considered to be applicable under RACT, as discussed in Section 6.3.4 of this report, are about 260 tons per year for the two potentially affected firms. The firms are likely to select an incineration method of compliance with the proposed regulations.

EXHIBIT 6-7
U.S. Environmental Protection Agency
INCINERATION COSTS FOR A TYPICAL FABRIC COATING LINE[a]

Incineration Device	Installed Cost ($)	Annualized Cost ($/yr.)	Control Cost[b,c] ($/ton of solvents recovered)
No heat recovery	315,000	88,000	890
Catalytic	298,000	92,000	920
Noncatalytic (Afterburner)			
Primary heat recovery			
Catalytic	402,500	102,000	1,020
Noncatalytic	385,000	100,000	1,000

a These costs are based on an air emission flow rate of 2,000 SCFM for a 25 percent LEL volatile organic content; oven temperature of 300°F and operating time of 2,000 hours per year. Other assumptions are as tabulated in EPA-450/2-76-028, Table 4-3 except capital costs are multiplied by 3.5 to account for common retrofit situations which may include modifications to improve collection system.

b In South Carolina plants are expected to require installation of incinerators for air flows from 2,300 to 4,000 SCFM. Use of smaller sized incinerators results in a higher $/ton control costs.

c These control costs in terms of $/ton as presented in Control of Volatile Organic Emissions from Existing Stationary Sources. Volume II, EPA-450/2-77-008 are about 1/20 of these values becasue of lower capital charges and use of the costs of a larger sized incinerator. This difference illustrates the misleading results of applying $/ton as a parameter in evaluating costs when different sizes of incinerators are used.

Source: Booz, Allen & Hamilton, Inc. revisions of data in EPA-450/2-76-028

Total costs of compliance were therefore based on 260 tons per year of emissions being treated by incineration.

For incineration costs, the capital and annualized costs presented in <u>Control of Volatile Organic Emissions from Existing Stationary Sources</u>, Vol. I (EPA-450/2-76-028) were used. This report projects estimated costs for the control system as a function of total air flow rate.

The air flow rate for one firm was obtained by interviewing plant personnel and was adjusted to reflect 25 percent of LEL. The air flow rate for the other affected firms was determined on the assumption of a 25 percent approach to LEL, other assumptions summarized in Exhibit 6-8 on the following page, and the firm's current estimated emissions. These air flow rates were then used to estimate costs from EPA-450/2-76-028.

By applying these cost estimating procedures, capital costs for incineration were estimated to be $274,000 with annualized costs of $75,000, of which $68,000 is capital charges. Both are adjusted for inflationary increases from mid-1975 (base period for EPA-450/2-76-028 data) to mid-1977 by using an average inflation rate of 8 percent per year.

However, discussions with equipment manufacturers and coaters and review of published information indicated that these capital costs are probably three to four times lower than those experienced in recent retrofit situations. This issue is also addressed in EPA-450/2-76-028 which indicated that baseline capital costs could be 1.5 to 3 times higher because of various retrofit difficulties.

Therefore, using multipliers of three and four it is estimated that actual capital costs in the non-attainment areas are more likely to range from $0.8 million to $1.1 million with corresponding annualized costs of $210,000 to $280,000.

The capital costs for each of the two affected firms would be approximately equal, and are estimated to vary from $400,000 for a multiplier of 3 to $500,000 for a multiplier of 4. The corresponding annualized costs would vary from $105,000 for a multiplier of 3 to $140,000 for a multiplier of 4. These costs are higher than those shown in Exhibit 6-7 because the affected plants have higher flow rates than that of the typical plant in Exhibit 6-7.

EXHIBIT 6-8
U.S. Environmental Protection Agency
SUMMARY OF ASSUMPTIONS USED IN COST ESTIMATE

Assumptions

90 percent of emissions are controlled by incineration with primary heat recovery; 90 percent of solvent emissions from the coating line are collected. Total reduction is 81 percent.

Air flow can be reduced to reach 25 percent LEL

Emission rate is constant over a period of 5,840 hours per year.

Other assumptions regarding incinerator prices and operating parameters,as estimated in Control of Volatile Organic Emissions from Existing Stationary Sources, Vol. I: Control Methods for Surface-Coating Operations, EPA-450/2-76-028, are valid.

Source: Booz, Allen & Hamilton Inc.

6.5.3 Estimated Emission Reduction

Assuming that 90 percent of all solvents used in coating operations can be collected by properly designed hoods and ovens, emissions could be reduced by about 210 tons per year. This is based on a 90 percent reduction of emissions in an incinerator (an overall reduction in emissions of 81 percent). This reducton represents 81 percent of those emissions affected by RACT (emissions from the two directly impacted firms).

6.6 DIRECT ECONOMIC IMPACTS

This section presents the direct economic implications of the RACT guidelines for surface coating of fabrics on a statewide basis. The analysis includes the availability of equipment and capital; feasibility of the control technology; impact on economic indicators, such as value of shipments, unit price (assuming full cost pass-through), state economic variables and capital investment; and impact on energy consumption.

6.6.1 RACT Timing

Currently proposed regulations for fabric coating in South Carolina suggest three sets of compliance deadlines for alternative methods of compliance.[1] For add-on systems, they call for installation of equipment and demonstration by May 1, 1981; for low solvent systems, by June 1, 1981 or December 1, 1981, depending upon the degree of research and development needed. Major coaters, material suppliers and equipment manufacturers believe these deadlines to be unattainable.

- Normally, large incinerator and carbon adsorption systems will require about a year or more from receipt of purchase order to install and start up the system. Engineering may require three months or more, fabrication three to six months and installation and startup as long as three months. A major paper coater with considerable experience with similar installations estimates that the complete cycle of installation, from initial selection of control method to testing of the system, would require 37 months plus an initial 13 months to establish an economically sound method of control.

- Only a small number of companies manufacture incineration systems with proven high heat recovery. The cumulative effect of equipment requirements of all firms in the U.S. needing control devices could severely impede the ability of these firms to supply equipment. In some cases, the most efficient devices are only now undergoing initial trials, and no production capacity has been developed.

> A major coating firm estimates that the use of low solvent or solventless coatings may take as long as 68 months from initial research, through product evaluation and customer acceptance to final production. Product and process development alone may take as long as 24 months and product evaluation over 14 months.

In general, it appears that if either add-on control systems are used or new low solvent systems need to be developed, deadlines may need to be extended.

6.6.2 Technical Feasibility Issues

As discussed above, low solvent or solventless materials are used in many coating operations. At present, however, many types of solvent-based systems have no satisfactory replacement. The alternative materials do not meet the product quality standards demanded by the coaters. Additional development is needed and will require the combined efforts of both the coaters (who must maintain product quality) and the coating material suppliers. Ideally, the new coating materials should be adaptable to existing coating equipment to minimize additional capital investment.

As discussed above, incineration is not a completely satisfactory add-on control system. Incineration requires large volumes of additional fuel if good heat recovery is not achieved.

6.6.3 Comparison of Costs with Selected Economic Indicators

The net increase in annualized operating costs to coaters was estimated at $210,000 to $280,000. These additional costs are projected to represent 2.9 percent to 3.9 percent of the total annual value of shipments of the two firms affected by the proposed regulations. Assuming a "direct passthrough" of these costs, prices can be expected to increase by about the same fraction. Such price increases would likely make these firms less competitive with firms not affected by similar regulations elsewhere.

The major economic impact in terms of cost to individual companies will probably be capital related rather than due to increased annual operating costs. Although the capital expenditure of $400,000 to $500,000 is significant, neither of the two potentially affected firms indicated it would consider closing that portion of its operations.

6.6.4 Selected Secondary Economic Impacts

This section discusses the secondary impact of implementing RACT on employment, market structure and productivity.

Total employment in the nonattainment counties is not expected to be significantly affected since only about 100 workers are employed in coating operations in the two plants that may be affected by the regulation.

Market structure is not expected to be affected by the proposed regulations. Productivity is not expected to be affected except for a short period when lines must be shut down for modifications or installation of equipment.

6.6.5 Impact of Compliance Upon Energy Consumpton

Based on the assumption that the affected emissions would be controlled by installation of direct fired incinerators with primary heat recovery only (at 35 percent efficiency), energy consumption is expected to increase by an amount equal to about 1,070 barrels of oil annually. The estimate is based further on the assumption that oven exhausts are about 300°F, and that a barrel of oil is equivalent to 6.0 x 10^6 BTUs. This increased requirement is considered to be negligible compared to current state consumption.

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Exhibit 6-9, on the following page, summarizes the conclusions and projected implications of the results from this study.

EXHIBIT 6-9(1)

U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR FABRIC COATERS IN THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	Two plants in the state's non-attainment areas are expected to be affected by these regulations.
Indication of relative importance of industrial sector to the state economy	The 1977 value of shipments of these two plants is estimated to be about \$7.1 million. They are estimated to employ 100 people in fabric coating operations.
Current industry technology trends	Newer plants are built with integrated coating and emission control systems; older plants are only marginally competitive now.
1977 VOC emissions (actual)	Current emissions are estimated at about 260 tons/year.
Industry preferred method of VOC control to meet RACT guidelines	Direct fired incineration
Assumed method of VOC control to meet RACT guidelines	Direct fired incineration with primary heat recovery.

Affected Areas in Meeting RACT	Discussion
Capital investment	Estimated to be \$0.8 million to \$1.1 million depending on retrofit situations.
Annualized cost	\$210,000 to \$280,000 annually.
Price	Assuming a "direct cost pass-through"--3 to 4 percent.
Energy	Assuming 35 percent heat recovery, annual energy requirements are expected to increase by approximately 1,070 equivalent barrels of oil.
Productivity	No major impact.
Employment	No major impact.
Market structure	No major impact.

EXHIBIT 6-9(2)

U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR FABRIC COATERS IN
THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Affected Areas in Meeting RACT	Discussion
RACT timing requirements (1981)	RACT guideline needs clear definition prior to enforcement. Nationwide, equipment deliverables and installation of incineration systems prior to 1981 are expected to present problems. Development of low solvent systems is likely to extend beyond 1981.
Problem areas	Retrofit situations and installation costs are highly variable. Type and cost of control depend on particular solvent systems used and reduction in air flow.
VOC emissions after RACT control	Approximately 50 tons/year (19 percent of 1977 VOC emissions level from affected plants.
Cost effectiveness of RACT control	$1,004 to $1,327 annualized cost/annual ton of VOC reduction.

Source: Booz, Allen & Hamilton Inc.

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Raybeston-Manhattan, Inc., Charleston, S.C.

Rock Hill Printing and Finishing, Rock Hill, S.C.

11.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR SOLVENT METAL DEGREASING IN THE NON-ATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

11.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR SOLVENT METAL DEGREASING IN THE NON-ATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA[1]

This chapter summarizes the estimated economic impact of the implementation of reasonably available control technology for volatile organic compound emissions from solvent metal degreasers in urban areas that are designated as non-attainment in South Carolina. Solvent metal degreasing is the process of cleaning the surfaces of articles to remove oil, dirt, grease and other foreign material by immersing the article in a vaporized or liquid organic solvent. The chapter is divided into five sections:

- Specific methodology
- Industry statistics
- Estimated costs of RACT implementation
- Direct economic impacts
- Selected secondary economic impacts.

Each section presents detailed data and findings based on analysis of the RACT guidelines; previous studies of metal degreasing; interviews with degreaser users and equipment and material suppliers; and a review of pertinent published literature.

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1 The economic impact of RACT guidelines in the State of South Carolina is examined for urban non-attainment counties only, which include Charleston, Lexington, Richland and Berkley.

11.1 SPECIFIC METHODOLOGY

11.1.1 Background

Solvent metal cleaning describes those processes using nonaqueous solvents to clean and remove soils from metal surfaces. These solvents, which are principally derived from petroleum, include petroleum distillates, chlorinated hydrocarbons, ketones and alcohols. Organic solvents, such as these, can be used alone or in blends to remove water-insoluble soils for cleaning purposes and to prepare parts for painting, plating, repair, inspection, assembly, heat treatment or machining.

Solvent metal cleaning can be divided into three categories: cold cleaning, open top vapor degreasing and conveyorized degreasing.

Cold cleaner operations include spraying, brushing, flushing and immersion of articles in a solvent. The solvent is occasionally heated but always remains well below its boiling point.

The two basic types of cold cleaners are maintenance cleaners and manufacturing cleaners. The maintenance cold cleaners are usually simpler, less expensive and smaller. They are designed principally for automotive and general plant maintenance cleaning. Manufacturing cold cleaners usually give a higher quality of cleaning than maintenance cleaners do, and are thus more specialized. Manufacturing cold cleaning is generally an integral stage in metal working production. There are fewer manufacturing cold cleaners than maintenance cleaners, but the former tend to emit more solvent per unit because of the larger size and workload. Manufacturing cleaners use a wide variety of solvents, whereas maintenance cleaners use mainly petroleum solvents such as mineral spirits (petroleum distillates and Stoddard solvents). Some cold cleaners can serve both maintenance and manufacturing purposes and are thus difficult to classify.

Cold cleaners are estimated to result in the largest total emission of the three categories of degreasers because there are so many of these units (more than 1 million nationally) and because much of the waste solvent that is disposed of is allowed to evaporate.

Open top vapor degreasers clean only one workload at a time. They clean through the condensation of hot solvent vapor on colder metal parts. The condensing solvent both dissolves oils and provides a washing action to clean the parts. The selected solvents boil at much lower temperatures than do the contaminants; thus, the solvent/soil mixture in the degreaser boils to produce an essentially pure solvent vapor. One section of the degreaser is equipped with a heating system that uses steam, electricity or fuel combustion to boil the solvent. As the solvent boils, the dense solvent vapors displace the air within the equipment. The upper level of these pure vapors is controlled by condenser coils which are supplied with a coolant such as water. Nearly all vapor degreasers are equipped with a water separator which allows the water (being immiscible and less dense than solvents) to separate from the solvent and decant from the system while the solvent flows from the bottom of the chamber back into the vapor degreaser.

The third category of degreasers is conveyorized degreasers. There are several types operating both with cold and vaporized solvents. The types of conveyorized degreasers include crossrod, rotating wheels, conveyor belts, and monorails as well as other systems which convey the parts through the degreasing medium.

In conveyorized equipment, most, and sometimes all, of the manual parts handling associated with open top vapor degreasing has been eliminated. Conveyorized degreasers are nearly always hooded or covered. The enclosure of a degreaser diminishes solvent losses from the system as the result of air movement within the plant. Conveyorized degreasers are used by a broad spectrum of metal working industries but are most often found in plants where there is enough production to provide a constant stream of products to be degreased.

The EPA has estimated[1] that about 1.3 million cold cleaners operate in the U.S.; about 70 percent are used in maintenance or service cleaning and 30 percent in manufacturing. There are also an estimated 22,200 open top vapor degreasers and 4,000 vapor conveyorized degreasers. In 1975, estimated emissions in the United States from these cleaners exceeded 700,000 metric tons, making solvent cleaning the fifth largest stationary source of organic emissions.

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[1] Control of Volatile Organic Emissions from Solvent Metal Cleaning, EPA-450/2-77-022, November 1977.

As recently as 1974, degreasing operations were exempt from regulation in 16 states, since they rarely emitted more than the 3,000 pounds per day of volatile organic compounds (VOC) which was the regulatory level then in effect in these states. They could also qualify for exemption by the substitution of a solvent not considered to be photochemically active. However, the EPA's current direction is toward positive reduction of all VOC emissions, and the EPA has proposed control technology for solvent metal cleaning operations which can achieve sizeable total VOC emission reduction. This technology involves the use of proper operating practices and the use of retrofit control equipment.

Proper operating practices are those which minimize solvent loss to the atmosphere. These include covering degreasing equipment whenever possible, properly using solvent sprays, employing various means to reduce the amount of solvent carried out of the degreaser on cleaned work, promptly repairing leaking equipment and most important, properly disposing of wastes containing volatile organic solvents.

In addition to proper operating practices, many control devices can be retrofitted to existing degreasers; however, because of the diversity in their designs, not all degreasers require the same type of control devices. Small degreasers using a room temperature solvent may require only a cover, whereas large degreasers using boiling solvent may require a refrigerated freeboard chiller or a carbon adsorption system. Two types of control equipment which will be applicable to many degreaser designs are drainage facilities for cleaned parts and safety switches and thermostats, which prevent large emissions from equipment malfunction. These controls, the types of degreasers to which they can be applied and the expected emission reductions are described later in this chapter.

11.1.2 Method of Estimation of the Number of Degreasers

Subsequent estimation of the economic impact of implementing the proposed RACT for solvent metal cleaning is based upon a determination of the number of solvent metal cleaners in the state. This determination was made on the basis of a detailed industrywide study of metal degreasing in the U.S., conducted by the Dow Chemical Company under contract to the EPA. The results of the study are reported in: Study to Support New Source Performance Standards for Solvent Metal Cleaning Operations, Contract No. 68-02-1329, June 30, 1976.

The report was based on a telephone survey of more than 2,500 plants in the metal working industry (SIC groups 25, 33, 34, 35, 36, 37, 38 and 39) with more than 19 employees. The report presents estimates of the:

- Percentage of U.S. plants using solvent degreasing
- Percentage of plants using cold cleaners, open top vapor degreasers or conveyorized cleaners
- Average number and type of vapor degreasers used in these plants
- Distribution of these quantities by region.

All of these quantities are further identified by the eight metal working industries. In the report (based on the 1972 Census of Manufactures) 15,294 open top and 2,796 conveyorized vapor degreasers were estimated to be in use in the eight SIC groups; an additional 5,000 to 7,000 open top degreasers were estimated[1] to be in use in 1972 in manufacturing or service firms not included in one of the eight SIC groups or in firms with less than 20 employees.

To determine the number of open top and conveyorized vapor metal degreasers in the four urban non-attainment areas, first the number of plants with more than 19 employees in each of the eight SIC groups was determined. The average number of plants using solvent metal degreasing and the average number and type of cleaners used per plant were then obtained by using the factors presented in the Dow report. The results of these calculations and the factors used are tabulated in Exhibit 11-1, in section 11.2. The total number of open top degreasers was then estimated by multiplying the number expected to be used in the eight metal working SIC groups by the ratio of 22,200/15,200 (the ratio of total open top units in the U.S. to those used in the eight SIC groups in the U.S.).

Because of their expense and function, conveyorized vapor degreasing units are most likely to be used in

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1 Interviews with Parker Johnson, Vice President, Sales, Baron-Blakeslee Corp., Cicero, Illinois and with Richard Clement, Sales Manager, Detrex Chemical, Detroit, Michigan, July 1978.

manufacturing only. Therefore, the total number of these units in the four urban non-attainment counties was assumed to be the same as that calculated for the eight SIC metal working industries. The total number of conveyorized cleaners, vapor and cold, was then determined by multiplying the number of vapor conveyorized cleaners by 100/85, the EPA[1] estimated ratio of total conveyorized cleaners to vapor conveyorized cleaners in the U.S.

The number of cold cleaners in the four urban non-attainment counties was based on the Dow estimates of cold cleaning done in plants in the eight SIC metal working industries and the EPA estimate of 1,300,000 cold metal cleaners in the U.S., which include 390,000 in manufacturing use and 910,000 in maintenance or service use.[2] Then:

- The EPA estimates of all cold cleaners in manufacturing use in the U.S. were multiplied by the ratio of the number of plants in the metal working industries (SICs 25 and 33-39) in the non-attainment counties to the number in the U.S.

- The EPA estimates of all cold cleaners in maintenance and service use in the U.S. were multiplied by the ratio of the number of plants in the metal working industries plus selected service industries (SIC codes 551, 554, 557, 7538, 7539, 7964) for the affected areas to the number in the U.S. These service industries are expected to have at least one or more cold cleaners.

    - SIC 551 applies to industries categorized as new or used car dealers.

    - SIC 554 applies to industries categorized as gasoline service stations.

    - SIC 557 applies to industries categorized as motorcycle dealers.

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1 Control of Volatile Organic Emissions from Solvent Metal Cleaning, EPA-450/2-77-022, November 1977.

2 Cold cleaners in manufacturing use are meant to include only those cleaners employed in the manufacturing process; cold cleaners in maintenance and service use are those employed for this purpose by either manufacturing or service establishments.

- SIC 7538 applies to industries categorized as general automotive repair shops.
- SIC 7539 applies to industries categorized as automotive repair shops, n.e.c.
- SIC 7964 applies to industries categorized as armature rewinding shops.

The estimates of the total number of cold cleaners in the affected state obtained by these calculations are tabulated in Exhibit 11-2, following Exhibit 11-1.

11.1.3 Method of Estimation of Affected Degreasers

The RACT guidelines propose several exemptions for degreasers based on size, type of solvent used or emission rate.

- The RACT guidelines apply to cleaners with emissions over 15 pounds in any one day or 3 pounds in any one hour whichever is greater. It has been estimated[1] that about 70 percent of cold cleaners would have VOC emissions less than this and would not be affected.
- Cleaners used exclusively for chemical or physical analysis or determination of product quality and acceptance are to be exempt. Since few such cleaners exist, no correction was made to the estimated number of cleaners used in determining the estimated compliance costs.
- Those cleaners using 1,1,1 trichloroethane and trichlorotrifluoroethane are to be exempt. Estimates of the number of open top degreasers which use either of these solvents range from 35 percent to 60 percent.[2] For the purpose of calculating

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1 Interview with Safety-Kleen Co., Gray-Mills Co. and Kleer-Flo Co. personnel; these firms are manufacturers of cold solvent metal degreasing equipment.

2 Based on information in EPA 450/2-77-022, op. cit., and interviews with Baron-Blakeslee and Detrex Chemical personnel.

cost impacts in this study, 35 percent was used. About 10 percent of conveyorized cleaners are expected to be exempt[1] and about 20 percent of cold cleaners.[2]

Open top vapor degreasers with less than one square meter (10.8 square feet) air/vapor interface and conveyorized degreasers with less than two square meters (21.6 square feet) are to be exempt. This exemption applies to about 30 percent of open top cleaners and 5 percent of conveyorized degreasers.[1]

The guidelines leave open to the degreaser user the option of changing from nonexempt solvent to an exempt one. In most cases, this will require some modification of the degreaser and an additional expense for the modification. In this study it was assumed that no substitution is made.

No reliable information has been found which relates size of cleaner with solvent composition. Therefore, we have assumed a uniform distribution of solvent composition with cleaner size, i.e., the number of small cleaners using exempt solvents is the same as the number of large cleaners using exempt solvents. For instance, the total of affected open top vapor degreasers in the state was determined by multiplying the total number of open top vapor degreasers in the state by the fractions that are nonexempt by solvent use and by size, i.e.:

Number exempt by size = (Total number of open top degreasers) x (Fraction exempt by size, 0.3)

Number exempt by solvent = (Total number of open top degreasers - number exempt by size) x (Fraction exempt by solvent, 0.35)

Total number of affected (nonexempt) degreasers = (Total number of open top degreasers) - (Number exempt by size) - (Number exempt by solvent)

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1 Based on information in EPA 450/2-77-022, op. cit., and interviews with Baron-Blakeslee and Detrex Chemical personnel.

2 Dow report, op. cit.

The resulting estimate of the total number of degreasers in the state and those exempt from the proposed regulations by size and solvent composition are summarized in Exhibit 11-3, in section 11.2.

11.1.4 Method of Estimation of Number and Type of Retrofitted Controls Needed

The proposed regulations specify certain controls which can be retrofitted to existing solvent metal cleaners. These are discussed in detail in a later section of this chapter. Briefly they are:

- For affected cold cleaners
  - A cover must be installed when the solvent used has a volatility greater than 15 millimeters of mercury at 38°C, or is agitated, or the solvent is heated; and
  - An internal drainage facility (or, where that is not possible, an external closed drainage facility) must be installed, such that the cleaned parts drain while covered when the solvent used has a volatility greater than 32 millimeters of mercury at 38°C; and
  - Where the solvent has a volatility greater than 32 millimeters of mercury at 38°C, a freeboard must be installed that gives a freeboard ratio (i.e., distance from cleaner top to solvent surface divided by cleaner width) greater than or equal to 0.7; or a water cover where the solvent is heavier and immiscible or unreactive with water; or some other system of equivalent control.
- For affected open top vapor degreasers--
  - The vapor degreaser must be equipped with a cover; and
  - A spray safety switch must be installed which shuts off the spray pump when the vapor level drops more than 4 inches; and

  - If the freeboard ratio is greater than 0.75, a powered cover must be installed or a refrigerated chiller; or an enclosure in which a cover or door opens only when the dry part is entering or exiting the degreaser; or a carbon adsorption system; or an equivalent control system.

- For affected conveyorized degreasers--

  - A refrigerated chiller; or carbon adsorption system; or another equivalent control system must be installed; and

  - The cleaner must be equipped with a drying tunnel or rotating basket to prevent cleaned parts from carrying out solvent; and

  - A condenser flow switch and thermostat, a spray safety switch and a vapor high level control thermostat must be installed; and

  - Openings must be minimized during operation so that entrances and exits silhouette workloads; and

  - Downtime covers must be provided for closing off the entrance and exit during shutdown hours.

Exhibits 11-14, 11-15 and 11-16, of this chapter, summarize estimates of the percentage of non-exempt cleaners needing these controls. Equipment manufacturers were the primary source of the percentages used. In applying this information, it was assumed that the number and type of control needed were independent of size.

11.1.5 Method of Estimation of Current Emissions and Expected Reductions

Current VOC emissions from solvent metal degreasing and the reductions anticipated by the enforcement of the proposed regulations are based on information presented in Control of Volatile Organic Emissions from Solvent Metal Cleaning, EPA-450/2-77-022, November 1977. This report estimates average emissions for each type of degreaser. The total current emissions were obtained by multiplying these estimated average emissions by the number of each type of degreaser in the affected areas of the state.

The report also estimates the reduction in emissions possible by implementation of various types of controls. The methods proposed in recent EPA guidance can result in reduction of 50 percent to 69 percent for various types of degreasers. Emission levels which would result from implementation of the RACT proposals for solvent metal cleaners was obtained by use of these estimated reductions for the number of affected cleaners in the state. For purposes of estimation, a 50 percent reduction was used for cold cleaners. For open top vapor and conveyorized cleaners, a 60 percent reduction was used.

11.1.6 Method of Estimation of Compliance Costs

Compliance costs also were based primarily on the cost data presented in the EPA report, Control of Volatile Organic Emissions from Solvent Metal Cleaning, for average-sized, cold, open top vapor and conveyorized cleaners. These cost data, however, were verified by discussions with equipment manufacturers. Where some costs, such as for safety switches or downtime covers, were not estimated in the report, estimates were made based on further discussions with equipment manufacturers. In the EPA report, costs were presented for various retrofit control options; in each case the control which would provide minimum net annualized costs was used in the estimates made here. Other costs not presented in the EPA report were determined as follows:

- Capital costs for safety switches, minimizing conveyorized cleaner openings, and downtime cover capital costs were estimated on the basis of discussions with equipment manufacturers. Costs used were:
  - $300 per manual cover and $100 per safety switch installation for open top vapor degreasers
  - $250 per safety switch installation, $300 per downtime cover installation, $2,500 per drying tunnel, and $1,000 for reducing openings for conveyorized cleaners.
- $300 was used as an average cost for increasing freeboard of cold cleaners using high volatility solvents.

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1 EPA-450/2-77-022

- Annual capital charges were estimated as 25 percent of capital costs, to include depreciation, interest, maintenance, insurance and administrative costs.

- Labor costs for mounting downtime covers on conveyorized cleaners at shift end were estimated at $1,500 per year per cleaner.

- Additional costs which might result from decreased productivity, labeling and other requirements of the proposed regulations were assumed to be small and negligible.

11.1.7 Quality of Estimates

Several sources of information were utilized in assessing the emissions, direct compliance cost and economic impact of implementing RACT controls on plants using solvent metal degreasers in the four urban non-attainment counties in South Carolina. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data, "B" indicates data that was not available in secondary literature and was extrapolated from hard data (i.e., data that is published for the base year) and "C" indicates data was estimated based on interviews, analyses of previous studies and best engineering judgment. Exhibit 11-1A, on the following page, rates each study output and overall quality of the data.

EXHIBIT 11-1A
U.S. Environmental Protection Agency
DATA QUALITY

Study Outputs	A "Hard Data"	B "Extrapolated Data"	C "Estimated Data"
Industry statistics		X	
Emissions		X	
Cost of emissions control		X	X
Statewide costs of emissions			X
Overall quality of data		X	

Source: Booz, Allen & Hamilton Inc.

11.2 INDUSTRY STATISTICS

This section summarizes an estimation of the total number of solvent metal cleaners affected in the state determined by the methods discussed in section 11.1.2 of this report. These estimates include only the four urban non-attainment areas of South Carolina. As shown in Exhibits 11-1 and 11-2, on the following pages, a total of 25 open top vapor degreasers, 5 conveyorized degreasers and 2,723 cold cleaners are estimated to be in use in the urban non-attainment areas in manufacturing, maintenance or service. As discussed earlier, not all of these will be subject to RACT regulations because of size or solvent exemptions. About 30 percent of open top vapor degreasers, 5 percent of conveyorized degreasers and 70 percent of cold cleaners are expected to be exempt on the basis of size. About 35 percent of open top vapor degreasers, 10 percent of conveyorized degreasers and 20 percent of cold cleaners are expected to be exempt because they use exempt solvents 1,1,1-Trichloroethane or Freon 113. Applying these factors results in the total of affected cleaners shown in Exhibit 11-3, following Exhibit 11-2.

It is difficult to estimate the number of establishments affected by the regulations, since a plant may have one or many cleaners of each type. In fact, large-scale users may have more than 100 degreasing operations in one plant location. Metal working industries would be major users; eight SIC codes, 25 and 33-39, cover these industries.

These classifications include such industries as automotive, electronics, appliances, furniture, jewelry, plumbing, aircraft, refrigeration, business machinery and fasteners. However, use of solvent cleaning is not limited to those industries, since many cleaners are used, for both manufacturing and maintenance, in nonmetal working industries such as printing, chemicals, plastics, rubber, textiles, paper and electric power. Also, most automotive, railroad, bus, aircraft, truck and electric motor repair stations use metal solvent cleaners at least part time.

EXHIBIT 11-1 (1)
U.S. Environmental Protection Agency
ESTIMATED NUMBER OF VAPOR DEGREASERS
IN SOUTH CAROLINA[c]
(Four Urban Non-Attainment Counties)

	SIC GROUP								
Item	25 Metal Furniture	33 Primary Metals	34 Fabricated Products	35 Nonelectrical Machinery	36 Electrical Equipment	37 Transptn. Equipment	38 Instruments and Clocks	39 Misc. Industry	Total
Number of South Carolina plants with more than 19 employees[a]	3	5	23	16	5	13	1	4	70
Percent of U.S. plants using solvent degreasing[b]	46	40	42	52	55	50	65	39	
Percent of South Carolina plants using solvent degreasing	44	38	40	50	53	48	62	37	
Number of South Carolina plants using solvent degreasing	1	2	9	8	3	6	1	1	31
Percent of U.S. plants using vapor degreasing	48	42	41	33	67	43	62	56	
Percent of South Carolina plants using vapor degreasing	40	35	34	27	55	36	51	46	
Number of South Carolina plants using vapor degreasing	0	1	3	2	2	2	1	0	11
Average number of vapor degreasers per U.S. plant	1.98	2.21	1.62	1.61	2.03	3.25	2.27	1.02	
Average number of vapor degreasers per South Carolina plant	1.76	1.96	1.44	1.43	1.80	2.88	2.01	0.90	
Number of vapor degreasers in South Carolina	0	2	4	3	4	6	2	0	21
Percent in U.S. as open top degreasers	73	79	79	81	87	87	94	89	

EXHIBIT II-1 (2)
U.S. Environmental Protection Agency
(South Carolina)

Item	SIC GROUP								Total
	25 Metal Furniture	33 Primary Metals	34 Fabricated Products	35 Nonelectrical Machinery	36 Electrical Equipment	37 Transptn. Equipment	38 Instruments and Clocks	39 Misc. Industry	
Percent in South Carolina as open top degreasers	67	72	72	74	80	80	86	82	
Number of open top vapor degreasers in South Carolina	0	2	3	2	3	5	2	0	17[c]
Number of conveyorized vapor degreasers in South Carolina	0	0	1	1	1	1	0	0	4[d]

Note: All data based on plants with more than 19 employees

a. Source: County Business Patterns, U.S. Dept. of Commerce, 1976.

b. Source of data on percentage of plants solvent degreasing, those with open top or conveyorized vapor degreasers and average numbers of degreasers per plant: Study To Support New Source Performance Standards for Solvent Metal Cleaning Operations, Dow Chemical Company under EPA Contract 68-02-1329, June 30, 1976.

c. To adjust quantities to account for vapor degreasers in other SIC groups multiply by the factor (22,200/15,200), the ratio of all open top vapor degreasers in U.S. to open top vapor degreasers in metal working SIC groups.

d. To adjust quantities to include cold conveyorized cleaners, multiply by 100/95, since conveyorized vapor cleaners are estimated to represent 85 percent of all conveyorized cleaners.

e. Number of degreasers rounded to the nearest whole integer.

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 11-2
U.S. Environmental Protection Agency
ESTIMATED NUMBER OF COLD
CLEANERS IN SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

	U.S.	South Carolina
Total number of plants in SIC Groups 25,33,34,35,36,37,38,39[a]	125,271	165
Estimated number of cold cleaners in manufacturing[b]	390,000	514
Total number of plants in service industries SIC 551,554,557,7538,7539,7964[a]	227,350	691
Estimated number of cold cleaners in maintenance and service use[b,c]	910,000	2,209
Estimated total number of cold cleaners[a]	1,300,000	2,723

Notes:

a. Source: 1976 County Business Patterns, U.S. Department of Commerce, 1976.

b. Source: Control of Volatile Organic Emissions From Solvent Metal Cleaning, EPA-450/2-77-022, November 1977.

c. This includes cold cleaners in maintenance and service applications in both manufacturing and repair firms.

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 11-3
U.S. Environmental Protection Agency
ESTIMATE OF AFFECTED SOLVENT METAL
CLEANERS IN SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

	Number of Cleaners by Type		
Exemption	Cold	Open Top Vapor	Conveyorized
Total number of cleaners	2,723	25	5
Number exempt by size	1,906	8	0
Number affected by size	817	17	5
Number further exempted by type of solvent used	163	6	1
Total number of affected cleaners	654	11	4

Source: Booz, Allen & Hamilton Inc.

As shown in Exhibit 11-1, 31 establishments in the SIC codes 25 and 33-39, with more than 19 employees, are estimated to use solvent metal degreasing. However, as shown in Exhibit 11-2, following Exhibit 11-1, there are a total of 165 plants in SIC groups 25 and 33-39 and an additional 691 plants in service industries; all of these are expected to have some type of solvent degreasers and could be potentially affected.

11.2.1 Proposed Emission Control Systems for Solvent Metal Cleaners

The EPA has proposed two different emission control methods, A and B, for each of the three types of cleaners: cold, open top vapor and conveyorized. The control methods can be combined in various ways to form a number of alternative control systems. Generally, control system A consists of proper operating practices and simple, inexpensive control equipment. Control system B consists of system A plus other devices that increase the effectiveness of control. Elements of control systems A or B can be modified to arrive at the level of control needed. The control systems are presented in the three exhibits, Exhibit 11-4, 5 and 6, on the following pages, and are briefly discussed below. In general, use of control system B has been proposed to maximize emission reductions.

11.2.1.1 Cold Cleaning Control Systems

The most important emission control for cold cleaners is the control of waste solvent. The waste solvent needs to be reclaimed or disposed of so that a minimum evaporates into the atmosphere. Next in importance are the operating practices of closing the cover and draining cleaned parts. Several other control techniques become significant only in a small fraction of applications.

The difference in effect between systems A and B (Exhibit 11-4) is not large because most of the cold cleaning emissions are controlled in system A. If the requirements of system A were followed conscientiously by nearly all of the cold cleaning operators, there would be little need for the additional system B requirements. However, because cold cleaning operators tend to be lax in keeping the cover closed, equipment requirements #1 and #4 in system B are added. Similarly, the modifications for #2 and the equipment requirements in #3 would effect significant emission reductions in a few applications.

The effectiveness of the control systems depends greatly on the quality of operation. On the average, system A is estimated to be able to reduce cold cleaning emissions by 50 (± 20) percent and system B may reduce it by 53 (± 20) percent. The low end of the range represents the emission reduction projected for poor compliance, and the high end represents excellent compliance. The expected benefit from system B is only slightly better than that for

EXHIBIT 11-4
U.S. Environmental Protection Agency
CONTROL SYSTEMS FOR COLD CLEANING

Control System A

Control Equipment:

1. Cover

2. Facility for draining cleaned parts

3. Permanent, conspicuous label, summarizing the operating requirements

Operating Requirements:

1. Do not dispose of waste solvent or transfer it to another party, such as that greater than 20 percent of the waste (by weight) can evaporate into the atmosphere.* Store waste solvent only in covered containers.

2. Close degreaser cover whenever not handling parts in the cleaner.

3. Drain cleaned parts for at least 15 seconds or until dripping ceases.

Control System B

Control Equipment:

1. Cover: Same as in System A, except if (a) solvent volatility is greater than 2 Kpa (15 mm Hg or 0.3 psi) measured at 38°C (100°F),** (b) solvent is agitated, or (c) solvent is heated, then the cover must be designed so that it can be easily operated with one hand. (Covers for larger degreasers may require mechanical assistance, by spring loading, counterweighting or powered systems.)

2. Drainage facility: Same as in System A, except that if solvent volatility is greater than about 4.3 Kpa (32 mm Hg or 0.6 psi) measured at 38°C (100°F), then the drainage facility must be internal, so that parts are enclosed under the cover while draining. The drainage facility may be external for applications where an internal type cannot fit into the cleaning system.

3. Label: Same as in System A

4. If used, the solvent spray must be solid, fluid stream (not a fine, atomized or shower type spray) and at a pressure which does not cause excessive splashing.

5. Major control device for highly volatile solvents: If the solvent volatility is 4.3 Kpa (33 mm Hg or 0.6 psi) measured at 38 C (100 F), or if solvent is heated about 50 C (120 F), then one of the following control devices must be used:

a. Freeboard that gives a freeboard ratio*** 0.7

b. Water cover (solvent must be insoluble in and heavier than water)

c. Other systems of equivalent control, such as refrigerated chiller or carbon absorption.

Operating Requirements:

Same as in System A

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* Water and solid waste regulations must also be complied with
** Generally solvents consisting primarily of mineral spirits (Stoddard) have volatilities 2 Kpa.
*** Freeboard ratio is defined as the freeboard height divided by the width of the degreaser.
Source: EPA-450/2-77-022, op. cit.

EXHIBIT 11-5(1)
U.S. Environmental Protection Agency
EPA PROPOSED CONTROL SYSTEMS FOR OPEN TOP VAPOR DEGREASERS

<u>Control System A</u>

Control Equipment:

1. Cover that can be opened and closed easily without disturbing the vapor zone.

Operating Requirements:

1. Keep cover closed at all times except when processing work loads through the degreaser.

2. Minimize solvent carry-out by the following measures:

a. Rack parts to allow full drainage.
b. Move parts in and out of the degreaser at less than 3.3 m/sec (11 ft/min).
c. Degrease the work load in the vapor zone at aleast 30 sec. or until condensation ceases.
d. Tip out any pools of solvent on the cleaned parts before removal.
e. Allow parts to dry within the degreaser for at least 15 sec. or until visually dry.

3. Do not degrease porous or absorbent materials, such as cloth, leather, wood or rope.

4. Work loads should not occupy more than half of the degreaser's open top area.

5. The vapor level should not drop more than 10 cm (4 in) when the work load enters the vapor zone.

6. Never spray above the vapor level.

7. Repair solvent leaks immediately, or shut down the degreaser.

8. Do not dispose of waste solvent or transfer it to another party such that greater than 20 percent of the waste (by weight) will evaporate into the atmosphere. Store waste solvent only in closed containers.

9. Exhaust ventilation should not exceed 20 m^3/min per m^2 (65 cfm per ft^2) of degreaser open area, unless necessary to meet OSHA requirements. Ventilation fans should not be near the degreaser opening.

10. Water should not be visually detectable in solvent exiting the water separator.

<u>Control System B</u>

Control Equipment:

1. Cover (same as in system A).

2. Safety switches

a. Condenser flow switch and thermostat - (shuts off sump heat if condenser coolant is either not circulating or too warm).

b. Spray safety switch - shuts off spray pump if the vapor level drops excessively, about 10 cm (4 in).

3. Major Control Device:

Either: a. Freeboard ratio greater than or equal to 0.75, and if the degreaser opening is $1m^2$ ($10\ ft^2$), the cover must be powered,

b. Refrigerated chiller,

c. Enclosed design (cover or door opens only when the dry part is actually entering or exiting the degreaser),

d. Carbon adsorption system, with ventilation 15 m^3/min per m2 (50 cfm/ft^2) or air/vapor area (when cover is open), and exhausting 25 ppm solvent averaged over one complete adsorption cycle, or

e. Control system, demonstrated to have control efficiency, equivalent to or better than any of the above.

4. Permanent, conspicuous label, summarizing operating procedures #1 to #6.

Operating Requirements:

Same as in System A.

Source: EPA-450/2-77-022, op. cit.

EXHIBIT 11-6
U.S. Environmental Protection Agency
EPA PROPOSED CONTROL SYSTEMS FOR CONVEYORIZED DEGREASERS

Control System A

Control Equipment: None

Operating Requirements:

1. Exhaust ventilation should not exceed 20 m^3/min per m^2 (65 cfm per ft^2) of degreaser opening, unless necessary to meet OSHA requirements. Work place fans should not be used near the degreaser opening.

2. Minimize carry-out emissions by:

a. Racking parts for best drainage.
b. Maintaining verticle conveyor speed at 3.3 m/min (11 ft/min).

3. Do not dispose of waste solvent or transfer it to another party such that greater than 20 percent of the waster (by weight) can evaporate into the atmosphere. Store waste solvent only in covered containers.

4. Repair solvent leaks immediately, or shut down the degreaser.

5. Water should not be visibly detectable in the solvent exiting the water separator.

Control System B

1. Major control devices; the degreaser must be controlled by either:

a. Refrigerated chiller,
b. Carbon adsorption system, with ventilation 15 m^2/min per m^2 (50 cfm/ft^2) of air/vapor area (when down-time covers are open), and exhausting 25 ppm of solvent by volume averaged over a complete adsorption cycle, or
c. System demonstrated to have control efficiency equivalent to or better than either of the above.

2. Either a drying tunnel, or another means such as rotating (tumbling) basket, sufficient to prevent cleaned parts from carrying out solvent liquid or vapor.

3. Safety switches

a. Condenser flow switch and thermostat - (shuts off sump heat if coolant is either not circulating or too warm).
b. Spray safety switch - (shuts off spray pump or conveyor if the vapor level drops excessively, e.g. 10 cm (4 in.)).
c. Vapor level control thermostat - (shuts off sump heat when vapor level rises too high).

4. Minimized openings: Entrances and exits should silhouette work loads so that the average clearance (between parts and the edge of the degreaser opening) is either 10 cm (4 in.) or 10 percent of the width of the opening.

5. Down-time covers: Covers should be provided for closing off the entrance and exit during shutdown hours.

Operating Requirements:

1. to 5. Same as the System A

6. Down-time cover must be placed over entrances and exits of conveyorized degreasers immediately after the conveyor and exhaust are shut down and removed just before they are started up.

Source: EPA-450/2-77-022, op. cit.

system A for an average cold cleaner because the additional devices required in system B generally control only bath evaporation, about 20 to 30 percent of the total emission from an average cold cleaner. For cold cleaners with high volatility solvents, bath evaporation may contribute about 50 percent of the total emission; EPA estimates that system B could achieve 69 (± 20) percent control efficiency, whereas system A might achieve only 55 (± 20) percent.

11.2.1.2 Open Top Vapor Degreasing Control Systems

The basic elements of a control system for open top vapor degreasers are proper operating practices and use of control equipment. There are about ten main operating practices. The control equipment includes a cover, safety switches and a major control device, either high freeboard, refrigerated chiller, enclosed design or carbon adsorption as outlined in Exhibit 11-5.

A vapor level thermostat is not included because it is already required by OSHA on "open surface vapor degreasing tanks." Sump thermostats and solvent level controls are used primarily to prevent solvent degradation and protect the equipment and thus are also not included here. The emission reduction by these controls is a secondary effect in any event. The two safety switches serve primarily to reduce vapor solvent emissions.

EPA estimates that system A may reduce open top vapor degreasing emissions by 45 (± 15) percent, and system B by 60 (± 15) percent. For an average-sized open top vapor degreaser, systems A and B would reduce emissions from 9.5 m tons/year down to about 5.0 and 3.8 m tons/year, respectively. It is clear that system B is appreciably more effective than system A.

11.2.1.3 Conveyorized Degreasing Control Systems

Control devices tend to work most effectively on conveyorized degreasers, mainly because they are enclosed. Since these control devices can usually result in solvent savings, they often will net an annualized profit. Two control systems for conveyorized degreasers as recommended by EPA are in Exhibit 11-6. Control system A requires only proper operating procedures which can be implemented, in most cases, without large capital expenditures. Control system B, on the other hand, requires a major control device.

Major control devices can provide effective and economical control for conveyorized degreasers. A refrigerated chiller will tend to have a high control efficiency, because room drafts generally do not disturb the cold air blanket. A carbon adsorber also tends to yield a high control efficiency, because collection systems are more effective and inlet streams contain higher solvent concentrations for conveyorized degreasers than for open top vapor degreasers.

11.2.2 Emissions and Expected Emission Reduction

In Exhibit 11-7, on the following page, are summarized the average emissions from solvent metal degreasers by type and also the percent emission reduction expected by implementation of Type B method of controls on nonexempt degreasers. The levels are based on estimated emissions as presented in the previously referenced EPA report (EPA 450/2-77-022) and represent current average emission levels and expected reductions achievable if emission controls are rigorously enforced. For estimation, 50 percent reduction was used for cold cleaners and 60 percent for open top vapor and conveyorized degreasers.

Exhibit 11-8, following Exhibit 11-7, presents the estimated current emissions from solvent metal degreasing and the expected emissions if the B methods of control are implemented for metal cleaners and proposed exemptions for size and type of solvent are implemented. As shown, emissions are expected to be reduced from about 1,330 short tons per year to a total of 980 short tons per year. The major portion of these emissions, 770 tons, are from solvent metal cleaners exempt from the proposed RACT regulations either by size or by the nature of solvent used. Implementation of the regulations is expected to reduce emissions by 350 tons per year (1,330-980).

EXHIBIT 11-7
U.S. Environmental Protection Agency
AVERAGE UNIT EMISSION RATES AND EXPECTED
EMISSION REDUCTIONS

EMISSION RATES WITHOUT CONTROLS

Type of Degreaser	Averaged Emission Rate Per Unit (short tons/yr.)
Cold cleaners, batch [a]	0.33
Open top vapor degreaser	11.00
Conveyorized degreaser	29.70

PERCENT EMISSION REDUCTION EXPECTED WITH TYPE B CONTROLS

Type of Degreaser	Percent Emission Reduction Expected
Cold cleaner, batch	
Low volatility solvents	53 (± 20)
High volatility solvents	69 (± 20)
Open top vapor degreaser	60 (± 15)
Conveyorized degreaser	60 (± 15)

a. Does not include emissions from conveyorized-type cold cleaners which represent about 15 percent of all conveyorized cleaners.

Source: EPA-450/2-77-022, op. cit.

EXHIBIT 11-8
U.S. Environmental Protection Agency
ESTIMATED CURRENT AND REDUCED EMISSIONS FROM
SOLVENT METAL CLEANING IN SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

Type of Cleaner	Estimated Current Emissions	Estimated From Nonexempt Cleaners After RACT	Estimated Emissions From Exempt Cleaners After RACT[a]	Estimated Total Emissions After RACT[a]
Open top vapor	280	50	60	110
Conveyorized	150	50	30	80
Cold	900	110	680	790
Total	1,330	210	770	980

a. Includes emissions from cleaners exempt by size or using 1,1,1-trichloroethane or Freon 113.

Source: Booz, Allen & Hamilton Inc.

11.3 ESTIMATED COSTS OF RACT IMPLEMENTATION

As discussed in Section 11.1.6 compliance costs are based upon EPA estimates of the costs and benefits of various retrofitted methods of control. These estimates are summarized in Exhibits 11-9 and 11-10, on the following pages.

Costs of implementation of the RACT regulations are summarized in Exhibits 11-11, 11-12 and 11-13 on the assumption that control methods B are used to maximize emission reduction on nonexempt cleaners. Exhibits 11-14, 11-15, and 11-16 summarize the number and type of controls needed by cleaner type as determined from interviews with cleaner manufacturers. Total expenditures for all cleaners, vapor and cold types, are estimated to be about $0.23 million in capital and about $0.03 million in net annualized costs. The low net annualized costs result primarily from the savings in solvent use which the regulations are expected to provide.

In no case are the regulations expected to present a severe financial burden to individual firms. The largest single expenditure would be for retrofitting a monorail conveyorized degreaser with chiller, switches, drying tunnel, reduced openings and downtime covers. Total cost for an average-sized degreaser of about 3.8 square meters area (40.9 ft^2) would be less than $12,500. A large unit, 14 square meters, would cost about $27,000 to $30,000. Since these conveyorized systems would only be used in large plants with large sales volumes, this implementation cost is not expected to present a hardship to any particular firm.

EXHIBIT 11-9
U.S. Environmental Protection Agency
CONTROL COSTS FOR COLD CLEANER
WITH 5.25 $ft.^2$ AREA

Item	Low Volatility Solvent[a]	High Volatility Solvent[b]
Installed capital ($)	25.00	365.00
Direct operating costs ($/yr.)	1.00	2.6
Capital related charges ($/yr.)	4.30	91.25
Solvent cost (credit) ($/yr.)	(4.80)	(39.36)
Annualized cost (credit) ($/yr.)	0.50	54.49

a. Costs include only a drainage facility for low volatility solvents.

b. Includes $65 for drainage facility, a mechanically assisted cover, and $300 for extension of freeboard.

c. Capital charges used in study estimate were 25 percent of capital instead of 17 percent used in EPA report.

Source: EPA-450/2-77-022, op. cit.

EXHIBIT 11-10
U.S. Environmental Protection Agency
CONTROL COSTS FOR AVERAGE-SIZED
OPEN TOP VAPOR AND CONVEYORIZED CLEANERS

1. CONTROL COSTS FOR TYPICAL SIZE OPEN TOP VAPOR DEGREASER
(Vapor to Air Area of 1.67 m^2)

Control Technique	Manual Cover	Carbon Adsorption[a]	Refrigerated Chiller	Extended Freeboard & Powered Cover
Installed capital ($)	300	10,300	6,500	8,000
Direct operating cost ($/yr.)	10	451	259	100
Capital related charges ($/yr.)	75	2,575	1,625	2,000
Solvent cost (credit) ($/yr.)	(860)	(1,419)	(1,290)	(1,161)
Net annualized cost (credit) ($/yr.)	(775)	1,607	594	939

2. CONTROL COSTS FOR TYPICAL CONVEYORIZED DEGREASERS
(Vapor to Air Vapor Area of 3.8 m^2)

	Monorail Degreaser		Crossrod Degreaser	
Control Technique	Carbon[a] Adsorber	Refrigerated Chiller	Carbon[a] Adsorber	Refrigerated Chiller
Installed capital (4)	17,600	8,550	17,600	7,460
Direct operating costs ($/yr.)	970	430	754	334
Capital related charges ($/yr.)				
Capital charges ($/yr.)	4,400	2,138	4,400	1,865
Solvent cost (credit) ($/yr.)	(5,633)	(5,633)	(2,258)	(2,258)
Annualized cost (credit) ($/yr.)	(263)	(3,065)	2,896	(59)

a. Not used in cost estimates since net annualized costs for carbon absorption are the highest for any control method.

b. Capital charges used in study estimate were 25 percent of capital instead of 17 percent used by EPA source.

Source: EPA 450/2-77-022, op. cit.

EXHIBIT 11-11
U.S. Environmental Protection Agency
ESTIMATED CONTROL COSTS FOR COLD CLEANERS
FOR THE STATE OF SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

1. CAPITAL COSTS

Item	Number of Degreasers Needing Conversion	Costs
Capital	445	$151,205

2. ANNUALIZED COSTS

Item	Costs
Direct operating costs	$ 1,104
Capital charges	37,301
Solvent cost (Savings)	(16,374)
Net annualized costs	$ 22,531

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 11-12
U.S. Environmental Protection Agency
ESTIMATED CONTROL COSTS FOR OPEN TOP
VAPOR DEGREASERS FOR THE STATE OF SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

1. CAPITAL COSTS

Item	Cost
Safety switches	$ 200
Powered covers	48,000
Manual covers	900
Total	$49,100

2. ANNUALIZED COSTS

Item	Cost
Direct operating costs	$ 630
Capital charges	12,175
Solvent cost (Savings)	(9,546)
Net annualized costs	$ 3,259

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 11-13
U.S. Environmental Protection Agency
ESTIMATED CONTROL COSTS FOR CONVEYORIZED DEGREASERS FOR THE STATE OF SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

1. CAPITAL COSTS

Item	Costs
Refrigerator chiller	
Monorail degreasers	$ 8,550
Crossrod degreasers	14,920
Safety switches	250
Drying tunnel	
Reduce openings	4,000
Downtime covers	1,200
Total	$ 28,920

2. ANNUALIZED COSTS

Item	Costs
Direct operating costs	$ 7,098
Capital charges	7,230
Solvent cost (Savings)	(10,149)
Net annualized cost	$ 4,179

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 11-14
U.S. Environmental Protection Agency
ESTIMATED NUMBER OF COLD CLEANERS
NEEDING CONTROLS IN THE STATE
OF SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

Type of Control	Percent of Cleaners Needing Control	Number of Cleaners[c] Needing Control
Drainage Facility[a]	5	33
Freeboard and[b] Drainage	63	412

a. Based on 10 percent of cleaners using low volatility solvents and half of these needing drainage facilities.

b. Based on 90 percent of cleaners using high volatility solvents and 70 percent of these needing additional freeboard and drainage.

c. Numbers rounded to nearest 10 units.

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 11-15
U.S. Environmental Protection Agency
ESTIMATED NUMBER OF OPEN TOP VAPOR
DEGREASERS NEEDING CONTROL IN THE
STATE OF SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

Type of Control	Percent of Cleaners Needing Control	Number of Cleaners Needing Control
Manual covers	30	3
Safety switches	20	2
Powered cover	60	6

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 11-16
U.S. Environmental Protection Agency
ESTIMATED NUMBER OF CONVEYORIZED
DEGREASERS NEEDING CONTROLS
IN THE STATE OF SOUTH CAROLINA
(Four Urban Non-Attainment Counties)

Type of Control	Percent of Cleaners Needing Control	Number of Cleaners Needing Control
Refrigerated chillers for monorail and miscellaneous type cleaners[a]	36	1
Refrigerated chillers for crossrod type cleaners	54	2
Safety switches	20	1
Drying tunnel	10	0
Minimized openings	90	4
Downtime covers	90	4

a. Refrigerated chillers were estimated to be needed only on about 90 percent of all conveyorized vapor degreasers; thus, the percent of units needed by monorail-miscellaneous and crossrod types add only to 90 percent.

Source: Booz, Allen & Hamilton Inc.

11.4 DIRECT ECONOMIC IMPLICATIONS

11.4.1 Time Required To Implement Proposed RACT Regulations

Because many degreasers are affected under the proposed regulation (11 open top vapor degreasers, 4 conveyorized degreasers and 614 cold cleaners in non-attainment areas alone) and because each requires retrofitting of a control device, some users may not be able to comply within proposed compliance schedules because of equipment availability. Discussions with personnel from the major manufacturers of vapor and cold degreasers reveal that none are prepared to provide the necessary controls in quantities to meet a cumulative U.S.-wide demand. Some cleaners could be converted to 1,1,1-trichloroethane and thus become exempt. In fact, many metal solvent cleaners have been converted to trichloroethane in the last few years in anticipation of RACT regulations. However, not all existing machines can be converted because of inadequate condensing sections or improper materials of construction. Trichloroethane can be extremely corrosive if stabilizers are insufficiently replenished. In fact, stainless steel vapor degreasers using 1,1,1-trichloroethane have been reported to fail because of corrosion following the loss of stabilizer.

11.4.2 Effect of Compliance Upon Selected Economic Indicators

Implementation of the proposed regulations is expected to have a negligible effect on South Carolina's statewide economy. Low capital and annual operating costs required by the solvent metal cleaner owners in meeting the proposed regulations are responsible for this minimal impact.

For example, South Carolina's estimated total capital expenditures in non-attainment counties for SIC groups 25 and 33-39 exceed $33 million for 1976. Total capital expenditures for retrofitting are estimated to be $0.23 million for all SIC groups in non-attainment counties, less than one percent of total capital expenditures for these counties.

Similarly implementation will have a negligible impact on total shipments, prices and the state economy as a whole. The total net annualized costs of the proposed regulations ($0.03 million) are negligible compared to the 1976 estimated total shipments of $3.5 billion in SIC groups 25 and 33-39 for the non-attainment areas.

Considering that these expenditures are spread over service industries and other industries not included in SIC's 25 and 33-39, the overall economic impact is even less significant.

Although solvent metal cleaners are particular to certain industries the proposed regulations are expected to not have an impact on the structure of the state industry. This is due to the dispersion of solvent metal cleaners over many industries and the minimal importance of solvent metal cleaning to the manufacturing processes.

Implementation of the regulations will reduce demand for metal cleaning solvents. This would result in a reduction in solvent sales of about $0.04 million annually which may result in a loss of employment for firms supplying metal cleaning solvents.

11.4.3 Effect of Compliance Upon Energy Consumption

Carbon adsorbers, refrigerated chillers and distillation units are the principal energy consuming control devices used for controlling degreasing emissions. The refrigerated chiller, which would probably be the preferred method of control because of its low capital and operating costs, will increase a degreaser's energy consumption by about 5 percent. The EPA has estimated consumption of 0.2 kw to 2.2 kw by a chiller, used on a typical open top vapor degreaser of $1.7m^2$ size.[1] For a typical conveyorized degreaser of about $3.8m^2$ size, consumption is estimated, on this basis, to be 0.5 kw to 5.0 kw. Only conveyorized degreasers are expected to use chillers to comply; and about 90 percent or 19 of these currently do not have chillers. Assuming 2,250 hours per year operation, total additional energy consumption annually would be about 21,300 kw-hours to 213,000 kw-hours. This is equal to $852 to $8,520 per year in additional power costs, at a cost of $0.04 per kw-hour. Most of this cost is recovered by savings in solvent use. A portion of the increase in energy consumption will be offset by reduced production and consumption of solvents; production because it takes energy to produce solvents and consumption because there is embodied energy in feedstocks such as petroleum distillates.

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1 EPA-450/2-77-022, op. cit.

11.5 SELECTED SECONDARY ECONOMIC IMPACTS

Implementation is also expected to have minor, if not negligible, impact upon other factors, such as employment, market structure and productivity. The proposed regulations include some change in work practices which will decrease productivity in the metal cleaning operation by 5 percent to 10 percent. Since metal cleaning is normally a minor step in the manufacturing or service process, any change in productivity and employment in user plants is expected to be insignificant.

There will, however, be some temporary increase in employment by those firms manufacturing such components as refrigeration chillers and drying tunnels, that may be required for retrofit controls. No estimates have been made because manufacturers of such components are located throughout the country. This temporary increase, however, may be balanced by a slight decrease in employment occurring because of lower solvent consumption. The decrease would occur primarily in shipping and repackaging operations.

The implementation of the RACT guidelines should not have any major affect on the current market structure of the industries using solvent metal cleaning. Cleaners requiring highest retrofitting costs (i.e., for conveyorized cleaners) are generally owned by large firms. Smaller firms would be expected to have only cold cleaners or open top vapor degreasers. The highest capital costs would be for an open top unit which would require an expenditure of $8,000 or less to comply. This is not expected to be a significant financial burden even to small-sized firms.

* * * *

Exhibit 11-17, on the following page, summarizes the conclusions presented in this report.

EXHIBIT 11-17
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR SOLVENT METAL DEGREASING
IN THE STATE OF SOUTH CAROLINA
(Non-Attainment Counties)

Current Situation	Discussion
Number of potentially affected facilities	About 700 plants in the four urban non-attainment counties
Indication of relative importance of industrial section to state economy	Value of shipments of firms in SIC groups affected for non-attainment counties is approximately $0.7 billion, about 20% of the county totals for these SIC groups
Current industry technology trends	Where technically feasible, firms are substituting exempt solvents
1977 VOC emissions (actual)	1,320 tons/year
Industry preferred method of VOC control to meet RACT guidelines	Substitution. Otherwise lowest cost option as specified by EPA will be used
Assumed method of VOC control meet RACT guidelines	Equipment modifications as specified by the RACT guidelines

Affected Areas in Meeting Ract	Discussion
Capital investment	$0.23 million
Annualized cost	$0.03 million (less than 0.01 percent of the value of shipments of the effected firms)
Price	Metal cleaning is only a fraction of manufacturing costs; price effect expected to be less than 0.01 percent assuming a "direct cost passthrough"
Energy	Approximately 35 equivalent barrels of oil per year increase
Productivity	5-10 percent decrease for manually operated degreasers. Will not effect conveyorized cleaners
Employment	No effect except a possible slight decrease in firms supplying metal degreasing solvents
Market structure	No change
RACT timing requirements (1981)	Equipment availability--only a few companies now supply the recommended control modifications
Problem areas	No significant problem areas seen
VOC emission after RACT control	980 tons/year (74 percent of 1977 VOC emission level--however, this does not include emission controls for exempt solvents)
Cost-effectiveness of RACT control	$87 annualized cost per ton of emissions reduced

Source: Booz, Allen & Hamilton Inc.

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U.S. Department of Commerce, Census of Manufactures, 1972

U.S. Environmental Protection Agency, Control of Volatile Organic Emissions from Solvent Metal Cleaning EPA-450/2-77-002, November 1977.

U.S. Environmental Protection Agency, Regulatory Guidance for Control of Volatile Organic Emissions from 15 Categories of Stationary Sources. EPA-905/2-78-001, April 1978.

Dow Chemical Company, Study to Support New Source Performance Standards for Solvent Metal Cleaning Operations. EPA Contract 68-02-1329, June 30, 1976.

Private conversations with the following:

Dextrex Chemical Company, Detroit, Michigan
Ethyl Corporation
DuPont
Dow Chemical Company
PPG
Allied Chemical Company
R.R. Street
Baron Blakeslee Corporation, Cicero, Illinois

13.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

13.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

This chapter presents a detailed analysis of the impact of implementing RACT controls for tank truck gasoline loading terminals in four non-attainment counties in the State of South Carolina[1]. The chapter is divided into six sections including:

- Specific methodology and quality of estimates
- Industry statistics
- The technical situation in the industry
- Cost and VOC reduction benefit evaluations for the most likely RACT alternatives
- Direct economic implications
- Selected secondary economic impacts.

Each section presents detailed data and findings based on the RACT guidelines, previous studies of tank truck gasoline loading terminals, interviews and analysis.

1. The four non-attainment counties are Berkeley, Charleston, Lexington and Richmond. In York County, which is also designated as non-attainment, no bulk terminals were identified.

13.1 SPECIFIC METHODOLOGY AND QUALITY OF ESTIMATES

This section describes the methodology for determining estimates of:

- Industry statistics
- VOC emissions
- Processes for controlling VOC emissions
- Cost of controlling VOC emissions
- Economic impact of emission control

for tank truck gasoline loading terminals in affected counties in the State of South Carolina.

An overall assessment of the quality of the estimates is detailed in the latter part of this section.

13.1.1 Industry Statistics

Industry statistics on tank truck gasoline loading terminals were obtained from several sources. All data were converted to a base year, 1977, based on the following specific methodologies:

- The number of establishments for 1977 was provided by the South Carolina Department of Health and Environmental Control.

- The number of employees in 1977 was derived by determining the number of employees per establishment in 1972 from the 1972 Census of Wholesale Trade, Petroleum Bulk Stations and Terminals and multiplying this factor by the number of establishments estimated for 1977.

- The number of gallons of gasoline sold from terminals in the affected counties was provided by the South Carolina Department of Health and Environmental Control.

- Sales, in dollars, of motor gasoline for 1977 were estimated by multiplying the number of gallons of gasoline sold from terminals in the affected counties in 1977 by the national dealer tankwagon price in 1977 (42.5¢/gallon), which was reported in the National Petroleum News Factbook, 1978.

13.1.2 VOC Emissions

VOC emissions for tank truck gasoline loading terminals in the affected counties in South Carolina were calculated by multiplying U.S. EPA emission factors by terminal throughput and tank capacity. The South Carolina Department of Health and Environmental Control provided data on terminal throughput and tank capacity. U.S. EPA emission factors were reported in Hydrocarbon Control Strategies for Gasoline Marketing Operations, EPA-450/3-78-017. Emissions were based on all terminals either top submerged filling or bottom loading.

13.1.3 Processes for Controlling VOC Emissions

Processes for controlling VOC emissions for tank truck gasoline loading terminals are described in Control of Hydrocarbons from Tank Trucks Gasoline Loading Terminals, EPA-450/2-77-026. These data provide the alternatives available for controlling VOC emissions from tank truck gasoline loading terminals. Several studies of VOC emission control were also analyzed in detail, and interviews with petroleum trade associations, terminal operators and vapor control equipment manufacturers were conducted to ascertain the most likely types of control processes which would be used in terminals in the affected counties in South Carolina. The specific studies analyzed were: Demonstration of Reduced Hydrocarbon Emissions from Gasoline Loading Terminals, PB-243 363; Systems and Costs to Control Hydrocarbon Emissions from Stationary Sources, PB-236 921; and The Economic Impact of Vapor Control in the Bulk Storage Industry, draft report to U.S. EPA by Arthur D. Little.

The alternative types of vapor control equipment likely to be applied to tank truck gasoline loading terminals were analyzed. A model plant reflecting two likely control alternatives was defined. Control alternatives likely to be used were applied to the number of tank truck gasoline loading terminals in the affected counties in the state. The methodology for the cost analysis of VOC emissions control is described in the following paragraphs.

13.1.4 Cost of Vapor Control Systems

The costs of vapor control systems were developed by:

- Determining the alternative types of control systems likely to be used

- Estimating the probable use of each type of control system
- Defining systems components
- Developing installed capital costs for systems components
- Aggregating installed capital costs for each alternative control system
- Defining a model terminal based on throughput for two likely control alternatives
- Developing costs of the alternative control systems for the model terminal including:
  - Installed capital cost
  - Direct operating costs
  - Annualized capital charges
  - Gasoline credit
  - Net annualized cost
- Assigning model terminal costs to terminals in the affected counties in South Carolina
- Aggregating costs to the total affected industry in South Carolina.

Costs were determined mainly from analyses of the RACT guidelines and from interviews with petroleum marketers' associations, terminal operators and vapor control equipment manufacturers.

13.1.5 Economic Impact

The economic impacts were determined by analyzing the lead time requirements needed to implement RACT; assessing the feasibility of instituting RACT controls in terms of capital availability and equipment availability; comparing the direct costs of RACT control to various state economic indicators; and assessing the secondary effects on market structure, employment and productivity as a result of implementing RACT controls in the four affected counties in South Caroina.

13.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, cost and economic impact of implementing RACT controls for terminals in the four affected counties in South Carolina. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (i.e., data that are published for the base year); "B" indicates data that were extrapolated from hard data; and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analyses of previous studies and best engineering judgment. Exhibit 13-1, on the following page, rates each study output listed and the overall quality of the data.

Exhibit 13-1
U.S. Environmental Protection Agency
DATA QUALITY

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics	●		
Emissions			●
Cost of emissions control		●	
Statewide costs of emissions			●
Economic impact			●
Overall quality of data		●	

Source: Booz, Allen & Hamilton Inc.

13.2 INDUSTRY STATISTICS

Industry characteristics, statistics and business trends for tank truck gasoline loading terminals in the affected counties in South Carolina are presented in this section. The discussion includes a description of the number of facilities and their characteristics, a comparison of the size of the affected gasoline terminal industry to state economic indicators, a historical characterization and description of the industry and an assessment of future industry patterns. Data in this section form the basis for assessing the impact on this industry of implementing RACT on tank truck gasoline loading terminals in the affected counties in South Carolina.

13.2.1 Size of the Industry

There were five tank truck gasoline loading terminals, as of 1977, in the four affected counties in South Carolina. Industry sales were in the range of $114 million, with an estimated yearly throughput of 270 million gallons of gasoline. The estimated number of employees in 1977 was 55. These data and the sources of information are summarized in Exhibit 13-2, on the following page. Annual capital investments have not been estimated. In general, tank truck gasoline loading terminal investments are for plant and equipment to replace worn-out facilities, modernize the establishments or improve operating efficiencies.

13.2.2 Comparison of the Industry to the State Economy

A comparison of the affected tank truck gasoline loading terminal industry to the economy of the State of South Carolina is shown in this section by comparing industry statistics to state economic indicators. Employees in the affected tank truck gasoline loading terminal industry represent a minimal percent of the total state civilian labor force of South Carolina. The value of gasoline sold from terminals represented less than 0.2 percent of the total value of wholesale trade in South Carolina in 1977.

13.2.3 Characterization of the Industry

Tank truck gasoline loading terminals are the primary distribution point in the petroleum product marketing

Exhibit 13-2
U.S. Environmental Protection Agency
INDUSTRY STATISTICS FOR TANK TRUCK
GASOLINE LOADING TERMINALS IN SOUTH CAROLINA

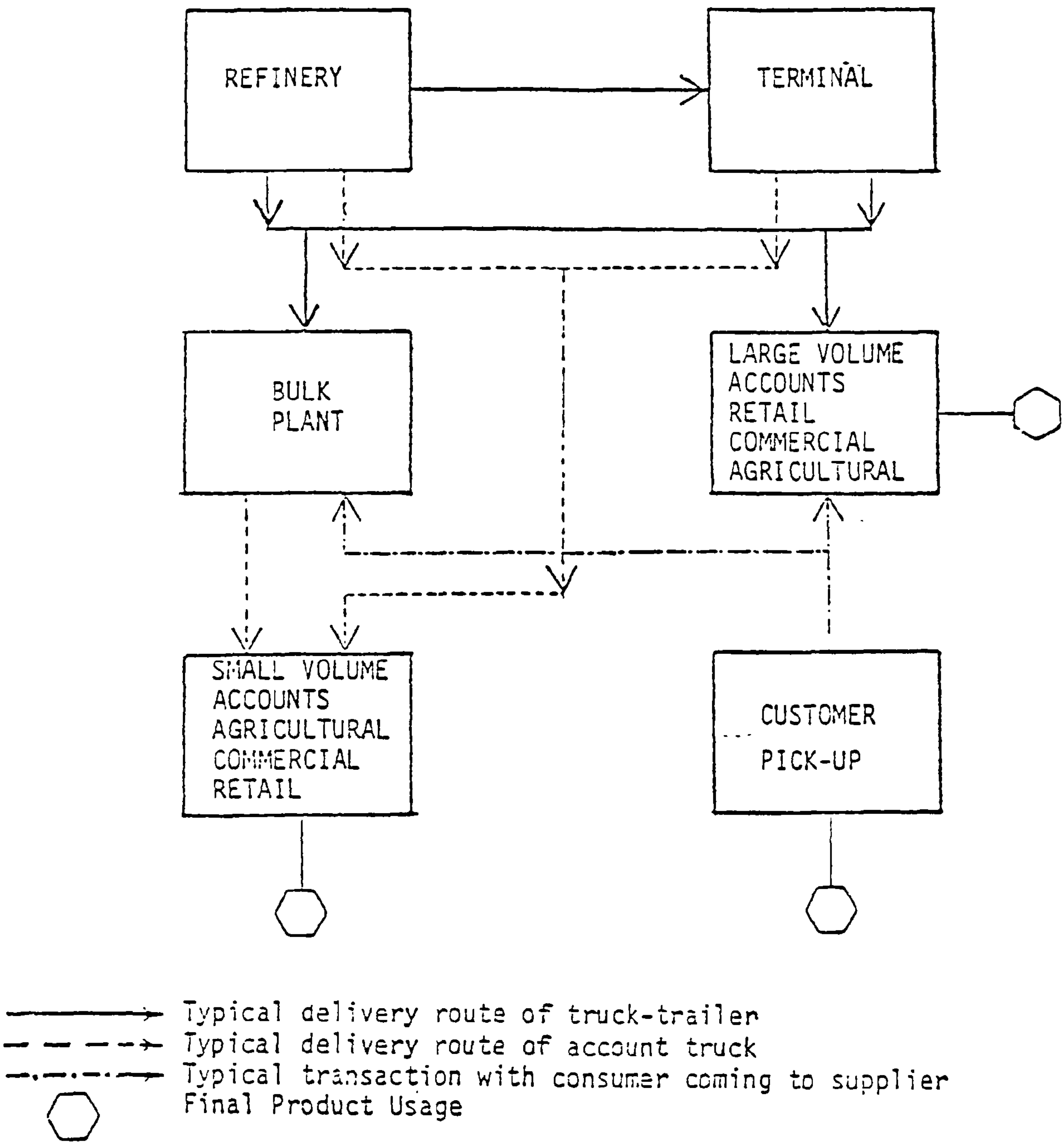
Number of Establishments	Number of Employees	Sales ($ Million, 1977)	Gasoline Sold (Millions of Gallons)
5[a]	55[b]	114[c]	270[a]

a. State of South Carolina, Department of Health and Environmental Control.

b. Booz, Allen & Hamilton Inc. estimate based on the ratio of the number of employees to the number of establishments in 1972.

c. Number of gallons of motor gasoline sold in 1977 multiplied by the national dealer tankwagon price in 1977 (42.51¢/gallon).

Exhibit 13-3
U.S. Environmental Protection Agency
GASOLINE DISTRIBUTION NETWORK



Source: Economic Analysis of Vapor Recovery Systems on Small Bulk Plants, EPA 240/1-77-013, September 1976, p. 3-2.

network as shown in Exhibit 13-3, following Exhibit 13-2. Terminals receive gasoline from refineries by pipeline, tanker or barge.

Most gasoline terminals load all of the petroleum product they receive into truck transports at the terminals' loading racks. These truck transports usually have storage capacities between 8,000 and 9,000 gallons and deliver gasoline to service stations and bulk gasoline plants for further distribution.

Over two-thirds of the gasoline terminals in the United States are owned by major oil companies and refiner/marketers. The remaining gasoline terminals are owned by independents. The major oil companies and regional refiners own a proportionately greater number of the large gasoline terminals and proportionately fewer of the small gasoline terminals.

Approximately ten years ago, petroleum companies began to consider gasoline terminals as separate profit centers. Terminals are now expected to recover all operating expenses as well as to provide an acceptable return on capital. Since terminals are now treated as profit centers, petroleum marketers have closed many uneconomic and marginal facilities throughout the country. Some marketers have withdrawn from selected regions of the country as part of their overall corporate strategy. Gasoline terminals in these markets are being consolidated, sold or closed.

Gasoline terminals are generally located near refineries pipelines and large metropolitan areas. The daily throughput nationally ranges from 20,000 gallons per day to over 600,000 gallons per day.

Exhibit 13-4, on the following page, shows the distribution of gasoline terminals by throughput in the four affected counties in South Carolina.

Exhibit 13-4

U.S. Environmental Protection Agency
TANK TRUCK GASOLINE LOADING TERMINAL
THROUGHPUT IN THE FOUR AFFECTED
NONATTAINMENT COUNTIES IN SOUTH CAROLINA

Terminal	Gasoline Throughput (gallons per day)
A	161,000
B	272,500
C	117,000
D	85,000
E	94,900

Source: State of South Carolina, Department of Health and Environmental Control.

13.3 THE TECHNICAL SITUATION IN THE INDUSTRY

This section presents information on tank truck gasoline loading terminal operations, estimated VOC emissions from terminal operations in the four affected counties in South Carolina, the extent of current control in use, the requirements of vapor control required by RACT and the likely RACT alternatives which may be used for controlling VOC emissions from the affected gasoline terminals in South Carolina.

13.3.1 Tank Truck Gasoline Loading Terminal Operations

Tank truck gasoline loading terminals are the primary distribution facilities which receive gasoline from pipelines, tankers and barges; store it in above-ground storage tanks; and subsequently dispense it via tank trucks to bulk gasoline plants and service stations. Tank truck gasoline loading terminals with an average daily gasoline throughput of 20,000 gallons per day or more (as defined by EPA) require vapor control equipment to reduce VOC emissions from gasoline terminal operations. Facilities and operations at tank truck gasoline loading terminals are described in detail in Control of Hydrocarbons from Tank Truck Gasoline Loading Terminals.

13.3.2 Emissions and Current Controls

This section presents the estimated VOC emissions from tank truck gasoline loading terminals in the four affected counties in South Carolina in 1977 and the current level of emission control already implemented.

Exhibit 13-5, on the following page, shows the total estimated emissions in tons per year from the five affected gasoline terminals in four nonattainment counties in South Carolina. The emissions are estimated to be 872 tons per year. Bottom filling or top submerge filling is reportedly used at the five affected terminals in South Carolina and no terminal is currently equipped with a vapor recovery system.

Exhibit 13-5
U.S. Environmental Protection Agency
VOC EMISSIONS FROM AFFECTED TANK TRUCK TERMINALS
IN FOUR NONATTAINMENT COUNTIES IN SOUTH CAROLINA

Number of Facilities	Estimated Annual Throughput (Millions of gallons)	Total Emissions (tons/year)
5[a]	270[a]	872

a. Data supplied by the South Carolina Department of Health and Environmental Control

Source: Booz, Allen & Hamilton Inc. and the State of South Carolina, Department of Health and Environmental Control.

13.3.3 RACT Guidelines

The RACT guidelines for VOC emission control from tank truck gasoline loading terminals require the following control systems:

- Top submerged or bottom fill of gasoline storage tanks and outgoing tank trucks
- Vapor collection from trailer-transport truck loading
- Vapor recovery or thermal oxidation of collected vapors
- Proper operation and maintenance of equipment.

Exhibit 13-6, on the following page, summarizes the RACT guidelines for VOC emissions control from tank truck gasoline loading terminals.

13.3.4 Selection of the Most Likely RACT Alternatives

Control of VOC emissions from tank truck gasoline loading terminals is achieved using submerged or bottom filling of storage tanks and of tank trucks and vapor control of the loading of outgoing trailer-transport trucks. There are several alternative means of achieving vapor control at tank truck gasoline loading terminals, based on the type of vapor control equipment installed.

Four likely alternatives for vapor control are:

- Adsorption/absorption
- Compression refrigeration absorption
- Refrigeration
- Thermal oxidation.

Each type of vapor control system is briefly described below.

13.3.4.1 Adsorption/Absorption (AA)

Vapor control by adsorption/absorption is achieved by the following method. Vapors from tank truck loading operations are collected and directed to one of two activated carbon beds. Vapors are condensed into pores in the carbon.

Exhibit 13-6
U.S. Environmental Protection Agency
VOC EMISSION CONTROL TECHNOLOGY FOR
TANK TRUCK GASOLINE LOADING TERMINALS

Facilities Affected	Sources of Emissions	RACT Control Guideline
Tank truck terminals with daily throughput of greater than 76,000 liters (20,000 gallons) of gasoline	Filling tank trucks and breathing and working losses from storage tanks	Top submerge of bottom fill tank truck and one of the following vapor control systems: - Adsorption/ Absorption - Refrigeration - Compression Refrigeration Absorption - Thermal Oxidation
	Leakage	Maintenance of areas that may leak

Source: U.S. Environmental Protection Agency

These vapors are then regenerated by pulling a vacuum over the bed. Cold gasoline is then circulated in a separator and the hot vapors are absorbed into the cold gasoline. This process has recently been marketed and is becoming competitive with the refrigeration system described below. It has been reported that less maintenance is required for this type of vapor recovery system than for the other three types.

13.3.4.2 Compression Refrigeration Absorption (CRA)

Vapor control by compression refrigeration absorption is achieved by the following method. Vapors from tank truck loading operations are collected in a vapor holder. The pressure is increased in the holder, thus causing vapors to condense. Further condensation is then achieved by mixing chilled gasoline and vapors under pressure and the vapors are absorbed into the gasoline. This system is becoming less popular than the more recently developed refrigeration system described below and it is not expected that this type of system will be used in South Carolina.

13.3.4.3 Refrigeration (RF)

Vapor recovery using refrigeration is based on the condensation of gasoline vapors by refrigeration at atmospheric pressure. Vapors displaced from tank truck loading operations enter a horizontal fin-tube condenser where they are cooled to a temperature of about -40°F and condensed. Because vapors are treated as they are vented from tank trucks, no vapor holder is required. Condensate is withdrawn from the condenser and the remaining air, containing only a small amount of hydrocarbons, is vented to the atmosphere. This system is priced competitively with AA systems because of market pressure, although it is estimated to be more costly to build.

13.3.4.4 Thermal Oxidation (OX)

Vapor control by thermal oxidation is achieved by incineration devices. Gasoline vapors are displaced to a vapor holder. When the vapor holder reaches its capacity, vapors are released to the oxidizer, after mixing with a properly metered air stream, and combusted. Later models of this type of thermal oxidizer do not require vapor holders; vapors from the tank trucks during loading operations are vented directly to the thermal oxidizer. It is not expected that this type of vapor control system will be used in South Carolina since there are fire hazards with a flame and terminal operators are also reportedly reluctant to burn valuable hydrocarbons.

13.3.5 Leak Prevention from Tank Trucks

For vapor control systems to operate optimally, it is essential to maintain leakless tank trucks. This is achieved by using proper operating procedures and periodic maintenance of hatches, P-V valves and liquid and gaseous connections.

13.4 COST AND HYDROCARBON REDUCTION BENEFIT EVALUATIONS FOR THE MOST LIKELY RACT ALTERNATIVES

Costs for VOC emission control equipment are presented in this section. Factory costs for the four types of vapor control systems described in Secton 13.3 are first presented followed by costs for a model tank truck gasoline loading terminal. The final section presents a projection of model terminal control costs to the affected industry.

13.4.1 Factory Costs for Four Types of Vapor Control Systems

The factory costs for the four types of vapor control systems (summarized in Exhibit 13-7, on the following page) were derived from analysis of the RACT guidelines; from interviews with terminal operators, major oil companies and equipment manufacturers; and from previous cost and economic studies of tank truck gasoline loading terminals.

Adsorption/absorption and refrigeration systems are expected to be the only two types of vapor control systems used at the affected tank truck gasoline loading terminals in South Carolina. It is estimated that three of the systems will be adsorption/absorption and the other two will be refrigeration systems. Factory costs for both systems are assumed to be equal because of competitive pressures. Maintenance costs for refrigeration systems are approximately 2 percent higher than those for adsorption/absorption systems.

13.4.2 Costs for Two Model Tank Truck Gasoline Loading Terminals

A model tank truck gasoline loading terminal and its associated vapor control costs are characterized in this section. The costs are based on the control estimates for adsorption/absorption and refrigeration systems reported by equipment manufacturers and through interviews.

Exhibit 13-8, following Exhibit 13-7, defines model tank truck gasoline loading terminal characteristics and associated control costs.

Exhibit 13-7
U.S. Environmental Protection Agency
FACTORY COSTS OF ALTERNATIVE
VAPOR CONTROL SYSTEMS

Type of Control System	Factory Cost[a] for 250,000 gallon per day system ($000, 1977)
Adsorption/Absorption	120[b]
Compression-Refrigeration-Absorption	128
Refrigeration	120[c]
Thermal Oxidation	72

a. Costs are based on average of range of costs quoted by vendors to the U.S. Environmental Protection Agency and reported in The Economic Impact of Vapor Control on the Bulk Storage Industry, draft report, July 1978.

b. Hydrotech Engineering reported a factory price of $92,000 for a 250,000 gallon per day unit.

c. Expect system priced competitively to adsorption/absorption system due to market pressure.

Source: Hydrotech, U.S. Environmental Protection Agency, Exxon and Booz, Allen & Hamilton Inc. estimates

Exhibit 13-8
U.S. Environmental Protection Agency
DESCRIPTION AND COST OF MODEL TANK
TRUCK GASOLINE LOADING TERMINALS
EQUIPPED WITH VAPOR CONTROL SYSTEMS

Tank Truck Gasoline Loading Terminal Characteristics	Model Terminal
Throughput	250,000 gallons/day
Loading racks	1
Storage tanks	3
Tank trucks	6
Compartments per account truck	4
Vapor control systems	Adsorption/Absorption Refrigeration

Tank Truck Gasoline Loading Terminals Costs	AA	RF
Installed capital cost	$258,000	$258,000
Annual direct operating costs		
. Electricity	3,900	9,900
. Maintenance	10,800	13,200
. Operating labor	1,500	1,500
. Carbon replacement	2,400	-
Subtotal (direct operating costs)	18,600	24,600
Annualized capital charges	54,180	54,180
Net annualized cost (not including gasoline credit)	72,780	78,780

Source: Booz, Allen & Hamilton Inc.

The costs for the model terminal are used in Section 13.4.3 to project costs of vapor control equipment to the affected industry in four nonattainment counties in South Carolina. The costs for the model terminal are:

- Installed capital cost, which includes equipment and modification costs, labor and costs to modify trucks ($3,000 per truck)

- Annualized costs which include electricity, maintenance, operating labor and carbon replacement costs. Maintenace costs for the adsorption/absorption system are slightly lower than those for refrigeration

- Annualized capital charges, which include costs for depreciation, interest, taxes and insurance and are estimated to be 21 percent of the installed capital cost

- Net annualized costs, which are the sum of the capital charges and direct operating costs. It should be noted that gasoline credit has not yet been accounted for. Gasoline credit will be taken into account when the costs are projected to the affected industry.

Another cost characterization that can be made is hydrocarbon reduction versus cost. This finding will also be shown in the affected industrywide analysis.

13.4.3 Projection to the Industry Affected In The Four Nonattainment Counties

Exhibit 13-9, on the following page, shows the projection of vapor recovery costs to the affected industry in South Carolina. The estimates are based on the following assumptions:

- In the four nonattainment counties in South Carolina three of the tank truck gasoline loading terminals are expected to implement the adsorption/absorption vapor control system to comply with RACT and the other two will implement the refrigeration system to comply with RACT.

- RACT is implemented at bulk gasoline plants and gasoline service stations in the four affected counties in the state. Ninety percent of the

Exhibit 13-9
U.S. Environmental Protection Agency
COSTS OF VAPOR CONTROL SYSTEM FOR THE AFFECTED TANK TRUCK GASOLINE LOADING TERMINALS IN THE FOUR NONATTAINMENT COUNTIES IN SOUTH CAROLINA

Characteristic/Cost Item	Data
Number of terminals	5
Total annual throughput (millions of gallons)	270
Uncontrolled emissions (tons/year)	872
Emission reduction (tons/year)	785
Installed capital cost ($ million, 1977)	1.4
Direct annualized cost ($ million, 1977)	0.105
Annual capital charges ($ million, 1977)	0.271
Annual gasoline credit[a] ($ million, 1977)	0.275
Net annualized cost ($ million, 1977)	0.101
Annualized cost per ton of emissions reduced at the terminal from terminal emission only ($ per ton)	347
Annualized cost per ton of emissions reduced at terminals including service stations and bulk plant emissions covered ($ per ton)	48
Annualized cost per ton of emissions reduced from gasoline marketing[b]	306

a. Based on 2,097 tons of emissions recovered which includes 1,193 tons collected from gasoline service stations, 119 tons collected from bulk plants and 785 tons collected at the terminal.

b. Calculated by dividing sum of annualized cost for service stations, bulk plants and terminals by the sum of emissions reduced from service stations, bulk plants and terminals.

gasoline vapors collected from bulk gasoline plants and gasoline service stations are recovered and credited to the tank truck gasoline loading terminal.

Based on the previous assumptions, the total cost to the affected industry for installing vapor recovery equipment is estimated to be $1.4 million. The amount of gasoline recovered is valued at $275,000. The annualized cost per ton of of emissions controlled from terminals operations only (not including emissions brought back and recovered from service stations or bulk gasoline plants) is estimated to be $347 per ton. Assuming that the reserved vapors from the control of bulk gasoline plants and service stations is reserved at the terminals, the cost per ton of emissions controlled is estimated to be $48 per ton.

13.5 DIRECT ECONOMIC IMPLICATIONS

This section presents the direct economic implications of implementing RACT controls to the affected industry in the four nonattainment counties including availability of equipment and capital, feasibility of the control technology, and impact on state economic indicators.

13.5.1 RACT Timing

RACT must be implemented statewide by May 1, 1981. This implies that tank truck gasoline loading terminal operators must have vapor control equipment installed and operating within the next two years. The timing requirements of RACT impose several requirements on terminal operators including:

- Determining appropriate vapor control system
- Raising capital to purchase equipment
- Acquiring the necessary vapor control equipment
- Installing and testing vapor control equipment to insure that the system complies with RACT.

The sections which follow discuss the feasibility and the economic implications of implementing RACT within the required timeframe.

13.5.2 Feasibility Issues

Technical and economic feasibility issues of implementing RACT controls are discussed in this section.

Several tank truck gasoline loading terminal operators in the U.S. have successfully implemented vapor control systems. State adoption of RACT regulations will generate a new demand for vapor control systems. It is expected that sufficient leadtime is available to meet the increased demand, thus making the implementation of RACT technically feasible.

In the area of economic feasibility, it has been reported that terminal operators have access to capital to purchase vapor control equipment, and it is expected that no terminal will cease operations solely because of the cost of implementing RACT.

13.5.3 Comparison of Direct Cost With Selected Direct Economic Indicators

This section presents a comparison of the net annualized cost of implementing RACT with the total value of gasoline sold from affected terminals in the four nonattainment counties and the value of wholesale trade in the state.

The net annualized cost to the tank truck gasoline loading terminals resulting from RACT represents 0.09 percent of the total gasoline sold from the affected terminals. When compared to the statewide value of wholesale trade, the annualized cost is small.

13.6 SELECTED SECONDARY ECONOMIC IMPACTS

This section discusses the secondary economic impact of implementing RACT on employment, market structure, and productivity.

- Employment. No decline in employment is expected solely because of RACT requirements. A slight increase in operating and maintenance labor may be required through implementation of RACT but this is predicted to have minimal impact on any employment increase.

- Market Structure. No change in market structure is expected from implementation of RACT.

- Productivity. No change in worker productivity is expected to result from implementation of RACT.

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Exhibit 13-10 presents a summary of the findings of this chapter.

Exhibit 13-10
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	5
Indication of relative importance of industrial section to state economy	1977 sales were $114 million with annual throughput of 270 million gallons at the effected facilities
Current industry technology trends	New terminals are being designed with vapor recovery equipment
1977 VOC actual emissions	872 tons per year
Industry preferred method of VOC control to meet RACT guidelines	Submerge or bottom fill and vapor recovery
Affected Areas in Meeting RACT	**Discussion**
Capital investment	$1.4 million
Annualized cost	$0.1 million (approximately 0.09 percent of value of shipments)
Price	No major impact
Energy	Assuming full recovery of gasoline—net savings of 5,362 barrels annually from terminal emissions
Productivity	No major impact
Employment	No direct impact
Market structure	No direct impact
Problem area	Gasoline credit from vapors from bulk gasoline plants and gasoline service stations require uniform RACT requirements throughout the state
VOC emission after RACT control	87 tons per year
Cost effectiveness of RACT control	$48 annualized cost/annual ton of VOC reduction from terminals assuming gasoline credit from vapors returned from bulk gasoline plants and gasoline service stations

Source: Booz, Allen & Hamilton Inc.

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14.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR BULK GASOLINE PLANTS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

14.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR BULK GASOLINE PLANTS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

This chapter presents a detailed analysis of the impact of implementing RACT controls for bulk gasoline plants in four urban nonattainment counties in the State of South Carolina.[1] The chapter is divided into six sections including:

- Specific methodology and quality of estimates
- Industry statistics
- The technical situation of the industry
- Cost and VOC reduction benefit evaluations for the most likely RACT alternatives
- Direct economic implications
- Selected secondary economic impacts.

Each section presents detailed data and findings based on the RACT guidelines, previous studies of bulk gasoline plants, interviews, and analysis.

1. The four urban nonattainment counties are: Berkeley, Charleston, Lexington and Richland. In York County which is also designated as nonattainment but subject to 100 tons per year potential exemption, it is estimated that no bulk plants would be affected.

14.1 SPECIFIC METHODOLOGY AND QUALITY OF ESTIMATES

This section describes the methodology for determining estimates of:

- Industry statistics
- VOC emissions
- Processes for controlling VOC emissions
- Cost of controlling VOC emissions
- Economic impact of emission control

for bulk gasoline plants in affected counties in the State of South Carolina.

An overall assessment of the quality of the estimates is detailed in the latter part of this section.

14.1.1 Industry Statistics

Industry statistics on affected bulk gasoline plants were obtained from several sources. All data were converted to a base year, 1977, based on specific methodologies:

- The number of bulk plants in the affected counties for 1977 was from the South Carolina Department of Health and Environmental Control.

- The number of employees in 1977 was derived from the 1972 Census of Wholesale Trade, Petroleum Bulk Stations and Terminals by determining the number of employees per establishment in 1972 and multiplying this factor by the number of affected establishments reported for 1977.

- Sales, in dollars, of motor gasoline for 1977 were estimated by multiplying the number of gallons of gasoline sold in 1977 from affected bulk gasoline plants by the national dealer tankwagon price in 1977 (42.51¢/gallon—reported in the National Petroleum News Factbook, 1978).

14.1.2 VOC Emissions

The South Carolina Department of Health and Environmental Control calculated emissions from the affected bulk gasoline plants using U.S. EPA emission factors reported in Hydrocarbon Control Strategies for Gasoline Marketing Operations.

14.1.3 Processes for Controlling VOC Emissions

Processes for controlling VOC emissions from bulk gasoline plants are described in Control of Volatile Organic Emissions from Bulk Gasoline Plants, EPA-450/2-77-035. These data provide the alternatives available for controlling VOC emissions from bulk gasoline plants. Several studies of VOC emission control were also analyzed in detail, and interviews with petroleum trade associations, bulk plant operators, and vapor control equipment manufacturers were conducted to ascertain the most likely types of control processes which would be used at bulk gasoline plants in South Carolina. The specific studies analyzed were Evaluation of Top Loading Vapor Balance Systems for Small Bulk Plants, EPA 340/1-77-014; Economic Analysis of Vapor Recovery Systems on Small Bulk Plants, EPA 340/1-77-013; Systems and Costs to Control Hydrocarbon Emissions from Stationary Sources, EPA PB-236 921; and Study of Gasoline Vapor Emission Controls at Small Bulk Plants, EPA PB-267-096.

The alternative types of vapor control equipment likely to be applied to bulk gasoline plants were arrayed, and percentage reductions from using each type of control were determined. The methodology for the cost analysis based on this scheme is described in the following paragraphs.

14.1.4 Cost of Vapor Control Systems

The costs of vapor control systems were developed by:

- Determining the alternative types of control systems likely to be used
- Estimating the probable use of each type of control system
- Defining systems components
- Developing installed capital costs for systems components
- Aggregating installed capital costs for each alternative control system
- Defining two model plants

- Developing costs of control systems for model plants including

  - Installed capital cost
  - Direct operating costs
  - Annual capital charges
  - Gasoline credit
  - Net annualized cost

- Assigning model plant costs to affected bulk plants in the four urban nonattainment counties in South Carolina

- Aggregating costs to the affected industry in the four urban nonattainment counties in South Carolina.

Costs were determined from analyses of the following previous studies:

- <u>Control of Volatile Organic Emissions from Bulk Gasoline Plants</u>, EPA 450/2-77-035

- <u>Study of Gasoline Vapor Emission Controls at Small Bulk Plants</u>, EPA PB-267 096

- <u>Economic Analysis of Vapor Recovery Systems on Small Bulk Plants</u>, EPA 340/1-77-013

- <u>Evaluation of Top Loading Vapor Balance Systems for Small Bulk Plants</u>, EPA 340/1-77-014

and from interviews with petroleum marketers' associations, bulk plant operators, and vapor control equipment manufacturers.

A profile of bulk plants for the affected bulk gasoline plants in South Carolina were determined from data supplied by the South Carolina Department of Health and Environmental Control.

14.1.5 Economic Impacts

The economic impacts were determined by analyzing the lead time requirements needed to implement RACT; assessing the feasibility of instituting RACT controls in terms of capital availability and equipment availability; comparing the direct costs of RACT control to various state economic indicators; and assessing the secondary effects on market structure, employment, and productivity as a result of implementing RACT controls in South Carolina.

14.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, cost, and economic impact of implementing RACT controls at bulk gasoline plants in the four urban nonattainment counties in South Carolina. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (i.e., data that are published for the base year); "B" indicates data that were extrapolated from hard data; and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analyses of previous studies, and best engineering judgment. Exhibit 14-1, on the following page, rates each study output listed and the overall quality of the data.

Exhibit 14-1
U.S. Environmental Protection Agency
DATA QUALITY

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics	●		
Emissions	●		
Cost of emissions control		●	
Economic Impact		●	
Overall quality of data		●	

Source: Booz, Allen & Hamilton Inc.

14.2 INDUSTRY STATISTICS

Industry characteristics, statistics, and business trends for affected bulk gasoline plants in the four urban nonattainment counties in South Carolina are presented in this section. The discussion includes a description of the number of facilities and their characteristics, a comparison of the size of the affected bulk gasoline plant industry to state economic indicators, a historical characterization and description of the industry, and an assessment of future industry patterns. Data in this section form the basis for assessing the impact on the affected industry from implementing RACT in the affected counties in South Carolina.

14.2.1 Size of the Industry

There were an estimated 40 affected bulk gasoline plants, as of 1977, in the four nonattainment counties in South Carolina. Industry sales from affected bulk plants were in the range of $21.9 million, with an estimated yearly throughput of 52 million gallons of gasoline. The estimated number of employees in 1977 was 220. These data and the sources of information are summarized in Exhibit 14-2, on the following page. Annual capital investments have not been estimated. In general, bulk plant capital investments are for plant and equipment to replace worn-out facilities, modernize the establishments or improve operating efficiencies.

14.2.2 Comparison of the Industry to the State Economy

A comparison of the affected bulk gasoline plant industry to the economy of the State of South Carolina is shown in this section by comparing industry statistics to state economic indicators. Employees in the bulk gasoline plant industry represent an insignificant percent of the total state civilian labor force of South Carolina. The value of gasoline sold from the affected bulk plants represented approximately 0.3 percent of the total value of wholesale trade in South Carolina in 1977.

14.2.3 Characterization of the Industry

Bulk plants are an intermediate distribution point in the petroleum product marketing network as shown in Exhibit 14-3, following Exhibit 14-2. Bulk gasoline plants

Exhibit 14-2
U.S. Environmental Protection Agency
INDUSTRY STATISTICS FOR AFFECTED
BULK GASOLINE PLANTS IN THE FOUR
NONATTAINMENT COUNTIES IN SOUTH CAROLINA

Number of Establishments	Number of Employees	Sales ($ Million, 1977)	Gasoline Sold (Millions of Gallons)
40[a]	220[b]	21.9[c]	52[d]

a. South Carolina Department of Health and Environmental Control.

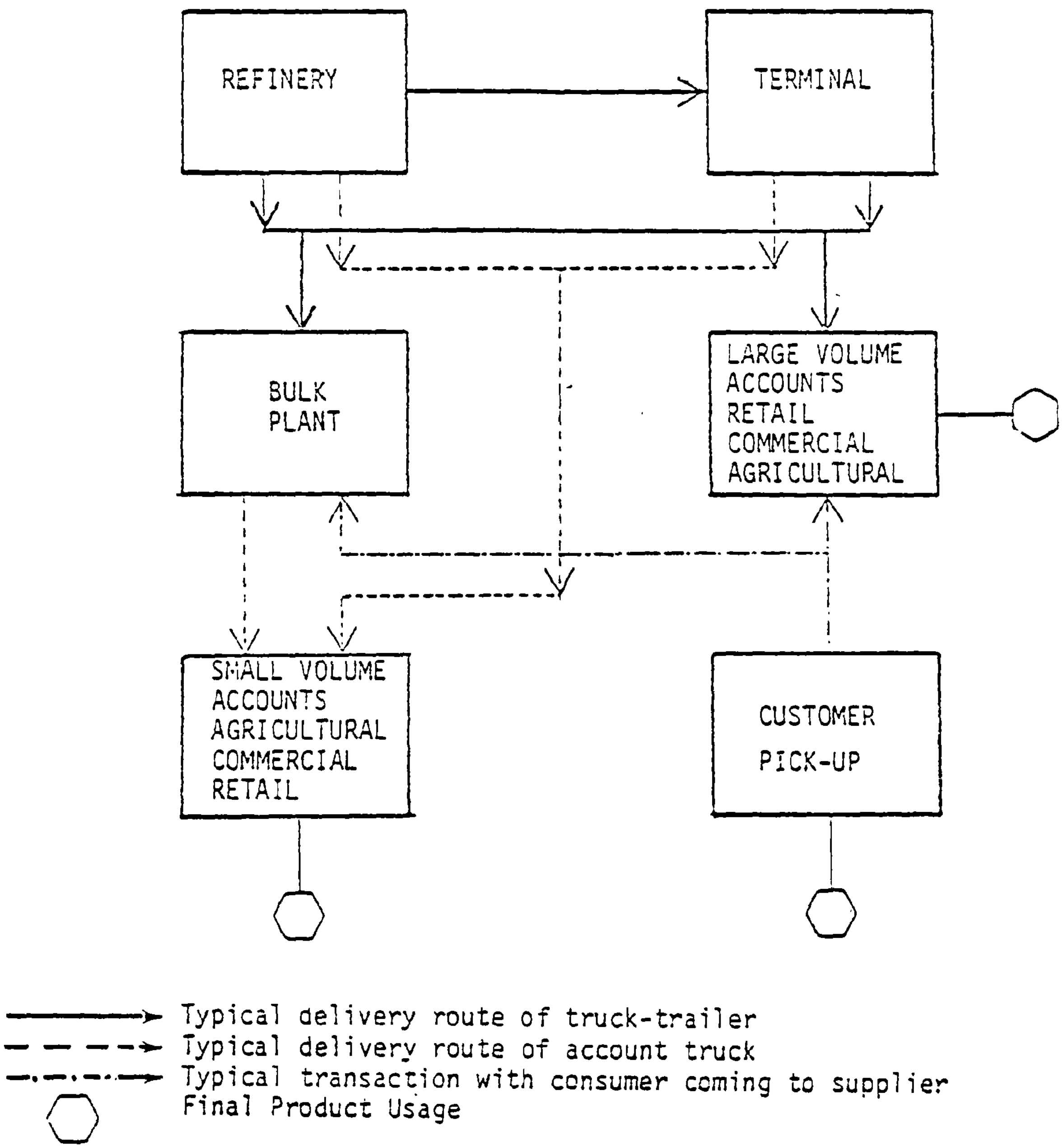
b. Booz, Allen & Hamilton estimate based on the ratio of the number of employees to the number of establishments in 1972.

c. Number of gallons of motor gasoline sold in 1977 multiplied by the national dealer tankwagon price in 1977 (42.51¢/gallon). National Petroleum News Factbook, 1978.

d. South Carolina Department of Health and Environmental Control.

Source: Booz, Allen & Hamilton Inc.

Exhibit 14-3
U.S. Environmental Protection Agency
GASOLINE DISTRIBUTION NETWORK



Source: Economic Analysis of Vapor Recovery Systems on Small Bulk Plants, EPA 340/1-77-013, September 1976, p. 3-2.

compete with bulk gasoline tank terminals and large retail gasoline outlets. Ownership and operation of bulk plants are predominantly by independent jobbers and commissioned agents but also include cooperatives and salaried employees. The independent jobber owns the equipment and structures at his bulk plant, the inventory, and rolling stock, and he contracts directly with the oil company for gasoline. A commissioned agent usually does not own the equipment and facilities but operates the bulk plant for a major integrated oil company.

Bulk gasoline plants are typically located near towns and small cities, since their predominant market is agricultural and small retail accounts. The maximum daily throughput of a bulk gasoline plant ranges from less than 2,000 gallons per day up to 20,000 gallons per day. Exhibit 14-4, on the following page, shows the distribution of affected bulk gasoline plants by plant throughput in the four affected counties in South Carolina.

It is estimated that the majority of the bulk gasoline plants are up to 25 years old, with a few new modernized, higher volume plants. Forty years ago, bulk gasoline plants were a major link in the gasoline distribution network. From that time, their importance has been declining in the marketing sector of the petroleum industry, basically for economic reasons. There is evidence that profitability in bulk gasoline plants has been decreasing. The number of bulk gasoline plants decreased by 11 percent nationally from 1967 to 1972 and is predicted to continue declining in the near term[1]. This decline is largely attributable to major oil companies disposing of commission-agent-operated bulk plants.

1 National Petroleum News Factbook, 1976.

Exhibit 14-4

U.S. Environmental Protection Agency

DISTRIBUTION OF BULK GASOLINE PLANTS BY AMOUNT OF THROUGHPUT FOR THE FOUR NONATTAINMENT COUNTIES IN SOUTH CAROLINA

Gasoline Throughput (gallons per day)	Estimated Number of Plants
Less than 2,000	10
2,000 to 3,999	14
4,000 to 5,999	13
6,000 to 7,999	4
8,000 to 9,999	2
10,000 to 20,000	3

Source: South Carolina Emission Inventory

14.3 THE TECHNICAL SITUATION IN THE INDUSTRY

This section presents information on bulk gasoline plant operations, estimated VOC emissions from affected bulk gasoline plant operations in the four urban non-attainment counties in South Carolina, the extent of current control in use, the requirements of vapor control required by RACT and the likely RACT alternatives which may be used for controlling VOC emissions from affected bulk gasoline plants in South Carolina.

14.3.1 Bulk Gasoline Plant Operations

Bulk gasoline plants are typically secondary distribution facilities which receive gasoline from bulk gasoline tank terminals by trailer-transport trucks; store it in above-ground storage tanks; and subsequently dispense it via account trucks to local farms, businesses and service stations. Bulk gasoline plants with an average daily gasoline throughput of 20,000 gallons per day or less have been defined by EPA as requiring vapor control equipment to reduce VOC emissions from bulk gasoline plant operations.

Bulk gasoline plant facilities and operations are described in Control of Volatile Organic Emissions from Bulk Gasoline Plants, EPA 450/2-77-035.

14.3.2 Emissions and Current Controls

This section presents the estimated VOC emissions from the 40 affected bulk gasoline plants in the four urban nonattainment counties in South Carolina in 1977 and the current level of emission control already implemented in the affected counties in the state. Exhibit 4-5, on the following page, shows the total estimated emissions in tons per year from the affected bulk gasoline plants in the affected counties. The estimated 1977 VOC actual emissions from the 40 bulk gasoline plants are 676 tons per year.

Exhibit 14-5
U.S. Environmental Protection Agency
VOC EMISSIONS FROM AFFECTED BULK
GASOLINE PLANTS IN THE FOUR URBAN
NONATTAINMENT COUNTIES IN SOUTH CAROLINA

Number of Facilities	Estimated Annual Throughput (Millions of gallons)	Total Emissions (tons/year)
40	52	676

Source: Booz, Allen & Hamilton Inc.

14.3.3 RACT Guidelines

The RACT guidelines for VOC emission control from bulk gasoline plants require the following control systems:

- Top submerged or bottom fill of gasoline storage tanks and outgoing account trucks
- Vapor balancing between the incoming trailer-transport truck and the gasoline storage tank
- Vapor balancing between the gasoline storage tank and the outgoing account truck
- Proper operation and maintenance of equipment.

Exhibit 14-6, on the following page, summarizes the RACT guidelines for VOC emissions control from bulk gasoline plants.

14.3.4 Selection of the Most Likely RACT Alternatives

Control of VOC emission from bulk gasoline plants is achieved using submerged or bottom filling of storage tanks and account trucks and vapor balancing between the loading and unloading of incoming and outgoing trailer-transport trucks and the gasoline storage tanks. There are several alternative means of achieving vapor control at bulk gasoline plants, based on the manner in which the bulk plant is operated.

Three likely control alternatives, summarized in Exhibit 14-7, following Exhibit 14-6, are discussed separately in the paragraphs which follow.

14.3.4.1 Alternative I

Control Alternative I involves top submerged loading and equipping the bulk plant with a vapor balancing system. In detail, this control alternative implies:

- Submerged filling of gasoline storage tanks
- Vapor balancing between the incoming trailer-transport truck and the gasoline storage tank
- Submerged top loading of outgoing account trucks

Exhibit 14-6
U.S. Environmental Protection Ageny
VOC EMISSION CONTROL TECHNOLOGY FOR
BULK GASOLINE PLANTS

Facilities Affected	Sources of Emissions	RACT Control Guidelines
Bulk plants with daily throughputs of 76,000 liters (20,000 gallons) of gasoline or less	Vapor displacement from filling account trucks, and breathing losses and working losses from storage tanks	Submerge filling and vapor balancing: . Vapor balancing of transport truck and storage tank . Vapor balancing of storage and account truck
	Cracks in seals and connections	Proper operation maintenance
	Improper hook up of liquid lines and top loading nozzles	Proper operation maintenance
	Truck cleaning	Proper operation maintenance
	Pressure vacuum relief valves	Proper operation maintenance

Source: Control of Volatile Organic Emissions from Bulk Gasoline Plants, EPA-450/2-77-035.

Exhibit 14-7

U.S. Environmental Protection Agency
ALTERNATIVE CONTROL METHOD
FOR VAPOR CONTROL AT BULK GASOLINE PLANTS

Alternative Number	Description of Control Method
I	Top submerged filling and vapor balance entire system
II	Vapor balance existing bottom filled bulk plant
III	Convert top filled bulk plant to bottom filled, and vapor balance total system.

Source: Booz, Allen & Hamilton Inc. analysis of Control of Volatile Organic Emissions from Bulk Gasoline Plants, EPA-450/2-77-035.

- Vapor balancing of gasoline storage tank and outgoing account truck

- Equipping account trucks with vapor balancing connections.

It is estimated that all 40 bulk plants in the affected counties in South Carolina would select Control Alternative I to achieve vapor recovery to meet the state RACT requirements based on data provided by the South Carolina Department of Health and Environmental Control. During interviews, the industry has questioned whether vapor recovery by this control method will achieve 90 percent emissions recovery as stated in the RACT guidelines.

14.3.4.2 Alternative II

Control Alternative II involves implementing a complete vapor balancing system on bulk plants which currently operate with bottom filling. In detail this control alternative encompasses:

- Vapor balancing between the incoming trailer-transport truck and the gasoline storage tank

- Vapor balancing between the gasoline storage tank and the outgoing account truck

- Modification of account trucks to accommodate a vapor recovery connection.

None of the affected bulk gasoline plants currently use bottom filling.

14.3.4.3 Alternative III

Control Alternative III involves converting top loading bulk gasoline plants to bottom filling and implementing a complete vapor balancing system. In detail, this control alternative entails:

- Converting the loading rack to bottom filling

- Converting storage tank loading to bottom filling

- Vapor balancing the incoming trailer-transport truck and the gasoline storage tank

- Converting the account truck to bottom loading and installing vapor balancing connections on the account truck.

The additional cost of converting a bulk plant from top filling to bottom filling makes Control Alternative III more costly than Control Alternative I. This additional cost may be attributable to improved bulk plant operations, rather than compliance with the proposed limitations.

14.4 COST AND HYDROCARBON REDUCTION BENEFIT EVALUATIONS FOR THE MOST LIKELY RACT ALTERNATIVES

Costs for VOC emission control equipment are presented in this section. The costs for the three alternative control systems described in Section 14.3 are described individually, followed by costs for a typical bulk plant. The final section then presents a projection of typical bulk gasoline plant control costs to the affected industry.

14.4.1 Costs for Alternative Control Systems

The costs for the three alternative control systems (summarized in Exhibit 14-8, on the following page) were derived from analysis of the RACT guidelines, from interviews with bulk plant operators and petroleum marketing trade associations and from previous cost and economic studies of small bulk plants.

Control Alternative I is expected to be the system used for bulk plants in the affected counties in South Carolina since these bulk gasoline plants employ top filling. The U.S. EPA currently endorses the cost estimates developed by Pacific Environmental Services, Inc. for the Houston/ Galveston area bulk plants. However, several large volume bulk plant operators who were interviewed have reported vapor control costs in excess of $50,000 which included conversion of the loading rack to bottom filling.

Control Alternative II is similar in cost to Control Alternative I.

Control Alternative III is the most costly control system. Several bulk gasoline plant operators interviewed in California and Maryland have adopted this system, although it cannot be shown from the data in South Carolina that any bulk gasoline plant would be willing to implement a system this costly. This alternative, therefore, is not included in the projection of vapor control costs to the affected industry in the next section.

14.4.2 Costs for Model Bulk Plant

A model bulk plant and its associated vapor control costs are characterized in this section. The costs are based on the control estimates for Control Alternative I, reported by Pacific Environmental Services, Inc. for bulk

Exhibit 14-8
U.S. Environmental Protection Agency
COSTS OF ALTERNATIVE VAPOR CONTROL SYSTEMS

Cost Estimates	Alternative I	Alternative II	Alternative III (Includes conversion to bottom filling)
National Oil Jobbers Council estimate	1 truck (4 compartments) 1 loading rack (3 arms) 3-inch system Pre-set meters Direct cost (no labor) $20,524 (without air) $22,754 (with air)	Similar to costs for alternative I	1 truck (4 compartments) 1 loading rack (3 arms) 3-inch system Pre-set meters Direct cost (no labor) $27,729
Pacific Environmental Services estimate of Houston/Galveston area system	1 loading rack Meters Average installed cost $3,200 (without metering) $7,700 (with metering)		
Wiggins system			1 truck 4 compartments) 1 loading rack (4 arms) Pre-set meters Installed cost $17,352 $18,416

plants in the Houston/Galveston area. Several other bulk plant operators have reported costs in excess of $50,000 for vapor control systems although U.S. EPA estimates that these systems exceed the level of adequacy required to meet RACT.

Exhibit 14-9, on the following page, defines a model bulk plant's characteristics and associated control costs. It is assumed that the 40 affected bulk gasoline plants in the four urban nonattainment counties in South Carolina can be characterized by the model plant.

The costs for the model plant are used in Section 14.4.3 to project costs of vapor control equipment to the affected industry. The costs for the model plant are:

- Installed capital cost, which includes parts and labor
- Annualized direct costs, expected to be 3 percent of installed capital costs, including costs for labor, utilities, recordkeeping and training costs
- Annualized capital charges, estimated to be 25 percent of installed capital costs, including costs for depreciation, interest, maintenance, taxes, and insurance
- Net annualized costs, which are the sum of the capital charges and annualized direct costs. It should be noted that gasoline credit has not yet been accounted for. Gasoline credit will be taken into account when the costs are projected to the affected industry.

Another cost characterization that can be made is hydrocarbon reduction versus cost. This finding will also be shown in the affected industrywide analysis.

14.4.3 Projection to the Affected Industry

Exhibit 14-10, following Exhibit 14-11, shows the projection of vapor recovery costs to the affected industry in the four urban nonattainment counties in South Carolina. The estimates are based on the following assumptions:

- In the affected counties, the affected bulk gasoline plants can be characterized by the model plant

Exhibit 14-9
U.S. Environmental Protection Agency
DESCRIPTION AND COST OF A MODEL BULK PLANT
EQUIPPED WITH VAPOR CONTROL

Bulk Plant Characteristics	Model Bulk Plant
Throughput	4,000 gallons/day
Loading racks	1
Storage tanks	3
Account trucks	2
Compartment per account truck	4
Vapor control system	Alternative I

Bulk Plant Costs	
Installed capital cost[a]	$13,700
Annual direct operating costs @ 3 percent of installed cost	411
Annualized capital charges @ 25 percent of installed capital cost	3,425
Net annualized cost (not including gasoline credit)	3,836

a. Assume $3,000 installed capital cost to modify one four compartment account truck. Does not include cost of $150 to install submerged fill pipe.

Source: Booz, Allen & Hamilton Inc.

Exhibit 14-10
U.S. Environmental Protection Agency
INDUSTRY COSTS OF VAPOR CONTROL SYSTEMS
FOR AFFECTED BULK GASOLINE PLANTS
IN THE FOUR URBAN NONATTAINMENT COUNTIES
IN SOUTH CAROLINA

Characteristics/Cost Item	Data
Number of facilities	40
Total annual throughput (millions of gallons)	52
Uncontrolled emissions (tons/year)	676
Emission reduction (tons/year)	498
Emissions after RACT control (tons/year)	178
Installed capital[a] ($, 1977)	550,000
Direct annual operating cost ($, 1977)	16,000
Annualized capital charges ($, 1977)	138,000
Annual gasoline credit[b] ($, 1977)	6,000
Net annualized cost ($, 1977)	148,000
Annualized cost per ton of emissions reduced ($ per ton)	297

a. Includes equipping bulk gasoline plants with submerged fill pipes.

b. Based on an estimated 10 percent of emissions reduced by converting from splash fill to submerged fill.

- All affected bulk plants will implement the Control Alternative I vapor control system to comply with RACT.

Actual costs to bulk plant operators may vary pending on the type of control alternative and manufacturer's equipment selected by each bulk plant operator.

Based on the above assumptions, the total cost to the affected industry for installing vapor recovery equipment is estimated to be $550,000. Ten percent of total emissions can be credited to the bulk plant since installation of vapor control equipment may reduce emissions by an estimated 10 percent. The annualized cost per ton of emissions controlled is estimated to be $297 per ton.

14.5 DIRECT ECONOMIC IMPLICATIONS

This section presents the direct economic implications of implementing RACT controls to the industry in the four affected counties in South Carolina including availability of equipment and capital; feasibility of the control technology; and impact on economic indicators, such as value of shipments, unit price (assuming full cost passthrough), state economic variables and capital investment.

14.5.1 RACT Timing

RACT must be implemented in the four affected counties by May 1, 1981. This implies that bulk gasoline plant operators must have vapor control equipment installed and operating within the next two years. The timing requirements of RACT impose several requirements on bulk plant operators including:

- Determining appropriate vapor control system
- Raising capital to purchase equipment
- Generating sufficient income from current operations to pay the additional annualized operating costs incurred with vapor control
- Acquiring the necessary vapor control equipment
- Installing and testing vapor control equipment to insure that the system complies with RACT.

The sections which follow discuss the feasibility and the economic implications of implementing RACT within the required timeframe.

14.5.2 Feasibility Issues

Technical and economic feasibility issues of implementing RACT controls are discussed in this section.

Several bulk plants in the U.S. have attempted to implement vapor control systems with varying degrees of success. One bulk plant operator interviewed in Maryland implemented vapor recovery at a cost of $65,000 in 1974. The operator indicated that recent tests have shown the system operates well within the 90 percent recovery requirement of RACT.

This particular bulk plant was converted to bottom filling and completely vapor balanced. The plant's throughput was 20,000 gallons per day and included one loading rack and three account trucks. This plant would be characterized as installing a sophisticated Alternative III control system. The plant is also operated by a major oil company, so capital availability problems were minimized.

Bulk plants in the Houston/Galveston area, on the contrary, have implemented "bare bone" type control systems that were individually designed and installed at a bulk plant which was owned by a major oil company. No emission data are available to verify whether these systems are in compliance, but U.S. EPA estimates that these control systems are sufficient to meet the requirements of RACT. These systems are not marketed by any equipment manufacturer; therefore, their availability for widespread application is doubtful at the present time.

Adoption of RACT regulations will generate a demand for economical vapor control systems for bulk plants. It is, therefore, anticipated that off-the-shelf systems could be developed within the next three years that are similar to the control system implemented in the Houston/Galveston area; thus making the implementation of RACT technically feasible.

A number of economic factors are involved in determining whether a specific bulk plant operator will be able to implement vapor control systems and still remain profitable. These include:

- Degree of competition
- Ability to pass on a price increase
- The current profitability of the plant
- Age of the plant
- State of repair of the plant
- Ownership—major oil company or private individual.

It is estimated that small bulk plants, with throughput less than 4,000 gallons per day, could experience a direct cost increase of nearly 0.5 cents per gallon if they implement RACT.[1] This may affect two of the affected bulk plants.

The key to the direct economic impact will be the ability of a bulk plant operator to pass on up to a 0.5

1. Estimated based on dividing net annual cost for model plant by annual throughput for a 4,000 gallon per day bulk gasoline plant. This assumes full cost passthrough.

cent increase in the price of gasoline to customers (assuming a full cost passthrough). One small bulk plant operator in Missouri reported during an interview that his gross profit margin per gallon of gasoline is 4 to 5 cents per gallon. His net profit margin is 0.5 cent per gallon. This operator stated that he plans to discontinue operations rather than comply with RACT. Again, sufficient data are not available to determine if this would be typical of the small bulk plants in the state. In a previous study of the economics of vapor recovery for small bulk plants, a trend of declining profitability in bulk plant operations was identified.[1] If this trend continues, vapor control systems may not be affordable at marginal plants. Some bulk plants now operate at a profit only because their plants are fully depreciated. In the same study it was also determined that a large percentage of small bulk plants may not be able to raise sufficient capital to purchase vapor control equipment. Furthermore, it is estimated that the price of vapor control systems is likely to increase in the future at a rate greater than the GNP. One bulk plant operator stated that prices for vapor control have risen 30 percent over the past three years. Industry decline may continue and some bulk plant operators may cease operations because of their present financial condition and the additional financial burden of the RACT requirements.

The paragraphs which follow compare the affected statewide compliance costs of RACT control, in 1977 dollars, to various economic indicators.

14.5.3 Comparison of Direct Cost with Selected Direct Economic Indicators

This section presents a comparison of the net increase in the annualized cost of implementing RACT with the total value of gasoline sold from the affected bulk plants in the state, the value of wholesale trade in the state, and the unit price of gasoline.

The net increase in the annualized cost to the bulk gasoline plants due to RACT represents 0.68 percent of the total gasoline sold from affected bulk gasoline plants in the state. When compared to the statewide value of wholesale trade, these annualized cost increases are minimal. The impact on the unit price of gasoline varies with the bulk plant throughput. As discussed in the preceding

1 Economic Analysis of Vapor Recovery Systems on Small Bulk Plants, EPA 340/1-77-013, September 1976.

section, the small bulk plants may experience a direct cost increase of over 0.5 cent per gallon of gasoline sold, whereas the larger bulk plants may experience a smaller direct cost increase.

14.6 SELECTED SECONDARY ECONOMIC IMPACTS

This section discusses the secondary impact of implementing RACT on employment, market structure and productivity.

For bulk gasoline plants that comply with the RACT requirements, additional manpower requirements are not likely to be required. Overall bulk gasoline plant industrial sector employment may continue to decline if the number of bulk gasoline plants operating in the state declines further. Based on the statewide estimates of number of employees and number of bulk plants, an average of approximately 4 jobs could be lost with the closing of a bulk plant. No estimate was made of the number of bulk plants that might close due to RACT.

The impact on the market structure for bulk plants differs significantly in urban and rural areas. The importance of bulk plants in the urban areas is apparently declining because of competition from retailers and tank truck terminals and may continue to decline regardless of RACT requirements.

The productivity of a specific bulk plant will be a function of the type of vapor control system installed. If a bulk plant converts to bottom filling along with vapor recovery, the productivity of the bulk plant should increase. However, some vapor control systems may decrease plant productivity if flow rates substantially decline, requiring longer times to load and unload trucks.

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Exhibit 14-11, on the following page, presents a summary of the findings of this report.

Exhibit 14-11
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS
OF IMPLEMENTING RACT FOR AFFECTED
BULK GASOLINE PLANTS IN THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Number of potentially affected facilities	40
Indication of relative importance of industrial section to state economy	1977 industry sales from affected bulk plants were $21.9 million. The estimated annual throughput was 52 million gallons.
Current industry technology trends	Only small percent of industry has new/modernized plants
1977 VOC actual emissions	676 tons per year
Industry preferred method of VOC control to meet RACT guidelines	Top submerge fill and vapor balancing

Affected Areas in Meeting RACT	Discussion
Capital investment	$550,000
Annualized cost	$148,000 (approximately 0.68 percent of value of shipments)
Price	Assuming a "direct cost passthrough" . Industry-wide--$0.0028 per gallon increase . Small operations--$0.005 per gallon increase
Energy	Assuming full recovery of gasoline--net savings of 3,400 barrels annually
Productivity	No major impact
Employment	No major impact; however, for plants closing, potential average of 4 jobs lost per plant closed
Market structure	Regulation could further concentrate a declining industry
Problem areas	Severe economic impact for some small bulk plant operations. Recovery efficiency of cost effective alternative has not been effectively demonstrated
VOC emission after RACT control	178 tons per year
Cost effectiveness of RACT control	$297 annualized cost/annual ton of VOC reduction

Source: Booz, Allen & Hamilton Inc.

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Evaluation of Top Loading Vapor Balance Systems for Small Bulk Plants, EPA 340/1-77-014, April 1977.

Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, EPA 905/2-78-001, April 1978.

Systems and Costs to Control Hydrocarbon Emissions from Stationary Sources, PB-236 921, Environmental Protection Agency, September 1974.

Control of Volatile Organic Emissions from Bulk Gasoline Plants, EPA 450/2-77-035, December 1977.

Hydrocarbon Control Strategies for Gasoline Marketing Operations, EPA 450/3-78-017

Memorandum, "Meeting with EPA and Others on Bulk Plant Vapor Recovery," National Oil Jobbers Council Mr. Bob Bassman, Counsel, March 21, 1978.

Letter to Mr. William F. Hamilton, Economic Analysis Branch, United States Environmental Protection Agency, from California Independent Oil Marketers Association, February 28, 1978.

Private conversation with Mr. Clark Houghton, Missouri Bulk Plant Operator.

Private conversation with Mr. D. L. Adams, Phillips Petroleum, Towson, Maryland.

Private conversation with Mr. Robert Schuster, bulk plant operator in Escondido, California.

Private conversation with Mr. Burton McCormick, bulk plant operator in Santa Barbara, California.

"The Lundburg Letter," Pele-Drop, North Hollywood, California.

Private conversation with Mr. William Deutsch, Illinois Petroleum Marketers Association, Springfield, Illinois.

Conversations with Mr. Jerry Chalmers, South Carolina Department of Health and Environmental Control.

15.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR STORAGE OF PETROLEUM LIQUIDS IN FIXED-ROOF TANKS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

15.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR STORAGE OF PETROLEUM LIQUIDS IN FIXED-ROOF TANKS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

This chapter presents a detailed analysis of the impact of implementing RACT controls for the storage of petroleum liquids in fixed-roof tanks in four non-attainment counties in South Carolina: Charleston, Berkeley, Lexington and Richland. The major sections of the chapter include:

- Specific methodology and quality of estimates
- Technical characteristics of fixed-roof tanks for storing petroleum liquids
- Profile of statewide fixed-roof tank industry and estimated annual VOC emissions
- Cost of controlling VOC emissions
- Economic impact.

Each section presents detailed data and findings based on analyses of the RACT guidelines, previous studies of fixed-roof storage tanks, interviews with industry representatives and analysis of the findings.

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[1] No fixed roof storage tanks over 400,000 gallons with potential emissions over 100 tons per year were identified in York County.

15.1 SPECIFIC METHODOLOGY AND QUALITY OF ESTIMATES

This section describes the methodology for determining:

- Technical characteristics of fixed-roof tanks
- Profile of fixed-roof tanks
- VOC emissions
- Cost of vapor control systems
- Economic impact of emission control for the storage of petroleum liquids in fixed-roof tanks.

The quality of these estimates is discussed in the last part of this section.

15.1.1 Technical Characteristics of Fixed-Roof Tanks

The technical characteristics of fixed-roof tanks and processes for controlling their emissions were obtained mainly from the RACT guideline entitled Control of Volatile Organic Emissions from Storage of Petroleum Liquids in Fixed-Roof Tanks. EPA-4501/2-77-036, and from several other studies of fixed-roof tanks listed in the reference section of this report.

15.1.2 Profile of Fixed-Roof Tanks

The South Carolina Department of Health and Environmental Control provided a listing of all petroleum storage facilities in the four-county nonattainment area. The storage capacity for each facility, the type of petroleum liquid stored and, for some facilities, the annual throughput were provided. Where not available, the annual throughput was calculated based on an assumed turnover rate of 25 cycles per year.[1]

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1 Based on throughput data for fixed-roof tanks in the State of Kentucky supplied by the Kentucky Department for Natural Resources and Environmental Protection.

15.1.3 VOC Emissions

The VOC emissions were calculated based on the emission factors for working and breathing losses of various types of petroleum liquids obtained from Revision of Evaporative Hydrocarbon Emission Factors, EPA-450/3-76-039.

15.1.4 Cost of Vapor Control Systems

The costs of vapor control systems were developed by:

- Determining the type of control system
- Developing installed capital costs for each tank
- Developing total annualized costs of control systems for the number of tanks in the state including:
    - Installed capital cost
    - Direct operating costs
    - Annual capital charges
    - Petroleum liquid credit
    - Net annual cost
- Aggregating costs to the total industry in South Carolina.

Costs were determined from analyses of the following studies:

- Control of Volatile Organic Emissions from Storage of Petroleum Liquids in Fixed-Roof Tanks, EPA 450/2-77-036
- Benzene Emission Control Costs in Selected Segments of the Chemical Industry, prepared for Manufacturing Chemists Association by Booz, Allen & Hamilton Inc., June 12, 1978.

and from interviews with petroleum marketers' associations, petrochemical manufacturers and vapor control equipment manufacturers.

The extrapolation of the estimated cost of control in the four nonattainment counties in South Carolina required a profile of fixed-roof tanks for storing petroleum liquids for the nonattainment area. These data were provided by the South Carolina Department of Health and Environmental Control.

15.1.5 Economic Impact of Emission Control

The economic impact of emission control for equipping fixed-roof tanks used for storing petroleum liquids can be determined only in terms of the aggregated costs of controls. Since several industries use fixed-roof tanks, economic impacts on individual industries depend on the extent to which those industries must bear the increased cost burden. The economic impact analysis in this report is, therefore, limited to estimating aggregated costs of controls and qualitatively assessing the potential impacts of these costs on various industries.

15.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, cost and economic impact of implementing RACT controls for fixed-roof tanks in the four nonattainment counties in South Carolina. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (i.e., data that are published for the base year); "B" indicates data that were extrapolated from hard data; and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analyses of previous studies and best engineering judgment. Exhibit 15-1, on the following page, rates each study output listed and the overall quality of the data.

EXHIBIT 15-1

U.S. Environmental Protection Agency
DATA QUALITY

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics	●		
Emissions			●
Cost of emissions control		●	
Statewide costs of emissions		●	
Economic impact			●
Overall quality of data		●	

Source: Booz, Allen & Hamilton Inc.

15.2 TECHNICAL CHARACTERISTICS OF RACT GUIDELINES FOR FIXED-ROOF TANKS FOR STORING PETROLEUM LIQUIDS

The technical characteristics of fixed-roof tanks for storing petroleum liquids, the sources and types of VOC emmitted by these tanks and the control measures for reducing VOC emission from fixed-roof tanks are described in the EPA guidelines series, Control of Volatile Organic Emissions from Storage of Petroleum Liquids in Fixed-Roof Tanks, EPA-450/2-77-036.

The RACT guidelines call for installation of an internal floating roof for fixed-roof tanks storing greater than 40,000 gallons of petroleum liquids with a true vapor pressure that exceeds 1.52 psi. The guidelines do not apply to storage tanks equipped with external floating roofs or to storage tanks having capacities less than 416,000 gallons used to store crude oil and condensate prior to lease custody transfer.[1]

It is expected that the State of South Carolina will prepare legislation for the storage of petroleum liquids which is modeled after the RACT guidelines.

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1 "Custody transfer" means the transfer of produced crude oil and/or condensate, after processing and/or treating in the production operations, from storage tanks or automatic transfer facilities to pipelines or any other forms of transportation.

15.3 PROFILE OF FIXED-ROOF TANKS FOR STORING PETROLEUM LIQUIDS AND ESTIMATED VOC EMISSIONS

This section contains a profile of fixed-roof tanks used for storing petroleum liquids in the four nonattainment counties in South Carolina and the estimated annual VOC emissions from these tanks.

The South Carolina Department of Health and Environmental control provided a listing of facilities with fixed-roof tanks used for storage of petroleum liquid. The total storage capacity for each facility was provided in the listing. The total number of storage tanks was estimated by assuming an average tank size of 300,000 gallons for the major petroleum companies and 60,000 gallons for the smaller petroleum distributers. It is estimated that there are approximately 44 fixed-roof tanks with greater than 40,000 gallons capacity not equipped with an internal floating roof in the 4-county area. The total storage capicity of these tanks is approximately 10.5 million gallons and the annual throughput is estimated at approximately 260 million gallons.

It is estimated that the annual VOC emissions from the storage of petroleum liquids in fixed-roof tanks in the nonattainment area are 1425 tons per year. By implementing RACT guidelines in the four nonattainment counties, these emissions could be reduced by 90 percent to an estimated 142 tons per year.

15.4 COST OF CONTROLLING VOC EMISSIONS

This section presents a cost analysis of equipping fixed-roof tanks used for storing petroleum liquids with internal floating roofs as a means for controlling VOC emissions.

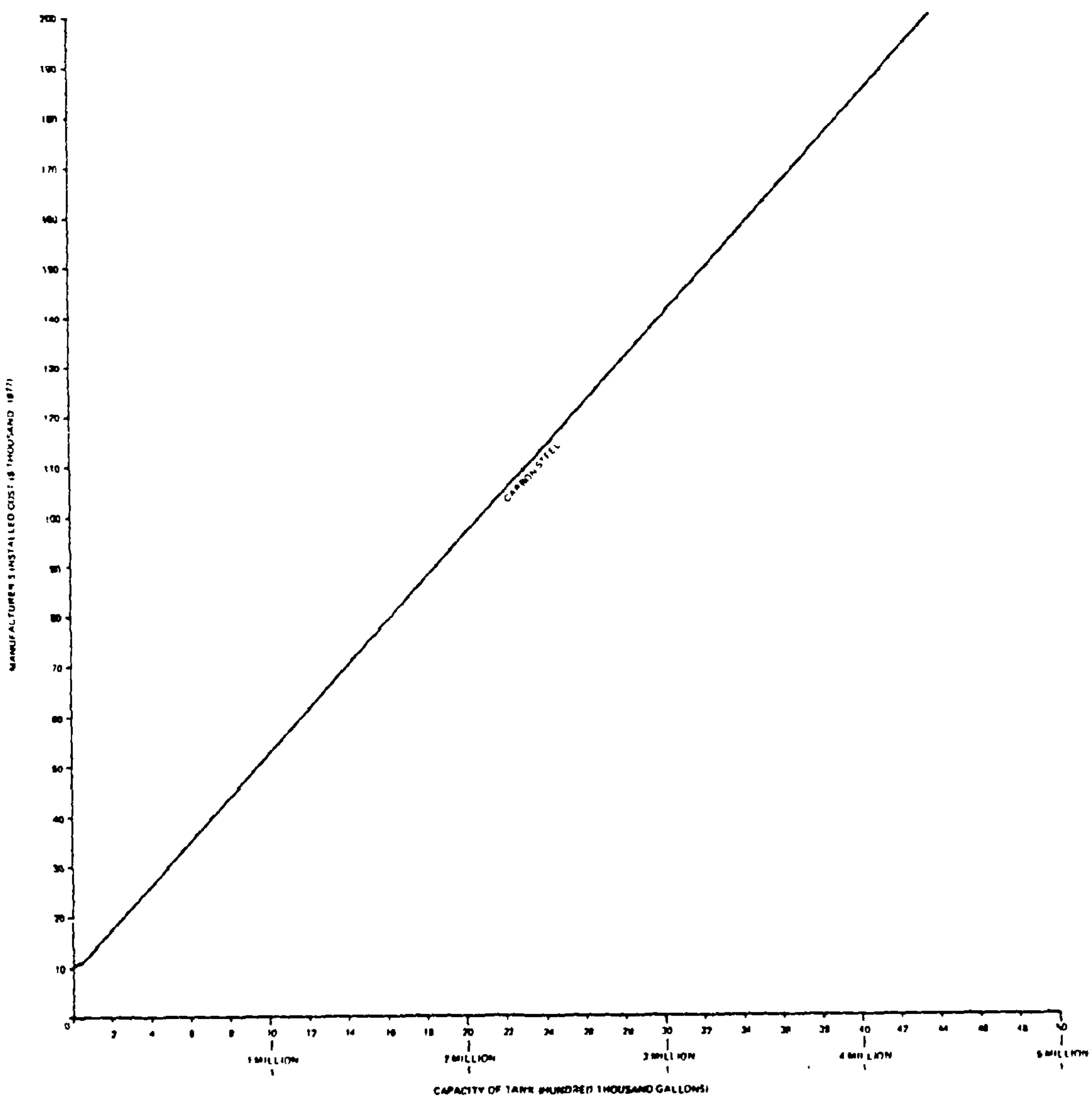
The cost factors for emission control equipment include:

- Installed capital cost, including parts and labor
- Annual capital charges, estimated to be 25 percent of installed capital cost and including costs for depreciation, interest, maintenance, taxes and insurance
- Annualized direct costs, estimated to be 2 percent of installed capital cost including costs for inspection and recordkeeping
- Annual petroleum liquid credit calculated by multiplying emission reduction by the volume of the petroleum liquid divided by the liquid density and multiplied by a value of $0.39 per gallon
- Net annualized costs, the sum of the capital charges and annualized direct costs less the petroleum liquid credit.

Capital costs were determined for each tank from the graph in Exhibit 15-2, on the following page. This graph was prepared by Booz, Allen based on interviews with petroleum refineries, petrochemical manufacturers, tank manufacturers and emission control equipment manufacturers. Total installed capital cost, including labor, is two times the value given on the graph. All costs are for 1977.

A summary of the aggregated cost for the control of emissions from petroleum liquids stored in fixed-roof tanks is shown in Exhibit 15-3, following Exhibit 15-2. The total installed capital costs for equipping approximately 44 fixed-roof tanks affected by RACT with internal floating roofs is approximately $1 million. The net annualized cost is approximately $118,000 taking into account a liquid petroleum credit of $159,000. The annualized cost per ton of emissions reduced is $92.

Exhibit 15-2
U.S. Environmental Protection Agency
INSTALLED COST OF SINGLE SEAL
FLOATING ROOF TANKS
(Prices Approximate)



<u>Source</u>: Communications with Ultra-Float Inc.; Booz, Allen & Hamilton Inc. analysis

EXHIBIT 15-3
U.S. Environmental Protection Agency
VOC EMISSIONS CONTROL COSTS FOR STORAGE
OF PETROLEUM LIQUIDS IN FIXED-ROOF
TANKS IN THE FOUR NONATTAINMENT COUNTIES
IN SOUTH CAROLINA

SUMMARY

Plant Characteristics	
Number of tanks	44
Total capacity (millions of gallons)	10.5
Estimated annual throughput (millions of gallons)	260
Uncontrolled emissions (tons per year)	1,425
Emissions reduction (tons per year)	1,283
Emissions after control (tons per year)	142
Costs	
Installed capital cost ($, millions, 1977)	1.02
Annualized capital charges ($, thousands, 1977)	256
Annualized direct costs ($, thousands, 1977)	20.5
Annual petroleum credit ($, thousands, 1977)	159[a]
Net annualized cost ($, thousands, 1977)	118
Annualized cost per ton of emissions reduced ($, 1977)	92

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[a] Assume value of petroleum liquid saved is $.39 per gallon and density of petroleum liquid is 6.1 lbs. per gallon.

Source: Booz, Allen & Hamilton Inc.

15.5 DIRECT ECONOMIC IMPACT

This section discusses the economic impact of equipping fixed-roof tanks used for storing petroleum liquids with an internal floating roof to control VOC emissions. The impacts analyzed include: total cost statewide; identification of industries that may be affected and their ability to raise the capital needed for the controls.

Installed Capital Cost in the Affected Counties in South Carolina. An estimated $1 million will be required in the four nonattainment counties in South Carolina to equip fixed-roof tanks for storing petroleum liquids with internal floating roofs. This represents 1 percent of the value of petroleum liquid throughput from uncontrolled fixed-roof tanks in the nonattainment area.

Industries Affected. Fixed-roof tanks affected by RACT guidelines are owned by major oil companies, large petrochemical firms and bulk gasoline tank terminal companies. It is predicted that these companies will be able to meet the capital requirements. The source of capital is likely to be the company's traditional source of funds.

15.6 SECONDARY ECONOMIC IMPACTS

It is expected that secondary economic impacts as a result of implementing RACT guidelines in South Carolina will be minimal. Employment, worker productivity, and market structure should remain unchanged.

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Exhibit 15-4 on the following page presents a summary of the findings of this report.

EXHIBIT 15-4
U.S. Environmental Protection Agency
Summary of Direct Economic Implications of
Implementing RACT for Storage of Petroleum
Liquid in the State of South Carolina
(NONATTAINMENT COUNTIES)

Current Situation	
Number of potentially affected storage tanks	44
Indication of relative importance of industrial section	The annual throughput was an estimated 260 million gallons
Current industry technology trends	Internal floating roof tanks utilizing a double seal have been proven to be more cost effective
VOC emissions	1,425 tons per year
Preferred method of VOC control to meet RACT guidelines	Single seal and internal floating roof
Affected Areas in Meeting RACT	
Capital investment	$1.02 million
Annualized cost	$118,000
Price	Assuming a "direct cost" passthrough-less than 0.05 cents per gallon of throughput
Energy	Assuming 90 percent reduction of current VOC level, the net energy savings represent an estimated savings of 8,000 equivalent barrels of oil annually
Productivity	No major impact
Employment	No major impact
Market Structure	No major impact
Problem area	Potential availability of equipment to implement RACT standard
VOC emission after RACT control	142 tons per year
Cost effectiveness of RACT control	$92 annualized cost/annual ton of VOC reduction

Source: Booz, Allen & Hamilton Inc.

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Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, EPA-905/2-78-001, U.S. Environmental Protection Agency, April 1978.

Revision of Evaporative Hydrocarbon Emission, PB-267 659, Radian Corp., August 1976.

16.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT STAGE I FOR GASOLINE SERVICE STATIONS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

16.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT STAGE I FOR GASOLINE SERVICE STATIONS IN THE NONATTAINMENT AREAS FOR OZONE IN THE STATE OF SOUTH CAROLINA

This chapter presents a detailed analysis of implementing RACT Stage I controls pertaining to gasoline dispensing facilities[1]. Presently, only four counties in South Carolina are classified as urban nonattainment areas. They are: Charleston, Berkeley, Lexington and Richland. The impact of RACT in these counties is investigated in six sections as follows:

- Specific methodology and quality of estimates
- Industry statistics
- The technical situation of the industry
- Cost and VOC reduction benefit evaluations for the most likely RACT control techniques
- Direct economic implications
- Selected secondary economic impacts.

Each section presents detailed data and findings based on analyses of the RACT guidelines, previous studies of gasoline service station vapor recovery, interviews and analysis.

The economic impact in this chapter is presented only for the four urban nonattainment counties as gasoline service stations in other areas of the state are not likely to have potential VOC emissions greater than 100 tons per year.

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1 Gasoline dispensing facility is a generic term which encompasses both retail facilities and private outlets. The latter are primarily establishments maintained by governmental, commercial or industrial consumers for their own fleet operations. The latter category also includes rural convenience stores, parking garages, marinas and other retail outlets not classified as service stations.

16.1 SPECIFIC METHODOLOGY

This section describes the methodology for determining estimates of:

- Industry statistics
- VOC emissions
- Processes for controlling VOC emissions
- Cost of controlling VOC emissions
- Economic impact of emission control

for gasoline dispensing facilities in the four urgan nonattainment counties in South Carolina.

The quality of the estimates based on a three-point scale is described in detail in the latter part of this section.

16.1.1 Industry Statistics

The focal year of the analysis is 1977 and all hard industry statistics are reported on this basis. When hard data for the base year are not available, appropriate scaling factors are applied to existing confirmed data to derive base year estimates.

To derive the total number of gasoline dispensing facilities in the four urban nonattainment counties a two-stage procedure is used. First, the number of statewide retail service stations is identified[1] and the figure is then scaled by a factor of 1.37[2] to produce an estimate of the number of private dispensing facilities. Next, these two statewide totals are disaggregated to the county level using coefficients developed from a Bureau of Census publication. In addition to providing a basis for estimating the total number of dispensing facilities at the county level, the census publication is also used to calculate total county employment levels.

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1 National Petroleum News Fact Book, 1978, p. 105.

2 The Economic Impact of Vapor Recovery Regulations on the Service Station Industry, Department of Labor, OSHA, C79911, March 1978, pp. 4-7.

3 County Business Patterns 1976: South Carolina, U.S. Department of Commerce, CBP-76-12, 1978.

Finally, to derive the volume of gasoline sold in the non-attainment counties, existing data on state sales totals[1] are disaggregated using coefficients reflecting the ratio of county establishments to state establishments. A value is assigned to this sales volume using the 1977 average national service station price (50.7¢/gal. excluding tax).[2]

16.1.2 VOC Emissions

The Illinois EPA estimated VOC emissions for gasoline service stations by applying an emission factor to the 1977 gasoline throughput. This emission factor and procedure were used to calculate emissions in affected counties in South Carolina.

16.1.3 Processes for Controlling VOC Emissions

Processes for controlling VOC emissions from gasoline service stations are described in "Design Criteria for Stage I Vapor Control Systems--Gasoline Service Stations." This document provides the base data on alternative methods available for controlling VOC emissions from gasoline service stations. In addition, several studies of VOC emission control were analyzed and interviews with petroleum trade associations, gasoline service station operators and vapor control equipment manufacturers were conducted to ascertain the most likely types of equipment which would be used in gasoline service stations in South Carolina. The specific studies analyzed were: Economic Impact of Stage II Vapor Recovery Regulations: Working Memoranda, EPA-450/3-76-042; A Study of Vapor Control Methods for Gasoline Marketing Operations, PB-246-088, Radian Corporation; Reliability Study of Vapor Recovery Systems at Service Stations, EPA-450/3-76-001; Technical Support Document, Stage I Vapor Recovery at Service Stations, draft, Illinois Environmental Proctection Agency.

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1 Federal Highway Administration Forms, MF 25, 26, 21.

2 National Petroleum News Fact Book, 1978, p. 100.

16.1.4 Cost of Vapor Control Systems

The cost of vapor control systems were developed by:

- Developing costs of two different control systems for a model service station including:
  - Installed capital cost
  - Direct operating costs
  - Annual capital charges
  - Gasoline credit
  - Net annual cost
- Aggregating costs to the countywide gasoline dispensing establishment industry.

Costs were determined from analyses of the studies listed previously, and from interviews with petroleum marketers' associations, gasoline service station operators and vapor control equipment manufacturers.

It was assumed that 75 percent of the gasoline dispensing facilities would install coaxial or concentric vapor balance systems and the remaining 25 percent would install the two-point vapor balance system. Costs for the two systems are assumed to be represented by the costs developed for the model service station discussed in Section 16.4.1. Non-attainment county costs were extrapolated from model costs.

16.1.5 Economic Impacts

The economic impacts were determined by analyzing the lead time requirements needed to implement RACT; assessing the feasibility of instituting RACT controls in terms of capital and equipment availability; comparing the direct costs of RACT control to various county economic indicators; and assessing the secondary impacts on market structure, employment and productivity resulting from implementation of RACT controls.

16.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, costs and economic impact of implementing RACT controls in gasoline service stations in the four urban nonattainment counties in South Carolina. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (i.e., data that are published for the base year); "B" indicates data that were extrapolated from hard data; and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analyses of previous studies and best engineering judgment. Exhibit 16-1, on the following page, rates each study output and the overall quality of the data.

EXHIBIT 16-1
U.S. Environmental Protection Agency
DATA QUALITY

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics	•		
Emissions		•	
Cost of emissions control		•	
Countywide costs of emissions			•
Economic impact		•	
Overall quality of data		•	

Source: Booz, Allen & Hamilton Inc.

16.2 INDUSTRY STATISTICS

Industry characteristics, statistics and business trends for gasoline service stations are presented in this section. The discussion includes a description of the number of facilities and their characteristics, a comparison of the size of the service station industry to state economic indicators, an historical characterization and description of the industry and an assessment of future industry patterns. Data in this section form the basis for assessing the impact on this industry of implementing RACT to VOC emissions from gasoline service stations in the affected counties in South Carolina.

16.2.1 Size of Industry

There were an estimated 400 retail gasoline dispensing facilities in the four urban nonattainment counties in South Carolina in 1977. In addition, there were an estimated 550 private dispensing establishments (which include gasoline dispensing facilities such as marinas, general aviation facilities, commercial and industrial gasoline consumers and rural operations with gas pumps). For all dispensing facilities sales were in the range of $183 million and yearly throughput was approximately 0.362 billion gallons of gasoline. The estimated number of employees in 1977 was 2,010 employees in retail outlets and 1,100 employees in private outlets for a total of 3,110 employees. These data and the sources of information are summarized in Exhibit 16-2, on the following page. Total capital investments by the gasoline dispensing industry were not identified, although in general gasoline dispensing outlet operators make investments in plant and equipment to: replace worn-out facilities and equipment; modernize the establishments; or improve operating efficiencies.

16.2.2 Comparison of Industry to State Economy

Employment and sales are used as reference indicators in order to gain a perspective on the economic significance of the gasoline dispensing industry. The estimated 3,140 employees and $183,000,000 in sales constitute approximately 0.6 percent of the civilian labor force and eight percent of the total four-county retail trade in 1977. In evaluating these percentages, it should be remembered that transportation is a vital linking element in the economy and any significant disruption to the gasoline dispensing sector could have indirect consequences for other sectors of the economy.

EXHIBIT 16-2
U.S. Environmental Protection Agency
INDUSTRY STATISTICS FOR GASOLINE SERVICE STATIONS
IN THE FOUR URBAN NONATTAINMENT COUNTIES IN SOUTH CAROLINA

Number of Facilities		Number of Employees			
Retail Dispensing Facilities	Private Dispensing Facilities	Retail	Private	Sales ($Billion, 1977)	Gasoline Sold (Billions of Gallons)
400[a]	550[b]	2,010[c]	1,100[d]	0.183[e]	0.362[f]

a. Estimate based on data in National Petroleum News Fact Book, 1978

b. Includes gasoline dispensing facilities such as marinas, general aviation facilities, commercial and industrial gasoline consumers and rural convenience store operations with gas pumps.

c. Estimate based on the ratio of the number of employees to the number of establishments (scaled appropriately) in the counties as of 1976.

Berkeley	2.86	employees per retail outlet
Charleston	5.68	"
Lexington	4.28	"
Richland	4.92	"

(Source: U.S. Department of Commerce, Bureau of the Census, County Business Patterns 1976: South Carolina CBP-76-12, 1978)

d. Estimate based on two employees per facility.

e. Number of gallons of motor gasoline sold in 1977 multiplied by the national service station price in 1977 (50.7¢/gallon), National Petroleum News Fact Book, 1978.

f. Estimate based on Federal highway statistics for 1977.

Source: Booz, Allen & Hamilton Inc.

16.2.3 Characterization of the Industry: Structure and Trends

Gasoline dispensing establishments are the final distribution point in the petroleum marketing network. Exhibit 16-3 shows the position of both retail and private dispensing facilities with the former located in the bottom row and the latter primarily in the source marked "Commercial/Industrial Consumer Accounts." As the graphic indicates, all petroleum marketers retail their gasoline through one of the following type operations:

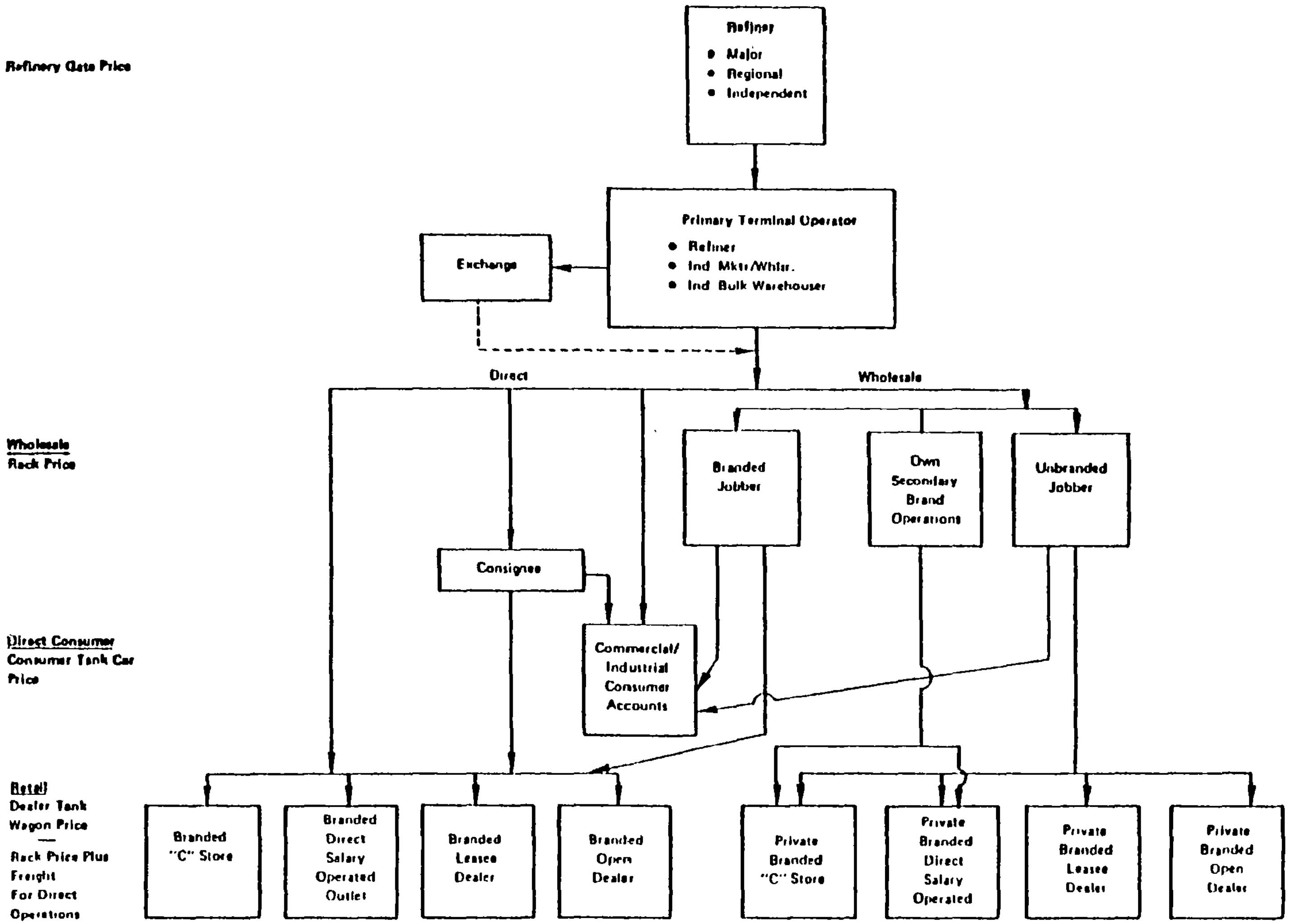
- Direct-salary operation: supplier-"controlled"/ supplier-operated
- Lessee dealer: supplier-"controlled"/lessee-dealer operated
- Open dealer: dealer-"controlled"/dealer-operated
- Convenience store.

According to this classification, the retail gasoline dispensing sector has the following dimensions: 18 percent direct outlets, 5.4 percent convenience stores, 46.9 percent lessee dealers and 29.7 percent open dealers. See Exhibit 16-4 for more details.

By way of contrast the private dispensing establishments have the following breakdown by end use: agriculture trucking and local service, government, taxis, school busses, and miscellaneous. See Exhibit 16-5 for more details.

Regardless of ownership pattern or end-use category, gasoline marketing is characterized by high fixed costs, with operations varying by degree of labor intensity. Conventional service stations (service bay with mechanics on duty and nongasoline automotive items available) are the most labor intensive, while self-service "gas and go" stations exemplify low labor intensity.

EXHIBIT 16-3
U.S. Environmental Protection Agency
GASOLINE DISTRIBUTION NETWORK



Source: U.S. Department of Labor, The Economic Impact of Vapor Recovery Regulations on the Service Station Industry, c-79911, March 1978, p. 56.

EXHIBIT 16-4
U.S. Environmental Protection Agency
U.S. RETAIL GASOLINE DISPENSING FACILITIES

% TOTAL OUTLETS

	Direct Outlets[a]	Convenience Stores	Leasee Dealer[b]	Open Dealer[c]	Total Directly Supplied
Major Oil Company	3.5	0.4	28.2	15.7	47.8%
Regional Refiner	2.3	0.1	5.3	1.1	8.8%
Independent Marketer/"Super Jobber"	9.3	4.3	2.5	0.6	16.7%
Small Jobber	2.9	0.6	10.9	12.3	26.7%
% Total Outlets	18.0%	5.4%	46.9%	29.7%	100.0%
Total Number of Outlets	32,070	9,600	83,690	53,030	178,390

a Company "investment"/company operated
b Company "investment"/leasee dealer
c Dealer "investment"/dealer operated

Source: U.S. Department of Labor "The Economic Impact of Vapor Recovery Regulations on the Service Station Industry," C-79911, March 1978, p. 58.

EXHIBIT 16-5
U.S. Environmental Protection Agency
U.S. PRIVATE GASOLINE DISPENSING FACILITIES

End-Use Sector	Number of "Private" Gasoline-Dispensing Outlets	Annual Gasoline Consumption (Million Gal)	% Total U.S. Private Gasoline Volume	% Total U.S. Gasoline Volume
Agriculture	32,600	3,801.3	15%	3%
Trucking and local service	21,900	5,241.6	21%	5%
Government	85,450		11%	2%
- Federal		227.6	0.9%	
- Military		174.1	0.6%	
- Other*		2,266.4	9.0%	
Taxis	5,380	882.1	3%	0.8%
School Busses	3,070	144.7	1%	0.1%
Miscellaneous**	94,530	12,497.2	49%	11%
Total Non-Service Station Segment	242,930	25,235.0	100%	23%
Retail Service Station Segment	178,390	84,412.0		77%
All Segments —	421,320	109,647.0		100%

*State and municipal governments.

**Auto rental, utilities, and other.

Source: U.S. Department of Labor, "The Economic Impact of Vapor Recovery Regulations on the Service Station Industry," C-79911, March 1978, p. 47.

Finally, no discussion of the industry would be complete without a characterization of major trends. The number of gasoline dispensing facilities, and in particular the retail service stations, has been declining nationally since 1972. At the same time throughput per station has been rising reflecting the switch to high volume self-service "gas and go" establishments.[1] This trend also appears in South Carolina and is predicted to continue. In 1972 there were 3,720 service stations and in 1977 this number fell to 2,898[2].

16.2.4 Gasoline Prices

Gasoline prices vary among types of gasoline stations within a geographical area. Convenience stores are apt to have higher pump prices than large self-service "gas and go" stations. The pump price less the dealer tank wagon price represents the gross margin on a gallon of gasoline. Retail gasoline service station operating costs then must come out of the gross margin for gasoline as well as the gross margin for other products which may be sold at the service station. Operating costs vary substantially among the various types of service stations. It is reported that some service stations operate with nearly zero net margin or profit on the sale of gasoline, while others may enjoy up to four to five cents profit per gallon. Insufficient detail is available on service stations in South Carolina to present a thorough analysis of existing price structures and degree of competition in the industry within the state.

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1 Economic Impact of Stage II Vapor Recovery Regulations: Working Memoranda, EPA-450/3-76-042, November 1976, p. 2. By 1980 one-half of all retail gasoline stations are expected to be self-service.

2 National Petroleum News Fact Book, 1978, p. 105.

16.3 THE TECHNICAL SITUATION IN THE INDUSTRY

This section presents information on gasoline dispensing outlet operations, estimated VOC emissions from these operations in the non-attainment areas, the extent of current control in use, the vapor control requirements of RACT and the likely alternatives which may be used for controlling VOC emissions from gasoline dispensing facilities in South Carolina.

16.3.1 Gasoline Dispensing

Gasoline service stations are the final distribution point in the gasoline marketing network. Taking retail and private outlets together the average monthly throughput per station in the four urban nonattainment counties is approximately 32,000 gallons. Some of these facilities are all subject to RACT regulations and will be required to comply with Stage I vapor control by May 1, 1981.

16.3.1.1 Facilities

Equipment at gasoline dispensing facilities includes: gasoline storage tanks, piping and gasoline pumps. The most prevalent type of gasoline storage tank is the underground tank. It was assumed that there are typically three storage tanks per facility. Gasoline is dispensed to motor vehicles through pumps and there may be anywhere from one to twenty pumps per facility. Stage I vapor control regulations apply to the delivery of gasoline to the facility and the subsequent storage in underground tanks.

16.3.1.2 Operations, Emissions and Controls

Uncontrolled VOC emissions at dispensing facilities come from loading and unloading losses from tank trucks and underground tanks, refueling losses from vehicle tanks and breathing losses from the underground tank vent. Stage I vapor control applies to tank truck unloading and working and breathing losses from underground storage tanks.

Tank trucks are unloaded into underground storage tanks either by splash loading or submerged loading. Splash loading results in more emissions than submerged loading.

More specifically, losses consist of:

- Organic liquid that evaporates into the air that is drawn in during the withdrawal of the tank compartment contents

- Losses from refilling the underground tank that occur as vapors are displaced from the tank

- Vapors vented into the atmosphere from underground storage tanks as a result of changes in temperature and pressure.

Exhibit 16-6 shows the estimated emissions in tons per year from all dispensing facilities in the four urban nonattainment counties. To arrive at this estimate it is assumed that 90 percent[1] of all storage tank loading is by the submerge fill method and 10 percent by the splash fill method. Given this assumption, emissions based on throughput are estimated to be 1,396 tons.

16.3.2 RACT Guidelines

The RACT guidelines for Stage I VOC emission control from gasoline service stations require the following controls:

- Submerged fill of gasoline storage tanks

- Vapor balancing between the truck and the gasoline storage tank

- Proper operation and maintenance of equipment.

Exhibit 16-7 summarizes the RACT guidelines for VOC emissions control from gasoline service stations.

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1 Source: Booz, Allen interviews with industry representatives.

EXHIBIT 16-6

U.S. Environmental Protection Agency
VOC EMISSIONS FROM GASOLINE DISPENSING
FACILITIES IN THE FOUR URBAN NONATTAINMENT
COUNTIES IN SOUTH CAROLINA

Estimated Number of Facilities	Average Yearly Throughput (Millions of Gallons)	Total Emissions[a] (Tons/Year)
950	362	1,396

[a] Splash fill emissions: 11.5 lbs/1000 gallons throughput
Submerge fill emissions: 7.3 lbs/1000 gallons throughput
assumes no vapor balancing

Source: Booz, Allen & Hamilton, Inc.

EXHIBIT 16-7

U.S. Environmental Protection Agency

VOC EMISSION CONTROL TECHNOLOGY FOR GASOLINE DISPENSING FACILITIES

Facilities Affected	Sources of Emissions	RACT Control Guidelines
Gasoline service stations and gasoline dispensing facilities	Storage tank filling and unloading tank truck	Stage I vapor control system, i.e., vapor balance system which returns vapors displaced from the storage tank to the truck during storage tank filling, and submerge filling; instructions to operator of facility on maintenance procedures; repair and replacement of malfunctioning or worn equipment; maintenance of meters and test devices

Source: Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, pp. 28-31.

16.3.3 Selection of the Most Likely RACT Control Techniques

Stage I control of VOC emissions from gasoline dispensing facilities can be achieved by using vapor balancing between the unloading of incoming tank trucks and the gasoline storage tank and by submerged filling of storage tanks. There are alternative means of achieving vapor balance based primarily on the method of connecting the vapor return line to the gasoline storage tank. The two primary methods for connecting vapor return lines are the two-point connection and coaxial or concentric connection (often referred to as tube-in-tube connection). The two-point connection method involves using two risers with the storage tank: one for fuel delivery and the other for returning vapors to the tank truck. The coaxial system uses a concentric liquid vapor return line and thus requires only one tank riser. EPA tests have shown the two-point system to be more effective than the coaxial system in transferring displaced vapors, but at the same time the two-point system is more expensive. It is judged that 25 percent[1] of gasoline dispensing facilities will install the two-point system, bearing a higher installed cost but achieving greater efficiency. Submerged fill is required by Stage I vapor control. It is achieved by using a drop tube extending to within six inches of the storage tank bottom.

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1 Source: Booz, Allen interviews with industry personnel.

16.4 COST AND HYDROCARBON REDUCTION BENEFIT EVALUATIONS FOR STAGE I RACT REQUIREMENTS

Costs for VOC emission control equipment are presented in this section. The costs for a typical gasoline service station are described, followed by an extrapolation to the non-attainment county industry.

16.4.1 Costs for Vapor Control Systems

The costs for vapor control systems were developed from information provided by petroleum marketing trade associations and from previous cost studies of gasoline dispensing facilities. These costs are summarized for a typical gasoline dispensing facility in Exhibit 16-8. The monthly throughput of an affected facility averages approximately 32,000 gallons or somewhat less than the average for all retail facilities in the United States.[1] Though South Carolina facilities are somewhat below the U.S. average, in general, service station equipment requirements (number of storage tanks) are not very sensitive to throughput over a large gallon range. Therefore, it appears that South Carolina facilities should be quite similar to the prototype facility described in Exhibit 16-8. Given this observation, Stage I vapor control costs have been estimated as follows.

Capital costs of installing the two-point vapor-balancing equipment at existing service stations are about $2,000 per station. This cost includes equipment costs ($300-$500) and installation ($1,300-$1,600).[2] The installed capital cost for a coaxial or concentric system is reported by U.S. EPA to be $150 to $200 per tank, including parts and labor. Annualized capital costs are estimated at 25 percent of installed capital cost and include interest, depreciation, taxes and maintenance.

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1 U.S. Department of Labor, OSHA, The Economic Impact of Vapor Recovery Regulations on the Service Station Industry, C-79911, March 1978, p. 29.

2 Air Pollution Control Technology Applicable to 26 Sources of Organic Compounds, U.S. Environmental Protection Agency, May 27, 1977. (This cost includes excavation and construction of manifolded storage tanks.)

EXHIBIT 16-8

U.S. Environmental Protection Agency
STAGE I VAPOR CONTROL COSTS FOR A
TYPICAL RETAIL GASOLINE DISPENSING FACILITY

Description of Model Gasoline Station

Monthly throughput (gallons)	39,000[a]
Number of storage tanks	3[b]

Costs
($, 1977)

	Two Point System	Coaxial or Concentric System
Installed capital	2,000[c]	600
Annualized capital charges[d]	500	150
Direct operating cost	0	0
Annualized cost[e]	500	150

a 39,000 is the national average. In South Carolina's non-attainment counties the average is 32,000.

b In private dispensing outlets, the number of tanks is assumed to be one as opposed to three. On the average, private stations have monthly throughput flows of only 23 percent of throughput in retail service stations.

c Includes cost of repaving but does not account for lost sales due to down time.

d Twenty-five percent of installed capital cost. Includes depreciation, interest, taxes, insurance and maintenance.

e Does not include credit for recovered gasoline.

Source: Booz, Allen & Hamilton Inc.

Based on these figures, the annualized cost[1] at a typical retail gasoline dispensing facility with 36,150 gallons/month throughput is estimated to be $500 for the two-point system and $150 for the concentric or coaxial system. It is worth noting that direct operating costs should not increase due to Stage I controls and thus the annualized cost will reflect only the capital charges associated with the control equipment.

In addition to the cost incurred at the gasoline dispensing facility, there are also the costs of vapor balancing borne by the owners of the tank trucks. The costs to bulk gas plants and terminals of Stage I vapor modifications of fleet trucks have been discussed in other chapters. Here the focus is on independent fleet operators subject to RACT vapor controls. By approximating the total number of tank trucks needed to service the gasoline dispensing facilities in the non-attainment counties, and by subtracting from this total the estimated number of trucks controlled by bulk terminals and gas plants, the size of the independent fleet is derived. Booz, Allen estimates that roughly 230 tank trucks require vapor modification.[2]

The cost of vapor control modification on trucks is estimated to be between $2,000 and $7,200 depending on whether top or bottom loading methods are used. For purposes of this analysis, it is assumed that the less expensive top loading method will be used, and that this system can be installed at a cost of $3,000 per truck. At 230 trucks total cost is $690,000. Annualized capital costs are estimated at 25 percent of installed capital cost and include: interest, depreciation, taxes and maintenance. Direct operating costs are assumed to be zero. See Exhibit 16-9 on the following page for more details.

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1 Gasoline recovery credit has not been accounted for here, but will be when the results are extrapolated to the countywide industry.

2 U.S. Environment Protection Agency, <u>Survey of Gasoline Tank Vehicles and Rail Cars</u>, EPA-68-02-2606, Preliminary Draft, pp. 1-3 and 2-10. Total stock of tank trucks is estimated to be 85,000. Booz, Allen estimates that statewide there are 1263 trucks and in non-attainment areas 278. Of these 278, it is estimated that 48 trucks are controlled by the bulk plants and terminals.

EXHIBIT 16-9
U.S. Environmental Protection Agency
STAGE I VAPOR CONTROL COSTS
FOR A TYPICAL GASOLINE DISPENSING TRUCK

Costs
($, 1977)

	Top Loading Method
Installed capital[a]	3,000
Annualized capital charges[b]	750
Direct operating cost	0
Annualized cost	750

a Booz, Allen interviews with equipment manufacturers.

b 25 percent of installed capital cost. It includes depreciation, interest, taxes, insurance and maintenance.

16.4.2 Extrapolation to the Industry in Non-Attainment Areas

Exhibit 16-10 shows the extrapolation of vapor control costs to the non-attainment area-wide industry. Costs include truck modifications and vapor control at the gasoline dispensing facilities. It should be noted that actual costs to the operators of trucks and gasoline dispensing outlets may vary depending on the control method and specific equipment selected.

Booz, Allen estimates that approximately 250 of the potentially affected facilities will be exempted because of exemptions in the proposed South Carolina regulations. Therefore, an estimated 700 facilities will be potentially affected. These facilities represent an estimated 1,250 tons of the 1,396 tons from gasoline dispensing facilities in the four nonattainment county area.

The total cost to the industry of installing vapor control equipment is estimated to be approximately $1.1 million. The amount of gasoline prevented from vaporizing by converting to submerged filling of the gasoline storage tank is estimated to be worth approximately $12,000. Based on these estimates, the annualized cost per ton of emissions controlled was $222 per ton.

EXHIBIT 16-10
U.S. Environmental Protection Agency
COSTS FOR STAGE I VAPOR CONTROL OF GASOLINE
DISPENSING FACILITIES IN THE FOUR URBAN
NONATTAINMENT COUNTIES IN SOUTH CAROLINA

SUMMARY OF COSTS

Number of facilities	700
Total annual throughput (billions of gallons)	0.324
Uncontrolled emissions (tons/year)	1,249
Emissions reduction (tons/year)	1,187[a]
Controlled emissions (tons/year)	62
Installed capital ($ millions)	1.1
. dispensing facilities	0.411
. tank trucks	0.690
Annualized capital cost ($ millions)	0.275
. dispensing facilities	0.102
. tank trucks	0.173
Annual gasoline credit ($ millions)	0.012
Net annualized cost ($ millions)	0.263
Net annualized cost per ton of emissions reduced ($ per ton/year)	$222

a Estimate based on 95 percent reduction in emissions.

b Gasoline credit to dispensing outlets is based on the conversion from splash to submerged filling. The actual formula relates throughput in splash fill facilities to potential captured vapors resulting from equipment conversion, and values the recoverable gasoline at its retail selling price (50.7¢/gallon). Bulk terminals also receive a gasoline credit for the recovered vapors brought back by tank trucks. This gasoline is estimated to be worth $163,000 when valued at the bulk wholesale price (42¢/gallon).

Source: Booz, Allen & Hamilton Inc.

16.5 DIRECT ECONOMIC IMPLICATIONS

This section discusses the direct economic implications for the non-attainment counties of implementing Stage I RACT controls.

16.5.1 RACT Timing

RACT must be implemented statewide by May 1, 1981. This means that gasoline service station operators must have vapor control equipment installed and operating within the next two years. The timing deadlines of RACT impose several requirements on service station operators including:

- Determining the appropriate method of vapor balancing
- Raising capital to purchase equipment
- Generating sufficient income from current operators to pay the additional annual operating costs incurred with vapor control
- Acquiring the necessary vapor control equipment
- Installing and testing vapor control equipment to ensure that the system complies with RACT.

16.5.2 Feasibility Issues

Technical and economic feasibility issues of implementing RACT controls are discussed in this section.

Gasoline service stations in several air quality control regions of the U.S. have successfully implemented Stage I vapor control systems.

State adoption of Stage I RACT regulations will generate additional demand for the vapor control systems for gasoline service stations. However, it is estimated that off-the-shelf systems will be readily available within the next three years, thus making the implementation of Stage I RACT technically feasible.

A number of economic factors are involved in determining whether a specific establishment will be able to implement vapor control systems and still remain profitable. These include:

- Ability to obtain financing
- Ownership—major oil company or private individual
- Ability to pass on a price increase
- The current profitability of the establishment
- Age of the establishment.

A major finding in a study on gasoline service station vapor control was that small service stations could have problems raising the necessary capital to purchase and install vapor control equipment. The inability to raise the necessary capital to install vapor control equipment could cause the closing of some service stations.[1]

Service stations that are owned by major oil companies may have better access to capital than privately owned service stations. A private service station owner may have to borrow capital from local banks, friends or relatives, whereas a station owned by a major oil company may receive funding out of the oil company's capital budget.

It is estimated that small gasoline service stations with throughput less than 10,000 gallons per month will experience a cost increase of nearly 0.25 cents per gallon to implement RACT, using the two-point vapor balance system. Larger service stations will experience a cost increase only one-fifth as much. But regardless of actual size the smaller stations will be at a competitive disadvantage in terms of passing on a price increase.

Recent experience indicates that temporary disruption due to Stage I RACT control can have serious impacts on the service stations' profitability. In an interview, the Greater Washington/Maryland Service Station Association reported that several service stations experienced a loss

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1 <u>Economic Impact of Stage II Vapor Recovery Regulations: Working Memoranda</u>, EPA-450/3-76-042, November 1976.

of business for up to three weeks while Stage I vapor control was being installed. Service station driveways were torn up, greatly restricting access to pumps. In some instances, oil company owned service stations were sold or closed down because the oil companies did not want to expend funds for vapor control at these marginally profitable operations.

The older service stations reportedly will experience greater costs than new service stations when implementing Stage I vapor control requirements. This is because older stations will have more extensive retrofit requirements and will probably experience more temporarily lost business during the retrofit.

The number of gasoline service stations have been declining nationally over the past few years for a number of reasons, reflecting a trend towards reducing overhead costs by building high throughput stations. This trend is likely to continue whether or not vapor control is required. Implementation of Stage I RACT control may simply accelerate this as marginal operators may opt not to invest in the required capital equipment. Sufficient data for South Carolina are not available to quantify the magnitude of this impact.

16.5.3 Comparison of Direct Cost With Selected Direct Economic Indicators

The net increase in the annualized cost to the gasoline service stations industry from RACT represents 0.14 percent of the value of the total gasoline sold in the non-attainment counties. Compared to the countywide value of retail trade, this annual cost increase would be insignificant. The impact on the unit price of gasoline varies with the gasoline service station throughput. As mentioned in the preceding section, the small stations, with less then 10,000 gallons per month throughput, may experience an annualized cost increase of up to 0.25 cents per gallon of gasoline sold, whereas the large service stations may experience an annualized cost increase only one-fifth as large.

16.6 SELECTED SECONDARY ECONOMIC IMPACTS

This section discusses the secondary impact of implementing RACT on employment, market structure, and gasoline station operation.

Employment is expected to decline, if a number of small marginally profitable gasoline service stations cease operating rather than invest capital for compliance with RACT. Based on the countywide estimates of number of employees and the number of facilities, approximately three jobs will be lost with the closing of each gasoline dispensing outlet. No estimate was made of the total number of facilities that may close due to RACT.

The market structure is not expected to change significantly because of Stage I vapor control requirements. The dominant industry trend is towards fewer stations with higher throughputs. This trend will continue with or without RACT.

The impact on a specific service station operation is expected to be slight. Fill rates for loading gasoline storage tanks may marginally decline if coaxial or concentric vapor hose connections are used.

*   *   *   *

Exhibit 16-11, on the following page, presents a summary of the findings of this report.

EXHIBIT 16-11(1)
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS
OF IMPLEMENTING RACT FOR
GASOLINE DISPENSING FACILITIES
IN THE STATE OF SOUTH CAROLINA

Current Situation	Discussion
Number of potentially affected facilities	700 in the four urban nonattainment counties
Indication of relative importance of industrial sector to county economy	4-county industry sales are $0.183 million with a yearly throughput of 0.362 billion gallons. Approximately 90 percent of the througnput (0.324 billion gallons) would be affected at the 700 facilities
Current industry technology trends	Number of stations has been declining and throughput per station has been increasing. By 1980, one-half of stations in U.S. are predicted to become totally self-service
1977 VOC emissions (actual)	1,396 tons per year from tank loading operation. The VOC emissions at the 700 affected facilities is estimated to be 1,250 tons per year.
Industry preferred method of VOC control to meet RACT guidelines	Submerged fill and vapor balance
Assumed method of control to meet RACT guidelines	Submerged fill and vapor balance

Affected Areas in Meeting RACT	Discussion
Capital investment	$1.1 million
Annualized cost	$0.263 million
Price	Assuming a "direct cost passthrough"--less than $0.00 per gallon of gasoline sold in the 4 counties
Energy	Assuming full recovery: 389,000 gallons/year (8,040 barrels of oil equivalent) saved[a]
Productivity	No major impact
Employment	No major impact

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a One gallon of gasoline has 125,000 BTU's. One barrel of oil equivalent has 6,050,000 BTU's.

EXHIBIT 16-11(2)

Affected Areas in Meeting RACT	Discussion
Market structure	Compliance requirements may accelerate the industry trend towards high through-put stations (i.e., marginal operations may opt to shut down)
RACT timing requirements (1981)	Retrofitting service stations within time constraints may be difficult in a few instances
Prolem area	Older stations face higher retrofit costs--potential concerns are dislocations during installations
VOC emission after RACT control	210 tons per year from tank loading operation. 62 tons per year at the affected facilities
Cost effectiveness of RACT control	$222 annualized cost/annual ton of VOC reduction

Source: Booz, Allen & Hamilton Inc.

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17.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR USE OF CUTBACK ASPHALT

17.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR USE OF CUTBACK ASPHALT

This chapter presents a detailed analysis of the impact of implementing RACT for use of cutback asphalt in the State of South Carolina and also for the 5 county non-attainment areas.[1] The impact of RACT is investigated in six sections as follows.

- Specific methodology and quality of estimates
- Industry statistics
- The technical situation in the industry
- Cost and VOC reduction benefit evaluations for the most likely RACT compliance techniques
- Direct economic implications
- Selected secondary economic impacts

Each section presents detailed data and findings based on review of the RACT guidelines, previous studies of the use of cutback asphalt, interviews and analysis.

17.1 SPECIFIC METHODOLOGY AND QUALITY OF ESTIMATES

This section describes the methodology for determining estimates of:

- Industry statistics
- VOC emissions
- Control of VOC emissions
- Cost of controlling VOC emissions
- Economic impact of emission control
- Data quality

for the use of cutback asphalt in South Carolina.

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1 Presently, only 5 counties are classified as non-attainment areas. They are: Berkeley, Charleston, Lexington, Richland and York. For purposes of this analysis, however, the focus is wider and encompasses potential impacts across the entire state.

17.1.1 Industry Statistics

Industry statistics on the use of cutback asphalt were obtained from the South Carolina Department of Health and Environmental Control. The value of shipments was calculated by applying an average unit price of 36 cents per gallon.

17.1.2 VOC Emissions

VOC emissions from the use of cutback asphalt in South Carolina were calculated by multiplying the emission factors for cutback asphalt by the number of tons of asphalt used. The emission factor for slow cure asphalt is 0.078 tons per ton, for medium cure asphalt 0.209 tons per ton, and for rapid cure asphalt 0.20 tons per ton.[1]

17.1.3 Process for Controlling VOC Emissions

The process for controlling VOC emissions from the use of cutback asphalt is described in "Control of Volatile Organic Compounds From the Use of Cutback Asphalt," EPA-450/2-77-037, and "Air Quality and Energy Conservation Benefits From Using Emulsions To Replace Cutbacks in Certain Paving Operations," EPA-450/12-78-004. Interviews were conducted with asphalt trade associations, asphalt producers, and government agencies to gather the most up-to-date information on: costs for cutback asphalt and asphalt emulsions, the feasibility of using emulsions in place of cutback asphalt and the associated cost implications. Other sources of information were "Mineral Industry Surveys," U.S. Bureau of Mines; "Magic Carpet, the Story of Asphalt," The Asphalt Institute; "Technical Support for RACT Cutback Asphalt," State of Illinois; "World Use of Asphalt Emulsion," paper by Cyril C. Landis, Armak Company, "A Brief Introduction to Asphalt and Some of Its Uses," The Asphalt Institute; and "Asphalt: Its Composition, Properties and Uses," Reinhold Publishing Corporation.

17.1.4 Cost of Vapor Control

The costs for control of VOC emissions from the use of cutback asphalt are incurred by using emulsions in place of cutback asphalt. These costs include:

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1 Control of Volatile Organic Compounds From the Use of Cutback Asphalt, EPA-450/2-77-037, pp. 1-3.

- Changes in equipment for applying emulsions in place of cutback asphalt
- Training of personnel to work with asphalt emulsions in place of cutback asphalt.

Additionally, if every state incorporates the RACT guidelines, additional plant capacity to produce asphalt emulsions would have to be created.

Costs were determined from analyses of the studies listed in the previous section and from interviews with asphalt trade associations, government agencies and producers and users of cutback asphalt and emulsions. These differential costs of replacing cutback asphalt with asphalt emulsions were then extrapolated to the state.

17.1.5 Economic Impacts

The economic impacts were determined by examining the effects of conversion to emulsion asphalts on: the costs of paving and road maintenance; the price of cutback and emulsion asphalts; the supply and demand for these asphalts; the employment of workers in end-use applications; and on labor productivity in end-use applications.

17.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, cost and economic impact of implementing RACT for the use of cutback asphalt. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (i.e., data that are published for the base year); "B" indicates data that were extrapolated from hard data; and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analyses of previous studies and best engineering judgment. Exhibit 17-1, on the following page, rates each study output listed and the overall quality of the data.

EXHIBIT 17-1
U.S. Environmental Protection Agency
DATA QUALITY

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics	•		
Emissions		•	
Cost of emissions control		•	
Statewide costs of emissions control			•
Economic impact		•	
Overall quality of data		•	

Source: Booz, Allen & Hamilton Inc.

17.2 INDUSTRY STATISTICS

This section presents information on the cutback asphalt industry, statewide statistics of cutback asphalt use, and comparison of cutback asphalt consumption to the statewide value of wholesale trade. A history of the use of cutback asphalt is also discussed. Data in this section form the basis for assessing the technical and economic impacts of implementing RACT in South Carolina.

17.2.1 Industry Description

The cutback asphalt industry encompasses the production and use of cutback asphalt. Cutback asphalt is one product resulting from the refining and processing as asphalt from crude oil. Cutback asphalt is produced from refined asphalt and petroleum liquids at an asphalt mixing plant. It is then stored in tanks or loaded into tank trucks and sold to the end users, primarily state highway organizations and construction contractors.

17.2.2 Size of the Cutback Asphalt User Industry

This report addresses the size of the cutback asphalt user industry in South Carolina. Although some cutback asphalt may be produced in South Carolina, the production industry is not the focus of this study since RACT requires control of the use of cutback asphalt. Sixteen thousand three hundred fifty-nine tons of cutback asphalt were purchased in South Carolina in 1977 at a value of $1.5 million. The value is based on an estimated average price per gallon of $0.36.

Though the uses of cutback asphalt in South Carolina are well documented, hard data on the number of employees involved in cutback paving operations are not currently available. Still, it is possible to make a reasonable estimate of the number of employees based on data found in the Department of Commerce County Business Patterns.

It is estimated that statewide approximately 750[1] people are engaged in operations where cutbacks can be used. Of these an estimated 160 are employed in the non-attainment county areas.

17.2.3 Comparison to Statewide Economy

The value of shipments of cutback asphalt to the statewide value of wholesale trade in South Carolina is estimated to be less then 0.02[2] percent.

17.2.4 Demand for Cutback Asphalt

In the 1920's and 1930's, the increasing sales of automobiles stimulated highway construction. The need for low-cost pavement binders which provided weather resistance and dust-free surfaces became apparent during this building cycle. Cutback asphalts emerged to fill this need. After World War II, the sale of cutback asphalts remained at an almost constant level. Since 1973, the use of cutback asphalt has decreased. Exhibit 17-2, on the following page, shows national sales from 1970 to 1976 of cutback asphalt, asphalt cement, and asphalt emulsions.

17.2.5 Prices of Products and Costs of Usage

Historically, cutback asphalts have been up to 10 percent more expensive per gallon than asphalt emulsions. In recent years, this differential has been negligible; however, in the past two years the historical price disadvantage has begun to reemerge.

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1 Statewide, approximately 3,750 people were employed in highway and street construction. It is assumed that the number of people employed in cutback and emulsion applications is proportional to the 3,750 people. The factor of proportionality is the ratio of 1977 state sales of cutbacks and emulsions to 1977 state sales of all petroleum asphalts and road oils. At an estimated 20 percent, employment is approximately 750. See County Business Patterns 1976: South Carolina, U.S. Department of Commerce CBP-76-12, 1978, p. 3.

2 Source: U.S. Department of Commerce, Bureau of the Census

EXHIBIT 17-2
U.S. Environmental Protection Agency
HISTORICAL NATIONAL SALES OF ASPHALT CEMENT,
CUTBACK ASPHALT AND ASPHALT EMULSIONS

	ASPHALT CEMENT		CUTBACK ASPHALT		ASPHALT EMULSIONS		TOTAL
YEAR	Use of (000 of tons)	Percent of Total	Use of (000 of tons)	Percent of Total	Use of (000 of tons	Percent of Total	Use of
1970	17,158	72.7	4,096	17.4	2,341	9.9	23,594
1971	17,612	73.8	3,994	16.7	2,275	9.5	23,821
1972	18,046	74.2	3,860	15.9	2,399	9.9	24,305
1973	20,235	74.8	4,220	15.6	2,585	9.6	27,040
1974	19,075	77.4	3,359	13.6	2,208	9.0	24,642
1975	16,324	75.7	3,072	14.2	2,197	10.1	21,593
1976	16,183	75.3	3,038	14.2	2,254	10.5	21,474

Source: U.S. Bureau of Mines

The comparison between cutbacks and emulsions is somewhat different when one looks at quantity requirements. Though technically interchangeable in many applications, it is typically the case that more emulsion must be applied than cutback for an identical task. This is because emulsions have a lower asphalt content than cutbacks on a per gallon basis. Estimates on quantity conversions (substitutability) range from one-to-one to one-to-two in favor of cutbacks depending on the type of emulsion and the given application.[1]

However, in terms of average cost of usage, currently, price and quantity differentials tend to be offsetting. Thus the cost of usage should be approximately the same.[2]

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1 Interview materials from The Asphalt Institute, College Park, Maryland

2 Ibid. Contentions that the price per mile of emulsions is cheaper than oil-based asphalts are currently being made. Though true, the contention is misleading because the comparison is between hot mix asphalts and emulsions in overlay applications. Cutbacks are not used in overlay applications.

17.3 <u>THE TECHNICAL SITUATION IN THE INDUSTRY</u>

This section presents information on the use and production of asphalt. The sources and characteristics of VOC emissions from the use of cutback asphalt are then described and are followed by: estimated statewide VOC emissions from the use of cutback asphalt; the VOC control measures required by RACT, and the VOC emission control procedure for use of cutback asphalt in South Carolina.

17.3.1 <u>Asphalt: Its Production and Uses</u>

Asphalt is a product of the distillation of crude oil. It is found naturally and is also produced by petroleum refining. In the latter instance, the crude oil is distilled at atmospheric pressure to remove lower boiling materials. Nondistillable asphalt is then recovered from selected topped crude by vacuum distillation; oil and wax are removed as distillates; and the asphalt is left as a residue. Asphalts can be produced in a variety of types and grades ranging from hard brittle solids to almost water-thin liquids. The type of asphalt produced depends on its ultimate use.

Asphalt is used as a paving material and in a wide range of construction applications. The cutback and emulsion asphalts that are the object of RACT legislation are paving materials used primarily in spraying and cold mix patching operations. For further information on asphalt production and use the reader is referred to: <u>A Brief Introduction to Asphalt and Some of Its Uses</u>, The Asphalt Institute, 1977.

17.3.2 <u>Sources and Characteristics of VOC Emissions From the Use of Cutback Asphalt</u>

Hydrocarbons evaporate from cutback asphalts at the job site and at the mixing plant. At the job site, hydrocarbons are emitted from equipment used for applying the asphaltic product and from road surfaces themselves. At the mixing plant, hydrocarbons are released during mixing and stockpiling. The largest source of emissions, however, is the road surface itself. In South Carolina, cutback asphalt is used in the construction and maintenance of secondary roads throughout the state.

It is the petroleum distillate (diluent) in the cutback asphalt that evaporates. The percentage of diluent that evaporates depends on the cure type.

The evaporating diluent in the three types of cutback asphalt constitutes the following percent of the asphalt mix by weight:

- Slow cure—25 percent
- Medium cure—70 percent
- Rapid cure—80 percent.

17.3.3 Statewide and Non-Attainment Area Emissions

Total emissions from the use of cutback asphalt in South Carolina during 1977 are estimated to be 3,396 tons. But given permitted RACT exemptions on cutback curtailment, only 611 tons are estimated to be subject to control.[1] . 1. See Exhibit 17-3 for details.

17.3.4 RACT Guidelines and the Implications of Their Implementation

Presently, the State of South Carolina is preparing draft legislation on the use of cutback asphalt which will be modeled after the RACT guidelines.

The RACT guidelines specify that the manufacture, storage and use of cutback asphalts may not be permitted unless: long-life storage is necessary; application at ambient temperatures below 50°F is necessary; or application as a penetrating prime coat is necessary.

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1 Representatives of the South Carolina Highway Department have indicated that RACT exemptions could account for 82% of current cutback usage. Because South Carolina began using emulsions years ago, those cutbacks remaining in use now are primarily for penetrating prime coat applications (75%) and maintenance patching applications (25%).

2 Based on amount of cutback asphalt applied in the non-attainment counties in 1977 (source: South Carolina Department of Health and Environmental Control).

"Insert A"

Of this amount approximately 665 tons of emission are from the five non-attainment counties. The distribution of emissions among these counties are as follows:

.	Berkeley	-	79 Tons
.	Charleston	-	165 Tons
.	Lexington	-	73 Tons
.	Richland	-	131 Tons
.	York	-	217 Tons
.	Total	-	665 Tons

EXHIBIT 17-3
U.S. Environmental Protection Agency
ESTIMATED HYDROCARBON EMISSIONS
FROM USE OF CUTBACK ASPHALT IN SOUTH CAROLINA

	Sales[a] of Cutback Asphalt (000 Tons)			Estimated Hydrocarbon Emissions in 1977 (000 Tons)				Estimated Non-Exempted Hydrocarbon Emissions in 1977 (000 Tons)
	Rapid Cure	Medium Cure	Slow Cure	Rapid Cure	Medium Cure	Slow Cure	Total	
State	3.76	12.60	0	0.77	2.63	0	3.40	.61[b]

[a] Source: U.S. Department of Energy, Bureau of Mines

[b] 18 percent of emissions are from non-exempted cutbacks. See footnote (a) to section 17.3.3.

Given these exemptions, general experience with asphalt emulsions in several regions of the U.S. indicates that emulsions are adequate substitutes for cutbacks.[1] Moreover, the same equipment that is used to apply cutback asphalt can be used with asphalt emulsions after minor modification. The few changes necessary to replace cutback asphalt with emulsion asphalt are as follows:

- Retrain employees on the use of asphalt emulsions
- Modify cutback asphalt equipment to accommodate asphalt emulsions, including:
  - Providing new nozzles on the distributor truck which applies the asphalt
  - Adjusting the pumps which apply the emulsion
  - Cleaning equipment prior to using emulsion
- Create emulsion plant capacity to meet the increased demand
- Provide asphalt manufacturing facilities with venting for steam.

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1 It is reported that emulsions cannot be applied in the rain. This is also true for rapid and medium cure cutbacks.

17.4 COST AND HYDROCARBON REDUCTION BENEFIT EVALUATIONS FOR RACT REQUIREMENTS

Costs for using asphalt emulsions in place of cutback asphalts are presented in this section. Each cost item is discussed, quantified, and then the total cost is calculated for the state.

17.4.1 Costs Associated With Using Asphalt Emulsions in Place of Cutback Asphalt

The information on the costs of using asphalt emulsions in place of cutback asphalt was gained from interviews with asphalt trade association members, asphalt manufacturers, and from analysis of existing studies on asphalt.

Costs to users of cutback asphalt who must convert to emulsions are primarily those expenditures associated with retraining personnel and making minor equipment modifications. The existing price/gallon advantage accruing to emulsions is approximately offset by the quantity advantage accruing to cutbacks (in terms of required asphalt content and comparative durability). Put differently, expenditures on materials should remain approximately constant, but those on capital and labor should increase as users convert to asphalt emulsions.

The most significant cost to the user will be for retraining personnel in the methods of asphalt emulsion application. It is estimated that these training costs are $300 per person including the cost of supervision for the training session.

Modification of trucks used in applying asphalt consists of replacing nozzles at a cost of $5 per nozzle. An average truck is equipped with 30 nozzles; therefore, the cost per truck would be $150. Other equipment costs include adjusting pumps and cleaning equipment before asphalt emulsions can be applied, and these are considered to be minimal.

Total user costs are assumed to be incurred on a one-time basis. Minor equipment costs are generally not capitalized but are expensed in the accounting period in which they are incurred. The paragraph which follows shows total costs to the non-attainment counties for converting from the use of cutback asphalt to asphalt emulsion.

17.4.2 Extrapolation to the Statewide Industry

Converting from cutback asphalts to asphalt emulsions in the state is estimated to cost approximately $100,000 statewide and $21,000 for the five nonattainment counties. This translates into $164 per tons of hydrocarbon emissions reduced statewide and $173 per ton for the affected counties. A summary of these costs is given in Exhbiit 17-4, on the following page.

EXHIBIT 17-4
U.S. Environmental Protection Agency
COSTS IN SOUTH CAROLINA FOR APPLYING
RACT TO THE USE OF CUTBACK ASPHALT

Direct Cost Summary	Statewide	Five Nonattainment Counties
Cutback asphalt used in the state (tons per year)	16,359	3,45[illegible]
Potential emissions reduction[a] from converting to use of emulsion asphalt (tons per year)	611	120
Retraining costs[b]	$ 44,100	$ 9,300
Equipment modification costs[c]	$ 56,250	$ 11,900
Total one-time costs	$100,360	$ 21,200
One-time costs per ton of emissions reduced	$ 164	$ 176
Annualized operating cost per ton of emission reduced	$ 0.00	$ 0.00

a Assumes 82% of cutback usage will be exempted from RACT control

b Retraining costs are calculated in two stages. First, it is assumed that the percent of the labor force unfamiliar with emulsion application will be roughly equal to a proxy ratio which relates sales of cutbacks to sales of cutback plus emulsions in 1977. Since the sales of cutbacks were 16,359 short tons and those of emulsions 67,025, the proxy ratio is about one-fifth. Second, this proxy is multiplied by the estimated total labor force (750) and the cost per person ($300).

c Representatives of national asphalt organizations have suggested that for every two workers there is approximately one distributor truck. This implies that 375 trucks will need modification at a cost of $150 per truck.

Source: Booz, Allen & Hamilton Inc.

17.5 ECONOMIC IMPACTS

This section discusses the economic impacts associated with applying RACT to the use of cutback asphalt in South Carolina. The focus is on: user cost, material prices, demand, employment and productivity.

- User Cost—The estimated one-time cost of $100,000 distributed across the state is small compared to the $163,850,000 spent for construction and maintenance during 1977.[1]
- Price—The prices of cutback and emulsion asphalts may be marginally affected by RACT to the extent that demand and supply shifts for both products are not offsetting. However, it is not RACT but rather the increasing cost of diluents used in cutbacks which will have the most decisive impact on price differentials in the future.
- Demand—If current usage patterns prevail through 1981 when RACT is scheduled for implementation, then the demand for cutbacks might fall off by 18 percent while the demand for emulsions rises by 4.5 percent.
- Employment--No change in employment is predicted from implementing RACT, although it will be necessary to retrain approximately 150 employees in the nonattainment areas of South Carolina on the use of asphalt emulsions and 750 employees if the regulation is applied statewide.
- Productivity--Given appropriate retraining, worker productivity is not expected to be affected by handling more emulsion asphalts.

17.5.1 Secondary Economic Impacts

Implementing RACT nationwide may cause a strain on current industry capacity to meet the increased demand for emulsion asphalts. To the extent that a supply-demand imbalance is inherent, it may be necessary for producers to invest in new plant capacity. Presently, it is anticipated that

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1 Source: Federal Highway Administration. Of the $163,850,000, $110,851,000 was spent on construction. This latter figure includes a small charge for depreciation on equipment.

sufficient lead time exists for any supply-demand imbalance to be redressed. Insufficient data are available to quantify these potential costs in South Carolina.

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Exhibit 17-5 presents a summary of the findings in this report.

EXHIBIT 17-5(1)
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS
OF IMPLEMENTING RACT FOR USE OF
CUTBACK ASPHALT IN THE STATE OF SOUTH CAROLINA
(NONATTAINMENT COUNTIES)

Current Situation	Discussion
Potentially affected use	In 1977, use of cutback asphalt was approximately 3,200 tons in the non-attainment counties
Indication of relative importance of industrial sector to statewide economy	1977 sales of cutback asphalt were estimated to be $0.3 million in the nonattainment counties
Current industry technology trends	Most of the use of cutback asphalt is for penetrating prime coat applications, which are exempt
1977 VOC emissions (actual)	665 tons annually; 120 of which are non-exempted
Industry preferred method of VOC control to meet RACT guidelines	Replace with asphalt emulsions
Assumed method of control to meet RACT guidelines	Replace with asphalt emulsions

Affected Areas in Meeting RACT	Discussion
Capital investment	$0.02 million
Annualized cost	No change in paving costs are expected
Price	No change in paving costs are expected
Energy	0[a]
Productivity	No major impact
Employment	No major impact

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[a] A saving of 1,160 barrels of oil equivalent accrues to manufacturer, no user. The total energy associated with manufacturing, processing and laying one gallon of cutback is approximately 50,200 BTUs/gallon. For emulsified asphalts, it is 2,830 BTUs/gallon. One barrel of oil equivalent is assumed to have 6.05 million BTUs, and one ton of cutback asphalt is assumed to have 256 gallons.

Affected Areas in Meeting RACT	Discussion
RACT timing requirements (1981)	Long-range supply of asphalt emulsions are expected to be available
Problem area	Winter paving
VOC emission after RACT control	Net VOC emission reduction is estimated to be 120 tons annually
Cost effectiveness of RACT control	$176 annualized cost/annual ton of VOC reduction in the first year. In subsequent years, the cost is $0.

Source: Booz, Allen & Hamilton Inc.

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Mr. Terry Drane, Emulsified Asphalt, Inc.

TECHNICAL REPORT DATA
(Please read instructions on the reverse before completing)

1. REPORT NO. EPA 904/9-79-032	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Economic Impact of Implementing RACT guidelines in five nonattainment counties for ozone in the State of South Carolina		5. REPORT DATE
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16. ABSTRACT

The major objective of the contract effort was to determine the direct economic impact of implementing RACT standards in five non-attainment counties for ozone in South Carolina. The study is to be used primarily to assist EPA and South Carolina decisions on achieving the emission limitations of the RACT standards.

The economic impact was assessed for the following 8 RACT industrial categories: surface coatings (paper and fabrics); solvent metal cleaning; bulk gasoline terminals; bulk gasoline plants; storage of petroleum liquids in fixed roof tanks; gasoline dispensing stations--Stage I; and use of cutback asphalt.

The scope of this project was to determine the costs and direct impact of control to achieve RACT guideline limitations for these 8 industry categories in South Carolina. Direct economic costs and benefits from the implementation of RACT limitations were identified and quantified while secondary impacts (social, energy, employment, etc.) are addressed, they were not a major emphasis in the study.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Gasoline marketing Air pollution Metal coatings Solvent substitution Emission limits	Air pollution control Stationary sources South Carolina Economic impact Hydrocarbon emissions Coatings	

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