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EPA

Economic Impact Analysis for the Polymers and Resins IV NESHAP

DRAFT

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ACRONYMS AND ABBREVIATIONS

ABS	acrylonitrile-butadiene styrene
ASM	*Annual Survey of Manufactures*
BCA	Benefit Cost Analysis
CAA	Clean Air Act
CTG	Control Technique Guideline
DuPont	E.I. du Pont de Nemours
EIA	economic impact analysis
EPA	U.S. Environmental Protection Agency
HAPs	hazardous air pollutants
HON	Hazardous Organic NESHAP
ITC	International Trade Commission
MABS	methyl methacrylate acrylonitrile butadiene styrene
MACT	maximum achievable control technology
MBS	methyl methacrylate butadiene styrene
MRR	monitoring, recordkeeping, and reporting
NESHAP	National Emission Standard for Hazardous Air Pollutants
OMB	Office of Management and Budget
PET	polyethylene terephthalate
PVC	polyvinyl chloride
RFA	Regulatory Flexibility Act
SIC	Standard Industrial Classification
SAN	styrene acrylonitrile
SBA	U.S. Small Business Administration
2SLS	two-stage least squares

EXECUTIVE SUMMARY

ES.1 ECONOMIC IMPACT ANALYSIS OBJECTIVES

The purpose of this economic impact analysis (EIA) is to evaluate the effect of the control costs associated with the Polymers and Resins Group IV National Emission Standard for Hazardous Air Pollutants (NESHAP) on the behavior of the regulated resin facilities. The EIA was conducted based on the cost estimates for one regulatory option chosen by the U.S. Environmental Protection Agency (EPA) for the regulation of affected facilities. This analysis compares the quantitative economic impacts of regulation to baseline industry conditions that would occur in the absence of regulation. The economic impacts of regulation are estimated for the industry based on facility-level costs.

Section 112 of the Clean Air Act (CAA) contains a list of hazardous air pollutants (HAPs) for which EPA has published a list of source categories that must be regulated. To meet this requirement, EPA is evaluating NESHAP alternatives for the regulation of industries classified within the Polymers and Resins Group IV source category. The NESHAP alternatives are based on different control options for the emission points within resin facilities that emit HAPs. This economic analysis analyzes the potential impacts of regulation on the following seven affected thermoplastic resin industries: styrene acrylonitrile (SAN), methyl methacrylate butadiene styrene (MBS), polyethylene terephthalate (PET), acrylonitrile-butadiene styrene (ABS), methyl methacrylate acrylonitrile butadiene styrene (MABS), polystyrene, and nitrile resins. These seven industries are classified in the Polymers and Resins Group IV source category and will be collectively referred to as Group IV industries throughout this report. This report presents the results of the economic analysis prepared to satisfy the requirements of Section 317 of the CAA which mandates that EPA evaluate regulatory alternatives through an EIA.

The objective of this EIA is to quantify the impacts of NESHAP control costs on the output, price, employment, and trade levels in each of the Group IV resin industries. The probability of resin facility closure is also estimated, in addition to potential effects on the financial conditions of affected firms. To comply with the requirements of the Regulatory Flexibility Act (RFA), attention is focused on the effects of control costs on the smaller affected firms relative to larger affected firms.

ES.2 INDUSTRY CHARACTERIZATION

The firms affected by the Polymers and Resins Group IV NESHAP produce MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins, and are classified in Standard Industrial Classification (SIC) code 2821. The proposed regulation will affect 75 facilities, which are owned and operated by 28 firms. MBS copolymers are characterized by high impact strength and transparency, and are typically higher in price than other common monomers. MBS resins are used primarily as an impact modifier for rigid polyvinyl chloride (PVC), which in turn is used in the production of packaging, building, and construction products. The MBS industry capacity is shared nearly equally by three producers, and no producer is clearly dominant in this market.

SAN copolymers are transparent, amorphous materials with high heat and chemical resistance. SAN's primary use is as a feedstock to ABS production, which is in turn used to provide weather resistance for applications including boats, swimming pools, and recreational vehicles. SAN resins are most often produced for captive use by ABS producers, although small amounts of SAN resins are also sold on the merchant market. There are three firms producing SAN at a total of five facilities. No firm is clearly dominant in this market.

PET is a high melting point polymer that is clear, and has good gas and moisture barrier properties. PET is produced in the following four basic forms: melt-phase resins, bottle-grade resins, PET film, and PET (polyester) fibers. Melt-phase PET resins are used to produce PET film, polyester fibers, and indirectly as an input to production of the solid state resins used to manufacture PET bottles. PET production as a whole involves the highest number of producers of any of the six resin industries in this analysis. The bottle-grade PET resin industry is more highly concentrated than the other three PET categories, having only four producers. PET melt-phase resins and PET film are each produced by 9 firms, and PET fibers are produced by 14 firms, with fiber production dominated by 2 major producers.

ABS is formed by blending SAN with SAN grafted-rubber which increases impact resistance and, combined with acrylonitrile, produces heat-resistant and solvent-resistant plastics which have extensive uses. In the automotive industry, ABS has replaced the majority of steel or aluminum parts for use in interior panels, grilles, wheelcovers, and mirror housings. Consumer goods manufactured with ABS include household appliances, housewares, luggage, toys, furniture, and sporting goods. In sheet form, ABS is used as a component of refrigerator door linings and food storage compartments. The ABS industry is highly concentrated, with 99 percent of total domestic ABS production capacity owned by three firms.

MABS is formed from ABS blended with methyl methacrylate which makes a clear ABS resin capable of uses similar to those listed for ABS. MABS polymers are utilized by the plastics industry in applications which require a tough, transparent, and highly impact-resistant material. The primary use of MABS resins is in the production of both food and non-food containers. There is only one domestic producer of MABS polymers.

Polystyrene resins are characterized by brittleness, optical clarity, and poor barrier properties to oxygen and water. Uses of the polystyrene polymer include the manufacture of durable goods, such as television cabinets, appliances, furniture, and building insulation board. Its most common use is for the manufacture of foam used in food trays, meat trays and egg cartons, as well as in packaging for electronics and other delicate items. The polystyrene industry is the least concentrated industry in the Group IV source category. There are 15 polystyrene producers, with 40 percent of total domestic production capacity concentrated in the hands of two producers and the remaining 60 percent of capacity shared by the 13 remaining producers.

Nitrile resins are characterized by good abrasion and water-resistant qualities, which makes them suitable for use in a wide variety of applications. The primary use of nitrile elastomers is in the manufacture of nitrile rubber, which, in turn, are used to produce components for automobiles. There is only one domestic nitrile resin producer.

ES.3 CONTROL COSTS AND COST-EFFECTIVENESS

The Polymers and Resins Group IV NESHAP would require sources to achieve emission limits reflecting the application of the maximum achievable control technology (MACT) to four affected emission points. This EIA analyzes one regulatory alternative that was chosen by EPA and is based on the available control options for four emission points within Group IV resin facilities. For existing sources, the MACT floor was based on the CAA stipulation that the minimum standard must represent the average emission limitation achieved by the best performing 12 percent of existing sources. For new sources, costs were estimated based on *projected* control of new process units and equipment built (or reconstructed or replaced) in the first five years after promulgation, and on the CAA requirement that the MACT floor be set at the level of emission control that is achieved in practice by the best controlled similar source.

Control costs were developed for the following major emission points within Group IV resin facilities: equipment leaks, miscellaneous process vents, wastewater collection and treatment systems, and storage tanks. Cost estimates were annualized for the fifth year after promulgation of the Polymers and Resins Group IV NESHAP and are expressed in 1989 dollars throughout this report. Economic impacts were estimated based on the facility-level costs for the proposed alternative, which represent the cost of the MACT floor option for all four emission points. Table ES-1 presents the national annualized cost estimates for controlling existing sources and newly constructed emission points. These costs were prepared by the engineering contractor for use in the EIA. Costs are provided by emission point for the MACT floor level of control in each Group IV industry. The total national annualized cost for implementation of the regulatory alternative is approximately $12.2 million [including monitoring, recordkeeping, and reporting (MRR) costs] for existing sources and a savings of nearly $3.9 million for sources forecasted to be built in the first five years after promulgation of the regulation.

Table ES-1 also shows the HAP emission reductions associated with control at the four emission points and the calculated cost-effectiveness of each control method. The HAP emission reductions were calculated based on the application of sufficient controls to each emission point to bring the point into compliance with the regulatory alternative. The cost-effectiveness of the predicted HAP emission reduction ranges from a savings of

TABLE ES-1. SUMMARY OF GROUP IV NESHAP COSTS IN THE FIFTH YEAR BY RESIN INDUSTRY AND EMISSION POINT[1]

Group IV Industry and Emission Point	Annual Fifth Year Costs (1989 Dollars per Year)			Annual HAP Emission Reduction (Mg/yr)	Cost-Effectiveness ($/Mg)
	Existing Sources	New Construction	Total		
A. MBS[2]					
Equipment Leaks	$47,285	$47,048	$94,333	211.5	$446.0
Miscellaneous Process Vents	$180,602	$236,280	$416,882	24.3	$17,155.6
Wastewater Systems	$143,239	$143,239	$286,478	10.0	$28,647.8
Storage Tanks	$0	$0	$0	0.0	$0.0
Total MBS	$371,126	$426,567	$797,693	245.8	$3,245.3
B. SAN[2]					
Equipment Leaks	$137,108	$220	$137,328	143.3	$958.3
Miscellaneous Process Vents	$0	$0	$0	0.0	$0.0
Wastewater Systems	$281,018	$113,171	$394,189	49.0	$8,044.7
Storage Tanks	$0	$0	$0	0.0	$0.0
Total SAN	$418,126	$113,391	$531,517	192.3	$2,764.0
C. PET[3]					
Equipment Leaks	$2,935,942	$2,318,967	$5,254,909	4,071.61	$1290.6
Miscellaneous Process Vents	$313,381	$758,276	$1,071,657	684.44	$1565.7
Wastewater Systems	$5,749,586	($9,653,905)	($3,904,319)	12,621.23	($309.3)
Storage Tanks	$64,678	$157,724	$222,402	113.33	$1,962.42
Total PET	$9,063,587	($6,418,938)	$2,644,649	17490.61	$151.2
D. ABS[2]					
Equipment Leaks	$168,089	$69,607	$237,695	404.0	$588.4
Miscellaneous Process Vents	$1,712,377	$1,779,934	$3,492,311	330.3	$10,573.5
Wastewater Systems	$0	$0	$0	0.0	$0.0
Storage Tanks	$0	$59,059	$59,059	4.2	$13,995.1
Total ABS	$1,880,465	$1,908,600	$3,789,065	738.5	$5,130.7

TABLE ES-1 (continued)

Group IV Industry and Emission Point	Annual Fifth Year Costs (1989 Dollars per Year)			Annual HAP Emission Reduction (Mg/yr)	Cost-Effectiveness ($/Mg)
	Existing Sources	New Construction	Total		
E. MABS[2]					
Equipment Leaks	$4,797	$0	$4,797	2.5	$1,918.8
Miscellaneous Process Vents	($79)	$0	($79)	38.0	($2.1)
Wastewater Systems	$0	$0	$0	0.0	$0.0
Storage Tanks	$0	$0	$0	0.0	$0.0
Total MABS	$4,718	$0	$4,718	40.5	$116.6
F. Polystyrene[2]					
Equipment Leaks	$579,031	$91,188	$670,218	1,303.4	$514.2
Miscellaneous Process Vents	($74,900)	($1,494)	($76,394)	198.8	($384.3)
Wastewater Systems	$0	$0	$0	0.0	$0.0
Storage Tanks	$0	$0	$0	0.0	$0.0
Total Polystyrene	$504,131	$89,694	$593,825	1,502.2	$395.3
G. Nitrile[2]					
Equipment Leaks	$6,164	$0	$6,164	6.8	$906 5
Miscellaneous Process Vents	$767	$0	$767	3.4	$223.7
Wastewater Systems	$0	$0	$0	0.0	$0.0
Storage Tanks	$0	$0	$0	0.0	$0.0
Total Nitrile	$6,931	$0	$6,931	10.2	$677.5
TOTAL FOR REGULATORY ALTERNATIVE	$12,249,084	($3,880,686)	$8,368,398	20,220.11	$413.9

NOTE: [1]Costs reflect absolute regulatory costs rather than incremental costs.
[2]Assumes regulatory Alternative 1 is chosen.
[3]Assumes regulatory Alternative 2 is chosen.

$384 to a cost of $28,648 per megagram, or an average of $413.9 per megagram for the proposed NESHAP. Table ES-2 presents the total investment capital costs by emission point associated with the regulatory alternative for each of the seven industries. Total capital investment costs are estimated to be approximately $111 million for new and existing sources for the seven affected industries five years subsequent to promulgation of the regulation.

ES.4 ECONOMIC METHODOLOGY OVERVIEW

In this study, data inputs are used to construct a separate, pre-control baseline equilibrium market model of each of the seven affected industries. The baseline models of the markets for these seven resins provide the basic framework necessary for analyzing the impact of proposed control costs on these industries. The *Industry Profile for the Polymers and Resins IV NESHAP* contained industry data that are used as inputs to the baseline models and to the estimation of price elasticities of demand and supply. The industry profile includes a characterization of the market structure of each affected industry, provides necessary supply and demand data, and identifies market trends. Engineering control cost studies provide the final major data input required to quantify the potential impact of control measures on the affected markets. These economic and engineering cost data inputs were evaluated within the context of the market models to estimate the impacts of regulatory control measures on each of the Group IV resin industries, and on society as a whole. The potential impacts include the following:

- Changes in market price and output;
- Financial impacts on affected firms;
- Predicted closure of affected resin facilities;
- Welfare analysis;
- Small business impacts;
- Labor market impacts;
- Energy use impacts;
- Foreign trade impacts; and
- Regional impacts.

The progression of steps in the EIA process is summarized in Figure ES-1.

TABLE ES-2. SUMMARY OF GROUP IV NESHAP CAPITAL COSTS BY RESIN INDUSTRY AND EMISSION POINT[1]

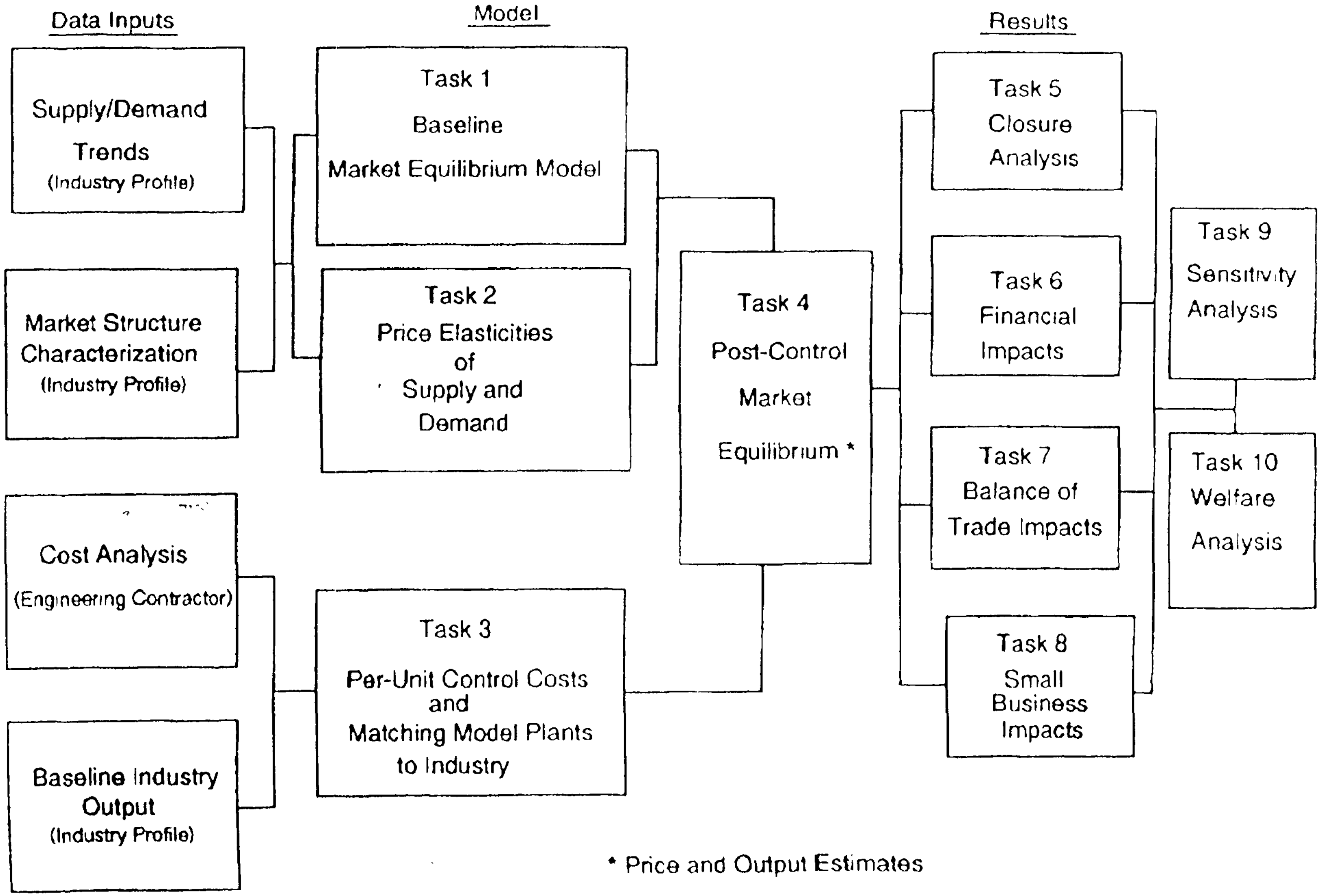
Group IV Industry and Emission Point	Total Capital Costs (1989 Dollars) Existing Sources	New Construction	Total
A. MBS			
Equipment Leaks	$174,426	$157,174	$331,600
Miscellaneous Process Vents	$93,204	$106,394	$199,598
Wastewater Systems	$279,051	$279.051	$558,102
Storage Tanks	$0	$0	$0
Total MBS	$546,681	$542.619	$1,089,300
B. SAN			
Equipment Leaks	$504,790	$0	$504,790
Miscellaneous Process Vents	$0	$0	$0
Wastewater Systems	$579,252	$259,217	$838,469
Storage Tanks	$0	$0	$0
Total SAN	$1,084,042	$259,217	$1,343,259
C. PET			
Equipment Leaks	$6,076,491	$4,876,206	$10,952,697
Miscellaneous Process Vents	$273,155	$442,362	$715,517
Wastewater Systems	$86,827,321	$0	$86,827,321
Storage Tanks	$266,078	$508,750	$774,828
Total PET	$93,443,045	$5,827,318	$99,270,363
D. ABS			
Equipment Leaks	$201,546	$98,161	$299,707
Miscellaneous Process Vents	$4,004,211	$3,419,086	$7,423,297
Wastewater Systems	$0	$0	$0
Storage Tanks	$0	$172,276	$172,276
Total ABS	$4,205,757	$3,689,523	$7,895,280
E. MABS			
Equipment Leaks	$0	$0	$0
Miscellaneous Process Vents	$89,673	$0	$89,673
Wastewater Systems	$0	$0	$0
Storage Tanks	$0	$0	$0
Total MABS	$89,673	$0	$89,673

TABLE ES-2 (continued)

Group IV Industry and Emission Point	Total Capital Costs (1989 Dollars) Existing Sources	New Construction	Total
F. Polystyrene			
Equipment Leaks	$933,194	$199,010	$1,132,204
Miscellaneous Process Vents	$243,527	$2,045	$245,572
Wastewater Systems	$0	$0	$0
Storage Tanks	$0	$0	$0
Total Polystyrene	$1,176,721	$201,055	$1,377,776
G. Nitrile			
Equipment Leaks	$0	$0	$0
Miscellaneous Process Vents	$8,770	$0	$8,770
Wastewater Systems	$0	$0	$0
Storage Tanks	$0	$0	$0
Total Nitrile	$8,770	$0	$8,770
TOTAL FOR REGULATORY ALTERNATIVE	$100,554,689	$10,519,732	$111,074,421

NOTE: [1]Costs reflect absolute regulatory costs rather than incremental costs.

Figure ES-1
Model Development for Economic Impact Analysis



* Price and Output Estimates

ES.5 PRIMARY REGULATORY IMPACTS

Primary regulatory impacts include estimated increases in the market equilibrium price of each of the Group IV resins, decreases in the market equilibrium domestic output or production of each resin, changes in the value of domestic shipments, and facility closures. The analysis was conducted separately for each of the seven affected industries with one exception. Insufficient data were available to analyze the MABS industry separately. For this reason the MABS impacts have been incorporated into the ABS analysis. MABS production and control costs represent a very small portion of the ABS and MABS totals. The primary regulatory impacts for each affected industry (MABS and ABS combined) are summarized in Table ES-3.

As shown in Table ES-3, the estimated price increases for Group IV resins range from increases of $0.0003 to $0.01, based upon 1989 price levels. These predicted price increases represent percentage increases ranging from a low of 0.07 percent for nitrile to a high of 2.8 percent for SAN. Domestic production will decrease for each of the resin products by 1.4 million kilograms of MBS, 3.8 million kilograms of SAN, 72.2 million kilograms of PET, 23.7 million kilograms of ABS/MABS , 10.2 million kilograms of polystyrene, and 0.028 million kilograms of nitrile annually. This estimated percentage decrease in annual production for each of the resins varies from a low of 0.17 percent to a high of 4.6 percent.

The predicted change in the dollar value of domestic shipments, or revenue to producers, is expected to decrease for the seven affected Group IV resin industries. Annual revenues for MBS will decline by $0.86 million, for SAN by $0.62 million, for PET by $33.80 million, for ABS/MABS by $6.17 million, for polystyrene by $0.72 million, and for nitrile by $.007 million annually. These revenue decrease estimates are also based upon 1989 price levels.

TABLE ES-3. SUMMARY OF PRIMARY ECONOMIC IMPACTS OF POLYMERS AND RESINS GROUP IV NESHAP

	Estimated Impacts[4]			
Group IV Industry	Price Increases[1]	Production Decreases[2]	Value of Domestic Shipments[3]	Facility Closures
MBS				
Amount	$0.009	(1.4)	($0.86)	None
Percentage	1.0%	(2.8%)	(1.9%)	
SAN				
Amount	$0.010	(3.8)	($0.62)	None
Percentage	2.8%	(4.6%)	(1.9%)	
PET				
Amount	$0.006	(72.2)	($33.80)	Five
Percentage	0.9%	(2.4%)	(1.6%)	
ABS/MABS				
Amount	$0.008	(23.7)	($6.17)	None
Percentage	1.8%	(4.1%)	(2.4%)	
Polystyrene				
Amount	$0.0008	(10.2)	($0.72)	None
Percentage	0.34%	(0.47%)	(0.13%)	
Nitrile				
Amount	$0.0003	(0.028)	($0.007)	None
Percentage	0.07%	(0.17%)	(0.10%)	

NOTES: [1]Prices are shown in price per kilogram (1989 dollars).
[2]Annual production quantities are shown in millions of kilograms.
[3]Values of domestic shipments are shown in millions of 1989 dollars
[4]Brackets indicate decreases or negative values.

No predicted facility closures are anticipated for the MBS, SAN, ABS/MABS, polystyrene, or nitrile resin industries. However, five potential closures are anticipated for the PET industry. These closures will not likely result in firm closures but may result in facility closures. To the extent that the affected facilities have the capability to produce alternative products, the facilities may shift production to products other than PET in response to the incurrence of regulatory costs rather than shut down. Closure decisions would be based upon many decisions including the ability and associated cost of switching to production of an alternative product. These facility closures are likely to be overstated for the following reasons:

- The model assumes that all PET facilities compete in a national market. In reality, some facilities may be protected by regional or local trade barriers.

- It is assumed that the facilities with the highest control cost per unit of production also have the highest baseline production costs. This is a worst-case assumption and may not be true in every case.

- Actual individual 1991 PET production data were unavailable for several affected PET facilities. In lieu of this information, capacity data per facility for 1991 was used to estimate the actual facility production based the ratio of total PET industry production to total PET industry capacity. Each facility was assumed to produce at the same percentage of total capacity as the utilization rate that occurred at the industry level. These production estimates may therefore differ from actual 1991 production levels at each facility.

  Additionally, PET melt-phase resin production was excluded from annual production amounts based on the premise that PET melt-phase resin is an intermediate product which is used in the production of other PET products. If PET melt-phase resin is a marketable commodity that is traded in the marketplace, this assumption will be correct for industry totals but may not lead to accurate production estimates for individual facilities. The exclusion of PET melt-phase resin production from individual facility production totals may understate production estimates for individual facilities and overstate the per unit control costs on a facility-specific basis.

ES.6 SECONDARY REGULATORY IMPACTS

Secondary impacts of the Polymers and Resins Group IV NESHAP include potential effects of the regulation on the labor market, energy use, foreign trade, and regional markets. The effects on the labor market, energy use, and balance of trade are summarized in Table ES-4.

Labor market losses resulting from the NESHAP are estimated to be approximately 85 jobs for all of the Group IV resin industries in total. This estimate reflects the reductions in jobs predicted to result from the anticipated decreases in annual production of these Group IV resins. No effort has been made to estimate the number of jobs that may be created as a result of the regulations, however, and as a result, this estimate of job losses is likely to be overstated.

Annual reductions in energy use as a result of the regulations are expected to amount to a savings of $2.1 million (1989 dollars) annually. Net annual exports are predicted to decrease by $16 million. This represents a percentage decrease ranging from a low of 0.84 percent for the nitrile industry to a high of 22.7 percent for the MBS industry.

Regional effects are expected to be minimal since there is no specific region of the country in which facilities will be experiencing a disproportionate burden of the regulatory costs.

ES.7 ECONOMIC COST

Air quality regulations affect society's economic well-being by causing a reallocation of productive resources in the economy. Resources are allocated away from the production of goods and services (Group IV resins) to the production of cleaner air. Economic costs represent the total cost to society associated with this reallocation of resources.

The economic costs of regulation incorporate costs borne by all of society for pollution abatement. The social, or economic, costs reflect the opportunity cost of resources used

TABLE ES-4. SUMMARY OF SECONDARY ECONOMIC IMPACTS OF POLYMERS AND RESINS GROUP IV NESHAP

	Estimated Impacts[1]		
Group IV Industry	Labor Input[2]	Energy Input[3]	Foreign Trade[4]
MBS			
Amount	(2)	($0.04)	(0.22)
Percentage	(2.8%)	(2.85%)	(22.7%)
SAN			
Amount	(2)	($0.05)	(0.98)
Percentage	(4.6%)	(2.5%)	(5.7%)
PET			
Amount	(65)	($1.61)	(6.3)
Percentage	(2.4%)	(1.1%)	(4.4%)
ABS/MABS			
Amount	(13)	($0.32)	(7.0)
Percentage	(4.1%)	(1.93%)	(19.2%)
Polystyrene			
Amount	(3)	($0.079)	(1.17)
Percentage	(0.47%)	(0.21%)	(0.87%)
Nitrile			
Amount	(0.015)	($0.0004)	(0.008)
Percentage	(0.17%)	(0.18%)	(0.84%)

NOTES: [1]Brackets indicate decreases or negative values.
[2]Indicates estimated reduction in number of jobs.
[3]Reduction in energy use in millions of 1989 dollars.
[4]Reduction in net exports (exports less imports) in millions of kilograms.

for emission control. Consumers, producers, and all of society bear the costs of pollution controls in the form of higher prices, lower quantities produced, and possible tax revenues that may be gained or lost. Annual economic costs of $9.8 million ($1989) for existing source controls are anticipated for the chosen alternative and are shown by industry in Table ES-5. Economic costs are a more accurate estimate of the cost of the regulation to society than the cost of emission controls to the directly affected industry.

The sum of economic costs for existing sources combined with the engineering estimates of new source annual costs is $5.9 million (1989$), and represents an estimate of the economic cost of the regulation five years after promulgation of the regulation.

TABLE ES-5. ANNUAL ECONOMIC COST ESTIMATES FOR THE POLYMERS AND RESINS GROUP IV REGULATION BASED ON EXISTING SOURCE COSTS[1]
(1989 Dollars)

Group IV Industry	Change in Consumer Surplus	Change in Producer Surplus	Change in Residual Surplus	Total Loss In Surplus
MBS	($437,482)	$43,232	$23,279	($370,971)
SAN	($681,344)	$286,402	$206,606	($188,336)
PET	($17,543,692)	$10,084,464	$0	($7,459,228)
ABS/MABS	($1,796,680)	$94,334	$232,852	($1,469,494)
Polystyrene	($1,732,072)	$884,124	$515,993	($331,955)
Nitrile	($4,726)	($1,429)	($319)	($6,474)
TOTAL	($22,195,996)	$11,391,127	$978,411	($9,826,458)

NOTE: [1]Brackets indicate economic costs.

ES.8 POTENTIAL SMALL BUSINESS IMPACTS

The RFA requires that a determination must be made as to whether or not the subject regulation would have a significant economic impact on a substantial number of small entities. The majority of affected Group IV firms are large chemical companies, and, consequently, significant small business impacts are not expected to result from implementation of the Polymers and Resins Group IV NESHAP. Based on available employment data for each of the affected firms, only two firms classify as small businesses. Costs expressed as a percentage of sales for these firms do not indicate that the NESHAP will result in adverse economic impacts.

1.0 INTRODUCTION AND SUMMARY OF CHOSEN REGULATORY ALTERNATIVE

1.1 INTRODUCTION

Section 112 of the CAA contains a list of HAPs for which EPA has published a list of source categories that must be regulated. EPA is evaluating alternative NESHAPs for controlling HAP emissions occurring as a result of the production of MBS, SAN, PET, ABS, MABS, polystyrene, or nitrile resins. These seven industries are categorized within the Polymers and Resins Group IV source category, and will be collectively referred to as Group IV resins throughout this report. This report evaluates the economic impact of one proposed standard on these affected industries. This analysis was conducted to satisfy the requirements of Section 317 of the CAA which requires EPA to evaluate regulatory alternatives through an EIA.

This chapter presents a discussion of the NESHAP alternative under analysis in this report. Chapter 2 of this report is a compilation of economic and financial data on the seven affected Group IV industries included in this analysis. Chapter 2 also presents an identification of affected resin facilities, a characterization of market structure, separate discussions of the factors that affect supply and demand, a discussion of foreign trade, a financial profile, and the quantitative data inputs for the EIA model. Chapter 3 outlines the economic methodology used in this analysis, the structure of the market model, and the process used to estimate industry supply and demand elasticities.

Chapter 4 presents the control costs used in the model, the estimated emission reductions expected as a result of regulation, and the cost-effectiveness of the regulatory option. Also included is a quantitative estimate of economic costs and a qualitative discussion of conceptual issues associated with the estimation of economic costs of emission controls. Chapter 5 presents the estimates of the primary impacts determined by the model, which include estimates of post-NESHAP price, output, and value of domestic shipments in each of the seven affected industries. A capital availability analysis is also included in this chapter as well as a discussion of the limitations of the model. Chapter 6 presents the secondary economic impacts, which are the estimated quantitative impacts on labor inputs, energy use, balance of trade, and regional markets. Lastly, Chapter 7 specifically addresses the potential impacts of regulation on small affected firms. Appendix A presents the results of sensitivity analyses conducted to quantify the extent to which the price elasticities of demand and supply affect the results of the model. Appendix B is an evaluation of the PET industry using an alternative model based on the assumption that all PET facilities incur equal per unit control costs.

1.2 SUMMARY OF CHOSEN REGULATORY ALTERNATIVE

The CAA stipulates that HAP emission standards for existing sources must at least match the percentage reduction of HAPs achieved by either: (1) the best performing 12 percent of existing sources, or (2) the best 5 sources in a category or subcategory consisting of fewer than 30 sources. For new sources, the CAA stipulates that, at a minimum, the emission standard must be set at the highest level of control achieved by any similar source. This minimum level of control for both existing and new sources is referred to as the MACT floor.

A source within a Group IV resin facility is defined as the collection of emission points in HAP-emitting production processes within the source category. The source comprises several emission points. An emission point is a piece of equipment or component of production that produces HAPs. The definition of source is an important element of this NESHAP because it describes the specific grouping of emission points within the source category to which this standard applies. The NESHAP considered in this EIA requires controls on the following emission points in Group IV resin producing facilities: storage tanks, equipment leaks, miscellaneous process vents, and wastewater collection and treatment systems. EPA chose one regulatory alternative for each of the seven regulated industries, and this report presents the results of the detailed economic impact analyses which were completed for each of the affected industries.

EPA provided cost estimates for controls deemed appropriate as options for Group IV resin-producing processes at existing facilities. Costs for new facilities were provided for the MBS, SAN, PET, ABS, and polystyrene industries. Costs represent the impact of bringing each facility from existing control levels to the control level defined by each regulatory alternative for each emission point. The proposed Group IV regulatory alternative reflects the application of the Hazardous Organic NESHAP (HON) rule and the Batch Process Control Technique Guideline (CTG), where applicable. The provisions of the single regulatory alternative developed for storage tanks and wastewater streams are equivalent to those required by Part 63, Subpart G of the HON rule. The levels of control for equipment leaks are identical to the application of the requirements of Part 63, Subpart H of the HON rule to all components in HAP service.[1] The process vent provisions also resemble the HON with the exception of provisions for some vents. For process vents that operate less than 500 hours per year, the regulatory alternative is based on EPA's draft CTG for Batch Processes. In either situation, the applicability of control requirements is based on vent stream characteristics.

For PET processes, costs were provided for new and existing facilities for two regulatory alternatives. Regulatory Alternative 1 represents the application of the HON rule and the Batch CTG, where applicable. Regulatory Alternative 2 is the same as Alternative 1, with the addition of determining whether the water leaving the ejector systems before going to the cooling tower is subject to the HON wastewater provisions.[2] The results of the economic analysis presented in this report are based on the cost estimates provided for Alternative 2.

REFERENCES

1. U.S. Environmental Protection Agency. Regulatory Alternative Briefing Package on the Polymers & Resins Group IV Industry. Received from John L. Sorrels, EIB. Research Triangle Park, NC. September 14, 1994.

2. Meardon, Kenneth. Pacific Environmental Services. Letter to Les Evans. U.S. Environmental Protection Agency. Revised Costs Summary for MBS, SAN, and PET Processes. Research Triangle Park, NC. July 14, 1994.

2.0 INDUSTRY PROFILE

2.1 INTRODUCTION

This chapter focuses on the markets for Group IV resins. Sections 2.2 through 2.6 of this chapter provide an overview of the activities of these seven affected industries. The economic and financial information in this chapter characterizes the conditions in these industries which are likely to determine the nature of economic impacts associated with the implementation of the NESHAP. The quantitative data contained in this chapter represent the inputs to the economic model (presented in Chapter 3) that were used to conduct the EIA. The general outlook for the Group IV industries is also discussed in this chapter.

Section 2.2 describes the resin production process, and identifies the unique market characteristics of each resin. Section 2.2 also identifies the affected resin facilities by industry location and production capacity. Section 2.3 characterizes the structure of the affected industries in terms of market concentration and firm integration. Also included in Section 2.3 is a financial profile of affected firms. Section 2.4 characterizes the supply side of the market based on production trends, supply determinants, and export levels. Section 2.5 presents demand-side characteristics, including end-use markets, consumption trends, and import levels. Lastly, Section 2.6 presents quantitative estimates of forecasts for growth in each industry.

2.2 PROFILE OF AFFECTED FIRMS AND FACILITIES

This section reviews the products and processes of the affected resin industries and identifies any differences among product markets. The affected firms are identified by capacity, employment, and location of facilities. (In this report, the term firm refers to the company or producer, while the term facility refers to the actual resin production site or plant.)

2.2.1 General Process Description

Plastics production involves using hydrocarbons -- large molecules derived from petroleum and natural gas (and to some extent, coal) -- which are separated through refining and cracking. The resultant smaller compounds are monomers, which are used to produce plastics. Polymerization is the process of linking these monomers in a series to produce long-chain molecules called polymers using moderate amounts of heat, pressure, catalysts, and reactive agents. The resultant basic plastic materials, known as resins, are sold by manufacturers in the form of pellets, flakes, powder, or granules.[1] The resins are used as input for many diverse plastic products, including food containers, appliances, construction materials, and automobile parts.

2.2.2 Product Description

The affected Group IV resins are classified as thermoplastic resins, and have a variety of end uses. This section describes the properties of each resin individually and identifies its primary uses.

2.2.2.1 Methyl Methacrylate Acrylonitrile Butadiene Styrene (MBS). MBS is a type of styrene butadiene copolymer that is characterized by high impact strength and transparency. Although higher in price than many other common monomers, the use of methacrylate includes inputs into products demanding unique stability characteristics, ease of use, and high quality standards. MBS polymers are useful as an impact modifier for rigid PVC, which, in turn, is used in the production of packaging, building, and construction products.

2.2.2.2 Styrene Acrylonitrile (SAN). SAN copolymers are transparent, amorphous materials with higher heat and chemical resistance than polystyrene. Because of its brittleness, SAN has been modified in different ways to form thermoplastics with greater impact strength. In terms of end use markets, SAN resins are most commonly used in consumer products, including dishwasher-safe housewares and refrigerator shelves. SAN's primary use, however, is as an input for ABS production, which is then used to provide weather resistance for applications including boats, swimming pools, and recreational vehicles.

2.2.2.3 Polyethylene Terephthalate (PET). A type of thermoplastic polyester, PET is a high melting point polymer that is clear, tough, and has good gas and moisture barrier properties. PET is produced in four basic forms that include PET bottle-grade resins, PET melt-phase resins, PET films, and PET (polyester) fibers.

PET bottle-grade resins, the most frequently used form, is as an input to the production of soft drink and liquor bottles. In addition to its light weight, the advantageous qualities of PET include barrier properties, impact strength, and clarity, which promoted its penetration into the markets for container applications other than its original use as soft drink bottles. PET has become the resin of choice for soft drink bottles. The initial benefit to using PET in the production of beverage bottles is that compared to glass, steel, and aluminum, the weight of the bottle is significantly lower. Because of this weight reduction, bottlers realize lower labor and energy costs throughout the distribution chain. In sheet form, PET film, which is manufactured with PET melt-phase resin, is a higher cost specialty film, as compared to low cost films made from PVC, polyethylene, and polyester. PET film's primary end uses are in photographic and magnetic film, as well as in packaging and electronic products.

A third form of PET is melt phase resin that is used in the production of two PET types: PET film and polyester fibers, and indirectly as an input to production of the solid state resins used to manufacture PET bottles. The fourth form of PET is a fiber form known as polyester fibers, which are used in the manufacture of clothing, furniture, carpets, and other industrial uses.

2.2.2.4 Acrylonitrile Butadiene Styrene (ABS). ABS materials are composed of acrylonitrile, butadiene, and styrene combined by a variety of methods, including copolymerization and physical blending. ABS is formed by blending SAN with SAN grafted-rubber. When blended with this polybutadiene rubber component, SAN (which is rigid and chemically resistant) creates ABS (which is opaque). Blending styrene with polybutadiene rubber increases impact resistance and, combined with acrylonitrile, produces heat-resistant and solvent-resistant plastics which have extensive uses. The favorable characteristics of ABS polymers include toughness, dimensional stability, chemical resistance, electrical insulating properties, and ease of fabrication.[2] The range of applications for ABS plastics is broad, given that ABS meets the property requirements for many plastic parts at a relatively low per-unit price. Primary end uses of ABS are for the manufacture of automotive parts, household appliances, and food packaging.

2.2.2.5 Methyl Methacrylate Acrylonitrile Butadiene Styrene (MABS). Like MBS, MABS resins are characterized by strength and transparency, and are more expensive than many other common monomers. MABS is formed from ABS blended with methyl methacrylate which makes a clear ABS capable of uses similar to those listed for ABS. MABS polymers are utilized by the plastics industry in applications which require a tough, transparent, highly impact-resistant, and formable material. With the exception of being transparent, MABS polymers are similar to opaque ABS plastics, and are primarily used in the production of both food and non-food containers. The primary end use is in packaging for items such as cups, lids, trays, and clamshells for the fast food industry.[3]

2.2.2.6 Polystyrene. Polystyrene resins are derived from petroleum by-products and natural gas, and are low cost resins with easy processability. Polystyrene is characterized by brittleness, optical clarity, and poor barrier properties to oxygen and water.[4] Differentiation in the production of polystyrene exists through variations of impact strength and chemical resistance. In liquid form, polystyrene can be easily fabricated into useful articles, which accounts for the high volume with which it is used in world commerce. Uses of the polystyrene polymer include the manufacture of durable goods, such as television cabinets, appliances, furniture, and building insulation board. Polystyrene's most common use is for the manufacture of foam used in food trays, meat trays and egg cartons, as well as in packaging for electronics and other delicate items.

2.2.2.7 Nitrile Resins. Nitrile resins, also referred to as acrylonitrile copolymer resins, offer a broad balance of low temperature, oil, fuel, and solvent resistance due to their acrylonitrile content. These characteristics, combined with their good abrasion and water-resistant qualities, make them suitable for use in a wide variety of applications with heat-resistant requirements. Different types of nitrile resins are produced by varying the proportion of acrylonitrile in the blend. The majority of nitrile elastomers produced are copolymers of acrylonitrile and butadiene. The primary use of nitrile elastomers is in the manufacture of nitrile rubbers, which, in turn, are used to produce components for automobiles.

2.2.3 *Affected Resin Facilities, Employment, and Location*

The proposed NESHAP will affect 75 facilities, which are owned and operated by 28 firms. Table 2-1 shows the relative sizes of the three MBS producers. The percentage of industry capacity owned by these three firms is fairly evenly divided. Kaneka Texas, Rohm and Haas, and Elf Atochem each own approximately one-third of domestic MBS capacity. Table 2-2 shows the distribution of operating capacity among the producers of SAN. Because capacity information was not available for three SAN facilities, the capacity is based on the average facility capacity, given total industry SAN production capacity. General Electric owns approximately half of domestic SAN production capacity, followed by Monsanto Chemical, which owns 38 percent of the industry capacity. Dow Chemical owns 13 percent of the total. It is important to note that all ABS resin producers have SAN resin production capacity. The SAN resin produced by these firms, however, is normally used for the manufacture of ABS resins. These companies actually sell relatively small quantities of SAN resin on the merchant market.

The capacity for producing PET melt-phase resin and PET bottles are presented in Table 2-3. Hoechst Celanese Corporation owns the highest share of melt-phase capacity with 26.4 percent, and DuPont owns 26.1 percent of the industry total. Kodak is the other major PET melt-phase resin producer with 22 percent of capacity. The remainder of PET melt-phase capacity is shared by 6 firms. Kodak dominates the PET bottle market with 52.6 percent of industry capacity, followed by Goodyear Tire & Rubber with 28.4 percent of industry capacity. As shown in Table 2-4, the capacity for producing PET film is shared by nine firms. E.I. du Pont de Nemours (DuPont) owns the highest degree of production capacity with 28.9 percent of the total. The second largest PET film producers are ICI American Holdings and Bridgestone, each with 15 percent of industry capacity. DuPont also owns the highest percentage of industry capacity for PET fibers at 34.4 percent, and has the second highest share of PET melt-phase resin capacity.

TABLE 2-1. MBS MANUFACTURERS BY CAPACITY (1991)[5, 6, 7]

Company	Facility Location	Capacity (million kilograms)	Percentage of Total (%)
Kaneka Texas Corporation	Pasadena, TX	23	35.9%
Elf Atochem	Mobile, AL	18	28.2%
Rohm and Haas Company	Louisville, KY	23	35.9%
Total		64	

TABLE 2-2. SAN MANUFACTURERS BY CAPACITY (1991)[5, 6, 7]

Company	Facility Location	Capacity (million kilograms)	Percentage of Total (%)
Dow Chemical	Midland, MI	30	12%
General Electric Joint Venture	Bay St. Louis, MS	59*	25%
General Electric	Selkirk, NY	59*	25%
Monsanto Chemical	Muscatine, IA	59*	25%
Monsanto Chemical	Addyston, OH	32	13%
Total		239	100%

NOTES: *Indicates that capacity reflects an average capacity based on total industry capacity.

TABLE 2-3. PET MELT-PHASE RESIN AND PET BOTTLE MANUFACTURERS BY CAPACITY (MILLION KILOGRAMS) (1991)[5, 6, 7]

Company	Facility Location	Melt-Phase Resin	Percentage of Total (%)	PET Bottle	Percentage of Total (%)
Allied Signal Inc.	Moncure, NC	63	2.1%		
BASF	Lowland, TN	68	2.2%		
DuPont*	Brevard, NC	113			
	Cape Fear, NC	113			
	Circleville, OH	113			
	Cooper River, SC	113			
	Florence, SC	113			
	Kinston, NC	113			
	Old Hickory, TN	113			
DUPONT TOTAL			26.1%		
Eastman Kodak	Columbia, SC	451		342	
	Kingsport, TN	193		147	
	Rochester, NY	23			
KODAK TOTAL			22.0%		52.6%
Goodyear Tire & Rubber (Shell)	Point Pleasant, WV	204	6.7%	263	28.4%
Hoechst Celanese Corp.**	Salisbury, NC	201			
	Shelby, NC	201			
	Spartanburg, SC	201		100	
	Greer, SC	201			
HOECHST CELANESE TOTAL			26.4%		13.2%
ICI Americas	Fayetteville, NC	84		54	
	Hopewell, VA	27			
ICI AMERICAS TOTAL			3.7%		5.8%
3M Corporation	Decatur, AL	27			
	Greenville, SC	11			
3M CORPORATION TOTAL			1.3%		
Wellman	Florence, SC	288	9.5%		
YKK	Macon, GA	N/A			
TOTALS		3,034	100%	929	100%

NOTES: *DuPont facilities' melt-phase resin capacities reflect an industry average based on the firm total of 793 million kilograms.
**Hoechst Celanese's melt-phase resin capacities reflect an industry average based on the firm total of 804 million kilograms.

TABLE 2-4. PET FILM AND PET FIBER MANUFACTURERS BY CAPACITY (MILLION KILOGRAMS) (1991)[5,6,7]

Company**	Facility Location	PET Film	Percentage of Total (%)	PET Fiber	Percentage of Total (%)
Allied Signal Inc.	**Moncure, NC**			63	3.6%
BASF	**Lowland, TN**			23	1.3%
Bemis Company	New London, WI	5	1.5%		
Bridgestone/Firestone	Hopewell, VA	50	14.9%	19	1.1%
DuPont	Kinston, NC			609	
	Parkersburg, WV			1	
	Brevard, NC	16			
	Circleville, OH	33			
	Florence, SC	48			
DUPONT TOTAL			28.9%		34.4%
Eastman Kodak	**Rochester, NY**	45	13.4%		
	Kingsport, TN			72	4.1%
	Rochester, NY	23			
KODAK TOTAL					
Foss Manufacturing	Haverhill, MA			18	1.0%
Goodyear Tire & Rubber (Shell)	Scottsboro, AZ			16	0.9%
Guilford Mills	Fuquay-Varina, NC			6	0.3%
Hoechst Celanese Corp.	**Shelby, NC**			279	
	Spartanburg, SC			279	
	Greer, SC	41	12.2%		
HOECHST CELANESE TOTAL					31.5%
ICI Americas	**Hopewell, VA**	50	14.9%		
Katema	Calenton, MD			2	0.1%
Martin Color-Fi	Sumter, SC			50	2.8%
North American Rayon	Elizabethton, TN			7	0.4%

TABLE 2-4 (continued).

Company**	Facility Location	PET Film	Percentage of Total (%)	PET Fiber	Percentage of Total (%)
3M Corporation	**Decatur, AL**	20			
	Greenville, SC	18			
3M CORPORATION TOTAL			11.3%		
Rhone-Poulenc Inc.	Holcomb, NY	2			
Tolaram Fibers	Ansonville, NC			29	1.6%
Wellman	**Fayetteville, NC**			45	
	Florence, SC			165	
	Palmetto, SC*			88	
WELLMAN TOTALS					16.8%
TOTALS		336	100%	1,774	100%

NOTES: *Wellman's Palmetto facility is scheduled to enter operation at the end of 1993.
**Facilities in boldface type represent facilities affected by the proposed Group IV regulation.

Table 2-5 shows the distribution of operating capacity among the four producers of ABS. There are nine affected facilities owned and operated by 4 firms. The majority of capacity is operated by 3 of these firms. Table 2-6 presents a similar industry breakdown for the affected polystyrene manufacturers. There are 15 polystyrene producers operating 33 facilities. Dow Chemical and Huntsman Chemical are the two primary producers, with 19 percent and 18.6 percent of industry capacity, respectively.

BP Chemicals operates the only nitrile resin facility. Its Lima, Ohio facility had a 1991 operating capacity of 19 million kilograms. Only one producer of MABS was identified, for which production capacity was not available.

On a firm level, employment data were available for each of the 28 affected firms. Firm-level employment data will satisfy the requirements of the RFA by identifying the percentage of affected firms that classify as small businesses. Specifically, the RFA requires the examination of the economic impacts of regulations on "small businesses." A regulatory flexibility analysis must be prepared if a proposed regulation will have a significant economic impact on a substantial number of small entities. The first step in the determination of the effect of the Group IV NESHAP on small firms is to assign the appropriate definition of a small entity in the Polymers and Resins Group IV industry. The U.S. Small Business Administration (SBA) defines small businesses in SIC code 2821 as employing a work force of 750 employees or less.[8]

Table 2-7 lists 1991 employment levels for each of the affected firms. Under the SBA definition, American Polymers, Kama, Novacor Chemicals, and Kaneka Texas Corporation employ less than 750 workers. Kama and Novacor Chemicals are both subsidiaries of larger firms, and therefore do not qualify as small businesses by SBA standards. American Polymers and Kaneka Texas Corporation are the only two firms affected by the Group IV NESHAP which meet SBA's definition of a small business. Given that the majority of affected firms are subsidiaries of large, chemical corporations, it is unlikely that a regulatory flexibility analysis is necessary. EPA may adopt an alternative definition of a small business if an alternative size cutoff can be justified. If EPA exercised this option, the determination of whether an RFA is necessary would need to be reconsidered.

TABLE 2-5. ABS MANUFACTURERS BY CAPACITY (1991)[5, 6, 7]

Company	Facility Location	Capacity (million kilograms)	Percentage of Total (%)
Diamond Polymers	Akron, OH	11	1.5%
Dow Chemical	Allyn's Point, CT	27	
	Hanging Rock, OH	32	
	Midland, MI	122	
	Torrance, CA	18	
	Dow Total	199	26.7%
General Electric	Ottawa, IL	136	
	Washington, WV	109	
	GE Total	245	32.7%
Monsanto Chemical	Addyston, OH	204	
	Muscatine, IA	90	
	Monsanto Total	294	39.3%
	INDUSTRY TOTAL	749	

TABLE 2-6. POLYSTYRENE MANUFACTURERS BY CAPACITY (1992)[5, 6, 7]

Company	Capacity (million kilograms)	Percentage of Total (%)
American Polymers Inc.	32	1.1%
Amoco Chemical	357	12.6%
ARCO Chemical	45	1.6%
BASF	283[a]	10.0%
Chevron Chemical	217	7.5%
Dart Container Corp.	32	1.1%
Dow Chemical	548	19.3%
Fina Oil and Chemical Co.	290	10.2%
Huntsman Chemical Corp.	527	18.6%
GE-Huntsman Joint Venture	45	1.6%
Kama Corporation	36	1.3%
Monsanto Chemical	72	2.5%
Novacor Chemicals	290	10.2%
Rohm & Haas	25	1.0%
Scott Paper Co.	41	1.4%
Totals	2,840	100.0%

[a]BASF purchased Mobil's 285-million kilogram polystyrene capacity in 1992.

TABLE 2-7. 1991 EMPLOYMENT LEVELS OF POLYMERS AND RESINS GROUP IV FIRMS[9, 10, 11]

Firm Name	Number of Employees
Allied Signal	105,800
American Polymers	45
Amoco	54,524
ARCO Chemical	27,300
BASF	133,759
BF Goodrich	11,892
BP Chemical	118,050
Chevron Chemical	54,028
Dart Container Corporation	3,000
Dow Chemical	62,100
E.I. du Pont de Nemours	143,961
Eastman Kodak Co.	134,450
Fina (American Petrofina)	3,997
General Electric	284,000
Hoechst Celanese Corp.	31,600
Huntsman Chemical	1,277
ICI American Holdings Inc.	9,500
Kama	300*
Kaneka Texas Corporation	160
Metco (Elf Atochem)	4,500
Monsanto Chemical	41,081
Novacor Chemicals	700*
Rohm and Haas Co.	12,872
Scott Paper Co.	29,100
Shell	30,000
3M	88,477
Wellman	2,900
YKK	1,900

Notes: * Kama and Novacor Chemicals are subsidiaries of larger firms which do not classify as small businesses by SBA standards.

National production capacity by resin type is summarized on a regional and State basis in Table 2-8. (Only EPA regions and States in which at least one resin facility is located are included in the table.) Certain industry characteristics are evident from the regional categorization in this table. Forty-three percent of facilities which produce the seven resin types are located in the Southeastern United States. The geographical distribution of the affected facilities will be critical to the determination of the regional impacts of the NESHAP. The leading States by total number of facilities are Ohio, North Carolina, and South Carolina. Table 2-8 also shows the total number of facilities by resin type. The majority of facilities in the Polymers and Resins IV category produce polystyrene, followed by PET. In terms of capacity, melt-phase PET resin production accounts for the highest capacity in Group IV (3,034 million kg), followed by polystyrene (2,840 million kg).

2.3 MARKET STRUCTURE

The purpose of this section is to characterize the market structures in the Group IV resin industries. Market structure has important implications for the resultant price increases that occur as a result of controls. For example, in a perfectly competitive market, the imposition of control costs will shift the industry supply curve by an amount equal to the per-unit control costs, and the price increase will equal the cost increase. An indication of the market structure of the seven affected Group IV resin industries is provided by an assessment of the number of firms operating resin facilities, vertical integration, and diversification.

2.3.1 Market Concentration

Market concentration is a measure of the output of the largest firms in the industry, expressed as a percentage of total national output. For each of the Group IV resin industries, however, the necessary production data on a facility level were not available. For this analysis, therefore, the firms in each of the seven industries were analyzed in terms of production capacity rather than by a specific measure of resin output. Because MABS and nitrile resins are produced by only one firm, market concentration is not considered for these two industries. As was shown in Table 2-1, the MBS industry capacity is shared nearly equally by the three firms with no single firm dominating the

TABLE 2-8. DISTRIBUTION OF MANUFACTURERS BY RESIN TYPE AND FACILITY LOCATION[5, 6, 7]

EPA Region	State	Total Facilities by Resin Type							State Total
		ABS	SAN	PET	MBS	MABS	Polystyrene	Nitrile	
I									
	Connecticut	1					1		2
	Massachusetts						2		2
II									
	New Jersey						1		1
	New York		1	1			1		3
III									
	Pennsylvania						3		3
	Virginia			1			1		2
	West Virginia			1		1			2
IV									
	Alabama			1	1		1		3
	Georgia			1			1		2
	Kentucky				1		1		2
	Mississippi		1						1
	North Carolina			7					7
	South Carolina			7					7
	Tennessee			3					3
V									
	Illinois	1					5		6
	Michigan	1	1				3		5
	Ohio	2	1	1			5	1	10
VI									
	Louisiana						1		1
	Texas				1		1		2
VII									
	Iowa	1	1						2
IX									
	California	1					3		4
	TOTALS	7	5	23	3	1	30	1	70

market. GE and Monsanto dominate the SAN industry, although there is not great diversity in the distribution of SAN capacity. PET production as a whole involves the highest number of producers of any of the seven resin industries in this analysis. The market concentration in the PET industry is less concentrated than in the SAN or MBS industries. The PET bottle industry is more highly concentrated than the other three PET categories, having only four producers. Of these four, Eastman Kodak owns slightly over half of the industry capacity, followed by Shell with 28.3 percent of total capacity. The ABS market is highly concentrated, given that 3 of the 4 firms share 98.7 percent of total industry production capacity. General Electric owns the highest share with 40 percent of the total, followed by Monsanto with 35 percent of ABS capacity, and Dow Chemical with 24 percent of total capacity.

The distribution of polystyrene capacity indicates that the polystyrene industry is the least concentrated industry in the Group IV source category. Dow Chemical and Huntsman Chemical are the top two firms by production capacity ownership, with 19.3 percent and 18.6 percent of industry capacity, respectively. Amoco owns the third highest percentage of polystyrene capacity with 12.3 percent. The remaining 49.8 percent of capacity is shared by the 12 remaining producers.

2.3.2 *Industry Integration and Diversification*

The majority of firms affected by the Group IV NESHAP are large firms that are vertically integrated to the extent that the same firm supplies input for several stages of the production and marketing process. The majority of firms in this industry own segments that are responsible for exploration and production of crude oil (a major input to chemical production) and for marketing the chemicals and polymers produced. For the larger firms in this industry, horizontal integration exists to the extent that these firms operate several resin-producing facilities. The major firms operate several facilities, and the largest, DuPont, operates seven domestic facilities. Of the 28 affected firms, 16 operate more than one facility. Diversification indicates the extent to which affected firms have developed other revenue-generating operations. Given that the majority of the affected firms are in divisions of large, diversified corporations, the financial resources for capital investment in control equipment may be more accessible than for an industry characterized by a large number of smaller firms.

2.3.3 *Financial Profile*

This subsection presents the available financial data for affected firms. In order to evaluate the financial condition of the firms, annual reports to stockholders were used as a primary source of data. Because the EIA is conducted on a firm level, it is useful to examine overall corporate profitability as a preliminary indicator of the baseline conditions of affected firms in the industry. Corporate-level data are also useful as an indication of the financial resources available to affected firms and the ability of this capital to cover increased compliance costs after promulgation of the NESHAP.

Table 2-9 presents net income to assets ratios that were averaged from 1987 to 1991 for each of their firms for which data were available. Also presented are long-term debt to long-term debt plus equity ratios for the most current year for which data were available. These ratios are used to represent the baseline in the financial impacts analysis, the results of which provide quantitative estimates of the effect of NESHAP control costs on the financial conditions of affected firms. The results of the capital availability analysis are presented in Section 5.3 of this report.

2.4 MARKET SUPPLY CHARACTERISTICS

This section analyzes the supply side of each of the Group IV resin industries. Historical production data are presented, and the factors that affect production are identified. The role of foreign competition in this industry is also assessed. The focus of the section is on overall industry supply and the existing conditions in the marketplace.

2.4.1 *Past and Present Production*

The domestic supply of MBS, SAN, and PET for the past decade are shown in Table 2-10. Of these three industries, PET has shown the greatest growth in domestic production. The average annual growth rate for PET between 1980 and 1991 was 7 percent. SAN's average annual growth during this period was only 0.6 percent. Production levels of MBS are shown for 1985 through 1991. Time-series data on the

TABLE 2-9. FINANCIAL STATISTICS FOR AFFECTED FIRMS[10]

Company	Net Income to Assets Ratio* 1987 to 1991 Average (%)	Long Term Debt to LT Debt and Equity (%)
Allied Signal Inc.	6.3	43.5
Amoco	5.5	28.2
ARCO	11.2	39.8
BP Chemicals	4.0	43.4
Chevron	3.9	28.2
E.I. de Nemours DuPont	2.7	N/A
Dow Chemical	8.7	66.8
Eastman Kodak	6.6	61.6
Elf Atochem	1.0	N/A
Fina	4.1	93.1
General Electric	3.1	58.7
ICI	7.5	30.2
Monsanto	6.7	36.3
Rohm & Haas	9.8	35.1
Scott	3.8	54.1
Shell	4.6	11.0
3M	13.0	10.7
Wellman	10.0	42.5

NOTES: *Net income reflects profits derived from all sources after deductions of expenses, taxes, and fixed charges, but before any discontinued operations, extraordinary items, and dividend payments.

TABLE 2-10. HISTORICAL PRODUCTION LEVELS FOR SAN, MBS,AND PET (1980 - 1991)[12]

Year	Production by Resin Type (million kilograms)		
	SAN	MBS	PET*
1980	N/A	N/A	1,616
1981	48.4	N/A	1,640
1982	41.2	N/A	1,781
1983	42.1	N/A	2,011
1984	44.8	N/A	2,000
1985	39.4	69.8	2,019
1986	41.6	88.1	2,144
1987	57.0	42.2	2,464
1988	67.0	52.0	2,623
1989	51.0	61.6	2,840
1990	61.1	N/A	2,795
1991	51.6	51.0	2,987

NOTES *PET production reflects the production of polyester fibers, PET bottle resins, and PET film.

production of MBS reflect significant yearly fluctuations due in part to changes in the line item definitions used by the U.S. International Trade Commission to report data. Historical production trends in the last decade for ABS and polystyrene are shown in Table 2-11. Relative stability has characterized the markets for ABS and polystyrene during the past decade. The average annual growth rate for ABS from 1980 through 1992 was 1.2 percent. Polystyrene growth averaged minus 0.6 percent over this same period. Polystyrene has been the weakest performing thermoplastic resin in recent years, with production having declined for 3 consecutive years since 1988, due in part to lower packaging demand. Environmental concerns related to the waste disposal problems associated with packaging products have also restricted growth. Time-series production information for MABS and nitrile resins were not available.

TABLE 2-11. HISTORICAL PRODUCTION LEVELS FOR ABS AND POLYSTYRENE (1980-1991)[12]

Year	Production by Resin Type (million kilograms)	
	ABS	Polystyrene
1980	444	2,352
1981	461	2,215
1982	371	2,372
1983	477	2,310
1984	552	2,347
1985	610	2,163
1986	515	2,023
1987	571	2,456
1988	873	2,562
1989	547	2,400
1990	521	2,351
1991	509	2,190

2.4.2 Supply Determinants

Resin production decisions are primarily a function of input prices, production costs, resin prices, existing capacity levels, and international trade trends. Decisions made by producers include identifying which processors and markets to continue to serve and which facilities to continue operating. The costs of the inputs to production are a major factor in the determination of production levels. Inputs to production include petroleum, natural gas, and coal, which are subjected to a refining process yielding petrochemical feedstocks. These basic materials are mixed with other substances (ammonia and formaldehyde, for example) to yield intermediates, which can then be catalyzed into monomers and finally to polymers or resins.[13]

Existing Federal, State, and local regulations can also have an impact on the quantity of resins supplied by U.S. facilities. Facilities that are already regulated may have previously altered their production, and may therefore have already altered the industry supply schedule. The industry supply curve used in the EIA incorporated any changes in production that have occurred as a result of other regulations to the extent that the supply curve accounts for the level of existing controls at companies in the industry.

Competition in the resin market takes place on two levels: among producers of the same resin type and among various resins with similar characteristics. In choosing the appropriate resin for a given application, end users consider polymer properties, fabrication technique, and devices (e.g., mold) to be used for manufacturing the final product. Surface appearance and impact resistance are both of importance. Consequently, resin suppliers are constantly seeking improvements to their products in order to maintain market share.

In 1992, for example, SAN producers were introducing high-clarity versions of SAN targeted to replace more costly resins in housewares applications. Overall, the movement in the supply of resins is toward higher levels of competition as environmental pressures, shifts in global supply via capacity expansion, and use-specific innovations require suppliers to maintain their competitive edge by developing resins designed to meet user specifications.

PET can compete effectively with the thermoset resins in certain applications requiring good electrical properties, better impact strength, and superior processing capabilities.[14] Enhancements in the PET market include the development of thin PET film. PET melt-phase and bottle producers are refining material properties to achieve benefits, including lighter bottle weight. PET bottles compete directly with glass bottles and aluminum cans. Thirty-five million kilograms of PET is manufactured into refillable bottles annually, but this number is projected to exceed 90 million kilograms over the next 5 years.[15]

Polystyrene competes with PVC, which is economical also but has marginal heat-distortion properties in some uses. Polystyrene competes directly with polypropylene and high-density polyethylene in packaging markets. The two former resins are more than 3.6 cents per kilogram cheaper than polystyrene, and if this gap continues, polystyrene could lose some market share in the packaging industry as the low-cost materials increase their use in packaging products. The low cost of polystyrene and its high thermal stability are important to the use of polystyrene in rigid thermoplastic foams, which permits its use in most construction applications.

Suppliers in turn are turning attention to developing polystyrene grades with improved properties for non-packaging applications. One growth area is in the substitution of polystyrene for ABS in refrigerator liners. Polystyrene producers are focusing market development on improving impact strength and surface appearance.[16] Polystyrene could also gain market share in other end-use markets where ABS could be considered an "overengineered" complex resin choice.[17]

ABS competes with polystyrene, polypropylene, and the engineered resin polycarbonate on price and performance. The ability to manufacture ABS with a method called continuous mass processing is becoming important to ABS producers. This production method allows for enhanced color consistence, which eliminates the need for painting, making ABS a more attractive option for applications where the elimination of the finishing step is cost-efficient and environmentally efficient. This technological development is expected to be the most significant in the automotive market, given that ABS has a significant share of appearance parts in automobile interiors. Polypropylene is the nearest competitor in this market. Upgraded commodity resins are "chipping away" at low-end ABS applications such as disk packaging and videocassettes, although ABS is gaining share in large markets like automotive interiors and appliances.[18]

2.4.3 *Exports of SAN, MBS, PET, ABS, and Polystyrene*

Some measure of the extent of foreign competition can be obtained by comparing exports with domestic production. The Foreign Trade Division of the U.S. Bureau of the Census collects trade data by resin type according to a commodity coding system. In 1991, exports of SAN represented 36 percent of domestic production and PET exports represented 7 percent of domestic production.[19] (MBS and nitrile resins were not assigned a unique export code during 1991.) Trade data for ABS and polystyrene were obtained from *Modern Plastics*.[20] In 1991, exports of ABS represented 16 percent of domestic production and polystyrene exports represented 6 percent of domestic production.

2.5 MARKET DEMAND CHARACTERISTICS

The purpose of this section of the chapter is to characterize the demand side of the MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resin industries. In the past decade, the overall demand for plastics has increased, as plastics have been recognized as substitutes for other, more costly materials. For example, plastics have replaced metals in construction and packaging applications, paper and glass in packaging, and wood in furniture production. Higher demand for plastics translates into higher demands for input resins, including those classified in the Polymers and Resins Group IV source category. The following sections present an examination of the factors that determine demand levels, including the identification of the end-use markets, an evaluation of historical consumption patterns, and an assessment of the role that imports play in satisfying domestic demand.

2.5.1 End-Use Markets for MBS, SAN, PET, ABS, MABS, Polystyrene and Nitrile Resins

The two primary end-use industries for MBS, SAN, and PET resins are the construction, automotive, and soft drink bottle markets, respectively. In addition to the construction and automotive markets, other major end use markets include packaging, consumer products, electronics, and furniture. Demand for packaging, disposables, and low-cost consumer goods usually follows GNP trends. The strongest source of demand for PET resins is from soft drink bottle makers. Given the high cost savings derived from using plastic rather than glass containers, this end use market is a strong one.

The most common end use market for ABS in 1992 was the consumer goods market, which accounted for 19 percent of ABS consumption, followed closely by the automotive market, accounting for 18 percent of ABS sales. Consumer goods manufactured with ABS include appliances, housewares, luggage, toys, furniture, and sporting goods. In sheet form, ABS is used as a component of refrigerator door liners and food storage compartments. In the automotive industry, ABS replaced the majority of steel or aluminum parts for use in interior panels and trim, grilles, wheelcovers, and mirror housings. In the business products end-use category, ABS is the most commonly used material for computer disk housings, and has historically been used to mold telephones, calculators, and business machines. Certain grades of ABS are made into pipes and rigid foam insulation for the building and construction market which accounted for 13 percent of ABS sales in 1992.

The leading uses for polystyrene in 1992 were in food containers and packaging (50.8 percent), electronics (12 percent), consumer products (15 percent), and construction (6 percent). The benefit to polystyrene for food service products is that polystyrene containers are sanitary, sturdy, lightweight, and economical. In sheet form, polystyrene is used for food trays and blister packaging. One variation of polystyrene is as a replacement material for micro floppy disk casings and television cabinets. Polystyrene film absorbs little moisture, has favorable dimensional stability, does not become brittle, and has the ability to pass through packaging machinery at high speeds. These are central factors in the use of polystyrene film in window envelopes, for example.

MABS polymers are similar to ABS plastics, and are used mainly for the manufacture of food and nonfood containers. The primary use of nitrile elastomers is in the manufacture of nitrile rubbers which, in turn, are used mainly to produce rubber hoses and tubes for automobiles, as well as in a variety of miscellaneous plastics products. Domestic sales of nitrile resins are closely related to the performance of the domestic automobile industry which is the main end user of this resin.

2.5.2 Demand Determinants

The demand for MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins is primarily determined by price level, the price of available substitutes, general economic conditions, and end-use market conditions. The degree to which price level influences the quantity of resins demanded is referred to as the *price elasticity of demand*, which is explored later in this report. Prices of Group IV resins affect the willingness of consumers to choose these resins over other substitute resins. Table 2-12 presents price levels for MBS, SAN, PET, ABS, and polystyrene for the years 1980 through 1991. Time-series price data for MABS and nitrile resins were not available. Increased competition

TABLE 2-12. PRICE LEVELS FOR MBS, SAN, PET, ABS, AND POLYSTYRENE (1980-1991)[21]

Year	Price/Kilogram (1990 Dollars)				
	MBS	SAN	PET	ABS	Polystyrene
1980	NP	NP	0.64	0.46	0.33
1981	NP	NP	0.60	0.47	0.30
1982	NP	0.66	0.57	0.49	0.26
1983	NP	0.67	0.54	0.49	0.24
1984	NP	0.47	0.82	0.48	0.20
1985	0.83	0.42	0.71	0.45	0.18
1986	1.07	0.61	0.73	0.39	0.17
1987	1.06	0.64	0.75	0.41	0.24
1988	1.28	NP	0.74	0.46	0.29
1989	0.93	NP	0.72	0.44	0.25
1990	NP	NP	0.64	0.40	0.18
1991	0.45	NP	0.70	0.38	0.18

NOTES: NP indicates that the International Trade Commission did not publish resin as a line item in that year has put considerable pressure on resin prices over the past decade. High-performance characteristics, coupled with highly price-sensitive demand for most plastic materials, continues to encourage material substitution among resins.[22]

In addition to price, the consumption of Group IV resins is determined by general economic conditions and the health of end use markets. In the market for polystyrene, in which the primary end uses are packaging, disposables, and low-cost consumer goods, consumption usually follows the trends of GNP. The decreases in demand for polystyrene are due, in part, to slow economic growth and environmentally induced cutbacks in packaging and disposables. As the recycling infrastructure develops more fully, demand decreases may intensify as the demand for polystyrene products weakens further.

The major end markets for the resin industry have been experiencing low growth rates since 1986. The two primary end-use industries for Group IV resins are the automotive and construction markets. The construction industry has been in a period of decline since 1986. This trend is expected to continue as high vacancy rates and loan problems for financial lenders continue.[23] Polystyrene sales are sensitive to conditions in the housing market. Housing starts have historically had a positive effect on polystyrene demand levels. Consequently, as new construction began a decline in 1988, a concurrent decline in polystyrene sales occurred.

Domestic production of automobiles has been declining since 1985, with the exception of 1988, which showed a slight rise in production. As discussed in the previous section, the most common use of ABS and nitrile resins is in the automotive market. The rise in ABS use in automobiles reflects a desire on the part of automobile manufacturers to decrease the weight and cost of their vehicles. As automobile production declines, as it has in recent years, ABS and nitrile resin demand from this sector will decrease.

2.5.3 Past and Present Consumption

Table 2-13 shows the sales of MBS, SAN, PET, ABS, and polystyrene from 1980 through 1991. The sales data for these five resins illustrate the fluctuations that occur in the resin industry due to constantly changing product specifications and the state of technology. (MABS and nitrile resins sales data were not available.) PET demand in the

TABLE 2-13. SALES LEVELS FOR MBS, SAN, PET, ABS, AND POLYSTYRENE (1980 - 1991)[24]

	Resin Sales by Type (million kilograms)				
	MBS	SAN[1]	PET	ABS	Polystyrene
1980	NP	NP	167	423	1,629
1981	NP	47.5	197	417	1,631
1982	NP	38.5	229	340	1,448
1983	NP	41.2	266	460	1,632
1984	NP	39.8	363	501	1,736
1985	NP	38.0	388	470	1,859
1986	NP	39.4	469	495	2,020
1987	78.2	57.5	546	562	2,199
1988	43.5	66.1	624	842	2,275
1989	61.2	48.9	1,019	500	2,321
1990	NP	60.6	969	519	2,285
1991	44.8	51.6	1,060	439	2,207

NOTES. [1]Includes SAN sales on the merchant market, in addition to SAN produced for captive use
[2]Includes sales of PET resins (film, bottle).

packaging resins and films end uses, however, has not experienced negative growth due to a slow economy. The ability of PET to remain in high demand has been attributed to new or expanded uses due to resin substitution and process innovations, in addition to PET's perceived environmental benefits.

After a peak in 1988, ABS demand has leveled out since 1989, with an average annual growth rate of 0.4 percent since 1980. The demand for polystyrene has increased slowly, but consistently, both domestically and worldwide, with an average annual growth rate of 3 percent since 1980.

2.5.4 Imports of SAN, MBS, PET, ABS, and Polystyrene

Imports as a percentage of domestic consumption range from 1.3 to 11 percent for Group IV resins. Trade data for MABS and nitrile resins were not available. Imports of PET resins have increased steadily since 1986 at an average annual growth rate of 12.2 percent, and in 1991, PET imports were only 2 percent of domestic consumption. As a percentage of domestic consumption, SAN imports were only 2.5 percent of domestic SAN sales in 1991. In 1991, imports of MBS copolymers accounted for 6.3 percent of domestic sales. Imports of ABS represented 11 percent of domestic consumption in 1991, and polystyrene import levels were 1.3 percent of domestic sales.

2.6 MARKET OUTLOOK

This section presents quantitative capacity growth projections available from the literature for each affected industry. Projections are important to the EIA since future market conditions contribute to the potential impacts of the NESHAP that are assessed for the fifth year after regulation. Planned capacity expansions for PET, ABS, and polystyrene are shown in Table 2-14.

TABLE 2-14. PLANNED CAPACITY EXPANSIONS THROUGH 1996 BY RESIN TYPE[25, 26, 27]

	Million Kilograms	
Resin Type	1991 Capacity	Planned Expansion through 1996
PET	6,073	1,387
ABS	839	175
Polystyrene	2,906	465

The PET market is currently characterized by production capacity that is already operating at nearly full capacity which, combined with the existing high levels of demand, may restrict growth in this market. Gains in process technology have permitted a high and an efficient amount of bottle production and markets with high growth potential have emerged. A likely result of this supply situation is an increase in price levels, given that demand is up, inventories are down, and raw materials costs are increasing. PET is also the plastic that is recycled the most as post-consumer scrap in the United States. Present markets for recycled PET include carpeting, fiberfill, unsaturated polyester, rigid urethane foam, strapping, and engineering plastics.

Growth projections for PET were available only in the soft drink bottle end use market. Average annual growth for PET bottles is currently 15 percent. Soft drink producers view PET refillable bottles as a growth product, which allows them to package their product in large containers in markets where the use of glass has restricted container size. Due to a high conversion cost, refillable PET bottles are not expected to be in high demand in the United States. *Chemical Marketing Reporter* predicts the bottle-grade PET resin market to grow at a rate of 10 percent per year through 1997.[25] In the absence of growth rates for the other 3 PET types, EPA's engineering contractor assumed an average annual growth rate of 3 percent.[28] Combining these two estimates results in growth of PET capacity by 1,387 million kilograms over the next 5 years.

No quantitative estimates of growth in the SAN industry were available. Given that SAN's primary use is as an input to the production of ABS, and that three of the four

SAN manufacturers also produce ABS, the outlook for SAN is expected to be in accordance with the ABS outlook in Table 2-14. Growth projections for the ABS market are 3 to 5 percent per year through 1998.[26]

Producers report that demand for polystyrene has been fairly steady for the past year. Polystyrene producers have been repositioning themselves to recreate old markets, including those in which polystyrene is not perceived as environmentally friendly. One growth market for polystyrene is in the disposable cutlery market, in which the primary competitor is polypropylene. Another end-use market that looks promising for output growth is for refrigerator linings, a use for which polystyrene competes directly with ABS. The outlook for polystyrene is positive, with an average annual growth rate of 3 percent.[27]

Quantitative growth estimates were not available for MBS. The uses of MBS are similar to those of polystyrene, which is estimated to have an average annual growth rate of 3 percent per year through 1998.[27] Because MBS polymers are mainly used as an impact modifier for rigid polyvinyl chloride, the outlook for this market will be determined mainly by the health of the packaging, building, and construction markets.

Quantitative growth estimates were not available for MABS and nitrile resins. As presented earlier in this chapter, the properties and end uses of these two resins are similar to those of ABS. MABS polymers are also similar to opaque ABS plastics, and are primarily used in the production of food containers. MABS is formed from ABS and is a clearer form of this resin, capable of uses similar to those of ABS.

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3.0 ECONOMIC METHODOLOGY

3.1 INTRODUCTION

The purpose of this chapter is to outline the economic methodology used in this analysis. Baseline values used in the partial equilibrium analysis are presented, and the analytical methods used to conduct the following analyses are described individually in this chapter:

- Partial equilibrium model used to compute post-control price, output, and trade impacts;
- Economic surplus changes;
- Labor and energy impacts; and
- Capital availability.

3.2 MARKET MODEL

The framework for the analysis of economic impacts on each of the seven affected resin industries is a partial equilibrium model. A partial equilibrium analysis is an analytical tool often used by economists to analyze the single market model. This method assumes that some variables are exogenously fixed at predetermined levels. The goal of the partial equilibrium model is to specify market supply and demand, estimate the post-control shift in market supply, estimate the change in market equilibrium (price and quantity), and predict plant closures. This section presents the framework of the partial equilibrium model, baseline equilibrium conditions, the calculation of the supply curve shift, and the methodology used to calculate impacts on trade, closure, and labor and energy inputs. The baseline inputs for each of the seven affected industries are also presented.

3.2.1 Partial Equilibrium Analysis

A partial equilibrium analysis was used to estimate the economic impacts of the chosen regulatory options for each of the seven affected industries. For modeling purposes, it was assumed that each of the industries is operating in a perfectly competitive market. Perfectly competitive industries are characterized by the following conditions: the presence of many sellers; production of a homogeneous product; a small market share owned by each firm in the industry; freely available information regarding prices, technology, and profit opportunities; freedom of entry and exit by firms in the industry; and competing sellers which are not considered as a threat to market share by other firms in the industry.[1] The implication of an assumption of perfect competition to this analysis is that perfect competition constrains firms in the industry to be price takers due to the absence of the market power necessary to affect market price. Firms which operate in a perfectly competitive industry are also assumed to minimize costs.

The seven affected Group IV industries in this analysis do not meet the strict definition of perfect competition particularly when evaluated on the basis of the most widely applied of these criterion - the number of firms in the market. The number of firms in each of the Polymers and Resins Group IV industries ranges from one to fifteen. Ignoring other factors, these firms are likely to be characterized as oligopolistists. However, the products produced by these firms have close substitutability with other resins produced in the marketplace. Thus, the affected firms producing Group IV resins face competition not only from other firms producing the same resins, and also from firms producing other resins which are technically produced by another industry, but are nonetheless considered to be a reasonable substitute by the consumer (i.e. business firm) using the resin as an input to production.

The presence of close substitutes in the marketplace yields the option of modeling industries with few producers as oligopolistic. Further adequate modeling of oligopoly markets requires more in-depth information on economic behavior than is currently available, given the scope of this analysis. It is accurate to conclude that the affected Group IV firms will exhibit greater market power (control over the market price) than is postulated in the perfectly competitive model used in the analysis. However, if one assumes the most extreme case - that each of these firms is a pure monopolist, the primary market impacts are likely to be less severe than those estimated in this analysis under the assumption of pure competition.

The pure monopolist maximizes profits by producing a level of production that equates the firm's marginal revenue (increase in revenue associated with producing one more unit of a product) with the firm's marginal cost of production (increase in cost resulting from production of one more unit of a product). Increases in fixed costs, such as emission control capital costs, will not alter the profit maximizing monopolist production quantity choice unless these costs force the firm to incur losses and shut down. Since a significant portion of the emission control cost estimates used in this analysis are due to the necessary capital investment required by firms, it is likely that the estimated market impacts under the assumption of a competitive marketplace (i.e. increases in market price and decreases in market output) would exceed those estimated assuming a monopoly market. From this standpoint, the assumption of perfect competition may be interpreted as an upper bound on the estimated market impacts resulting from the proposed NESHAP.

3.2.2 Market Demand and Supply

The baseline, or pre-control levels for each of the Group IV resin markets are each defined with a domestic market demand equation, a domestic market supply equation, a foreign supply equation (imports), and a foreign demand equation (exports). It is assumed that each of these markets will clear, or achieve an equilibrium. The following equations identify the market demand, supply, and equilibrium conditions for each affected industry:

$$Q^{D_d} = \alpha P^{\varepsilon}$$

$$Q^{D_f} = \delta P^{\varepsilon}$$

$$Q^{S_d} = \beta P^{\gamma}$$

$$Q^{S_f} = \rho P^{\gamma}$$

$$Q = Q^{D_d} + Q^{D_f} = Q^{S_d} + Q^{S_f}$$

where:

Q^{Dd} = the quantity of the Group IV resin demanded by domestic consumers annually,

Q^{Df} = the quantity of the Group IV resin demanded by foreign consumers and produced by domestic producers annually (or exports),

Q^{Sd} = the quantity of the Group IV resin produced by domestic supplier(s) annually,

Q^{Sf} = the quantity of the Group IV resin produced by foreign suppliers and sold in the United States annually (or imports),

P = the price of the Group IV resin,

ϵ = the price elasticity of demand for the Group IV resin, and

γ = the price elasticity of supply for the Group IV resin.

The constants, α, δ, β, and ρ, are parameters estimated by the model, which are computed such that the baseline equilibrium price is normalized to one. The market specification assumes that domestic and foreign supply elasticities are the same, and that domestic and foreign demand elasticities are identical. These assumptions are necessary, since data were not readily available to estimate the price elasticity of supply for foreign suppliers and the price elasticity of demand for foreign consumers.

3.2.3 Market Supply Shift

The domestic supply equation shown above may be solved for the price, *P,* of each of the seven Group IV resins, respectively, to derive an inverse supply function that serves as the baseline supply function for each industry. The inverse domestic supply equation for each industry is as follows:

$$P = (Q^{S_d}/\beta)^{\frac{1}{\gamma}}$$

A rational profit maximizing business firm will seek to increase the price of the product it sells by an amount that recovers the capital and operation costs of the regulatory control requirements over the useful life of the emission control equipment. This relationship is identified in the following equation:

$$\frac{[(C \bullet Q) - (V + D)]\,(1 - t) + D}{S} = k$$

where:

C = the increase in the supply price,

Q = output,

V = a measure of annual operating and maintenance control costs,

D = annual depreciation (straight line depreciation is assumed),

t = the marginal corporate income tax rate,

S = a capital recovery factor, and

k = the investment cost of emission controls.

Thus, the model assumes that individual polymer and resin facilities will seek to increase the product supply price by an amount, C, that equates the investment costs in control equipment, k, to the present value of the net revenue stream (revenues less expenditures) related to the equipment. Solving the equation for the supply price increase, C , yields the following equation:

$$C = \frac{kS - D}{Q(1 - t)} + \frac{V + D}{Q}$$

Estimates of the annual operation and maintenance control costs and of the investment cost of emission controls, V and k, respectively, were obtained from engineering studies conducted by an engineering contractor for EPA and are based on 1989 price levels. Production levels reflect calendar year 1991 values. The variables for annual depreciation and the capital recovery factor, D and S, respectively, are computed as follows:

$$D = \frac{k}{T}$$

$$S = \frac{r(1 + r)^T}{[(1 + r)^T - 1]}$$

where:

r = the discount rate faced by producers, which is assumed to be 10 percent, and

T = the life of the emission control equipment, which is 10 years for most of the proposed emission control equipment.

Emission control costs will increase the supply price for each Group IV resin by an amount equivalent to the per unit cost of the annual recovery of investment costs plus the annual operating costs of emission control equipment, or C_i (i denotes the number of affected facilities in each of the seven industries). The baseline product cost curve for each of the Group IV resins is unknown because production costs for the individual facilities are unknown. Therefore, an assumption is made that the affected facilities in each industry with the highest after-tax per unit control costs are marginal in the post-control market. In other words, those firms with the highest after-tax, per unit control costs also have the highest per-unit pre-control production costs. This is a worst-case scenario model assumption that may not be the case in reality. The assumption, however, results in the upper bound of possible market impacts occurring as the result of regulation. Based upon this assumption, the post-control supply function can be expressed as follows:

$$P = (Q^{S_d}/\beta)^{\frac{1}{\gamma}} + C\,(C_i\,,\ q_i)$$

where:

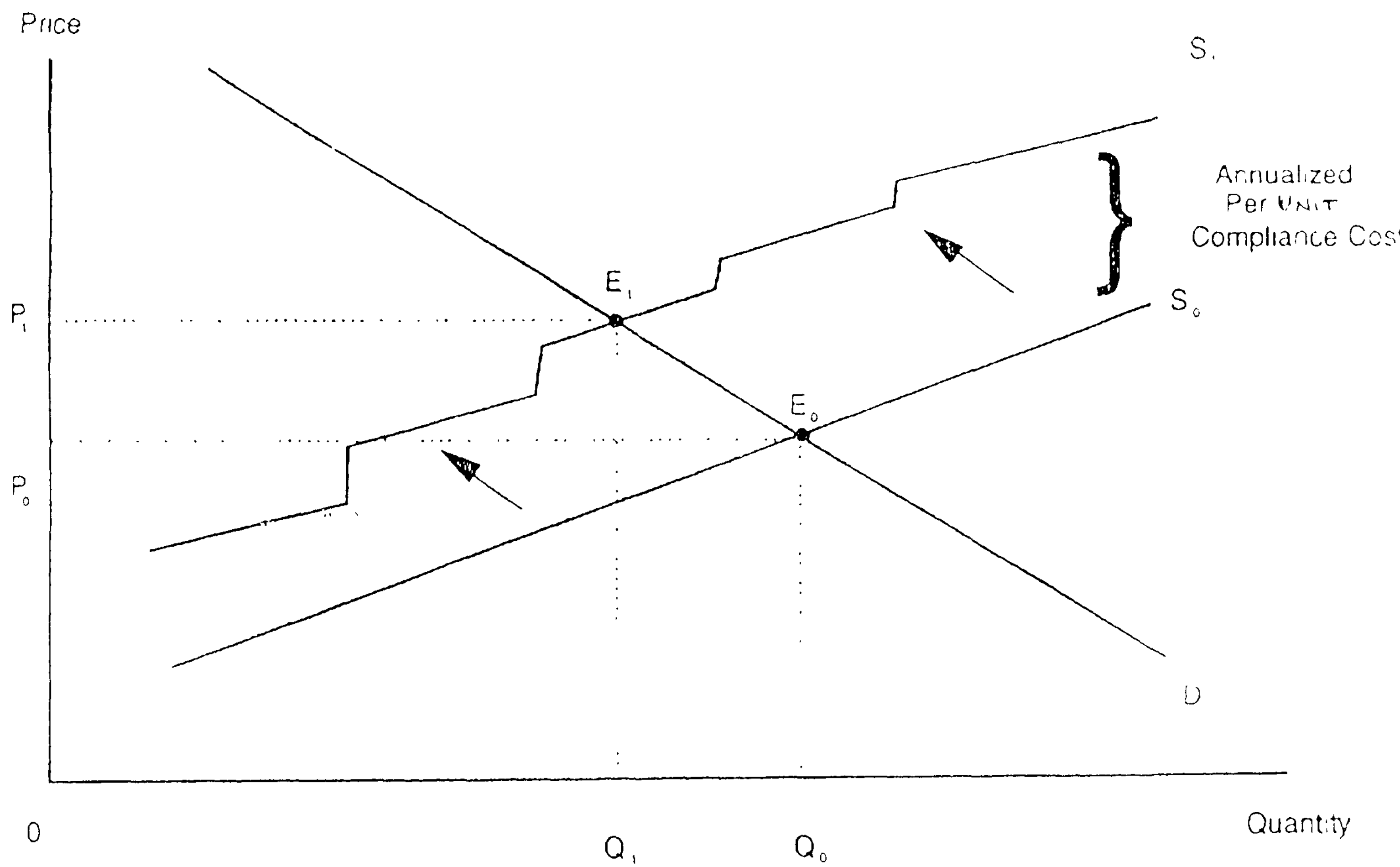
$C\,(C, q_i)$ = a function that shifts the supply function to reflect the incurrence of control costs,

C_i = the vertical shift that occurs in the supply curve for the ith facility to reflect the increased cost of production in the post-control market, and

q_i = the quantity produced by the ith facility producing each Group IV resin, respectively.

This shift in the supply curve is shown graphically in Figure 3-1.

FIGURE 3-1. ILLUSTRATION OF POST-NESHAP MODEL



3.2.4 *Impact of the Supply Shift on Market Price and Quantity*

The impact of the proposed control standards on market equilibrium price and output is derived by solving for the post-control market equilibrium and comparing the new equilibrium price and quantity to the baseline equilibrium conditions. Since post-control domestic supply is assumed to be segmented, or a step function, a special algorithm was developed to solve for the post control market equilibrium. The algorithm first searches for the segment in the post-control supply function at which equilibrium occurs, and then solves for the post-control market price that clears the market.

Since the market-clearing price occurs where the sum of domestic demand and foreign demand of domestic production equals post-control domestic supply plus foreign supply, the algorithm simultaneously solves for the following post-control variables:

- Equilibrium market price;
- Equilibrium market quantity;
- Change in the value of domestic production or revenues to producers;
- Quantity supplied by domestic producers;
- Quantity supplied by foreign producers (imports);
- Quantity demanded (domestic production) by foreign consumers (exports); and
- Quantity demanded by domestic consumers.

The changes in these equilibrium variables are estimated by comparing baseline equilibrium values to post-control equilibrium values.

3.2.5 *Trade Impacts*

Trade impacts are reported as the change in both the volume and the dollar value of exports, imports, and net exports (exports minus imports). The price elasticity of demand for each of the products has been assumed to be identical for foreign and domestic consumers, and the price elasticity of supply is presumed the same for foreign and domestic producers. As the volume of imports rises and the volume of exports falls, the volume of net exports will decline. Since each of the resins being analyzed has elastic demand, it is possible to predict the directional change anticipated in the dollar value of net exports. As a result of the emission controls, the quantity of exports will decline, while the price of each of the Group IV resins, respectively, will increase. Price increases for products with elastic demand result in revenue decreases for the producer. Consequently, the dollar value of exports is anticipated to decrease as a result of the emission controls. Since the price paid for imports and the quantity of imports increase, the dollar value of imports will increase. Since the dollar value of imports rise and the dollar value of exports fall, the resulting dollar value of net exports will decline in the post-control market.

The following algorithms are used to compute the trade impacts of the proposed regulatory alternative:

$$\Delta Q^{S_f} = Q_1^{S_f} - Q_0^{S_f}$$

$$\Delta VIM = (P_1 \bullet Q_1^{S_f}) - (P_0 \bullet Q_0^{S_f})$$

$$\Delta Q^{D_f} = Q_1^{D_f} - Q_0^{D_f}$$

$$\Delta VX = (P_1 * Q_1^{D_f}) - (P_0 * Q_0^{D_f})$$

$$\Delta NX = \Delta Q^{D_f} - \Delta Q^{S_f}$$

$$\Delta VNX = \Delta VX - \Delta VIM$$

where:

ΔQ^{Sf}	=	the change in the volume of imports,
ΔVIM	=	the change in the dollar value of imports,
ΔQ^{Df}	=	the change in the volume of exports,
ΔVX	=	the change in the dollar value of exports,
ΔNX	=	the volume change in net exports, and
ΔVNX	=	the change in the dollar value of net exports.

The subscripts 1 and 0 refer to the post- and pre-control equilibrium values, respectively, and all other variables have been previously identified.

3.2.6 Plant Closures

It is assumed that a Group IV facility will close if its post-control supply price exceeds the post-control market equilibrium price. Closures in this analysis relate to facilities. Since most of the affected firms produce diversified products, closure of a facility in the analysis may simply mean that the firm is likely to cease production of a particular Group IV resin, or to eliminate one line of production. The firm itself will not shut down; however, an individual facility may close or simply a line of production be discontinued.

3.2.7 Changes in Economic Welfare

Regulatory control requirements will result in changes in the market equilibrium price and quantity of Group IV resins produced and sold. These changes in the market equilibrium price and quantity will affect the welfare of consumers of products manufactured with Group IV resins, producers of these products, and society as a whole. The methods used to measure these changes in welfare are described below.

3.2.7.1 Changes in Consumer Surplus. Consumers will bear a loss in consumer surplus, or a dead-weight loss, associated with the reduction in the amount of Group IV resins sold due to higher prices charged for these resins. This loss in consumer surplus represents the amount consumers would have been willing to pay over the pre-control price for production eliminated. Additionally, consumers will have to pay a higher price for post-control output. This consumer surplus change for domestic consumers, ΔCS_d, is given by:

$$\Delta CS_d = \int_{Q_1^{D_d}}^{Q_0^{D_d}} (Q^{D_d}/\alpha)^{\frac{1}{\varepsilon}}\, dQ^{D_d} + P_1 Q_1^{D_d} - P_0 Q_0^{D_d}$$

The change in consumer surplus is an estimate of the losses of surplus incurred by domestic consumers only. Although both domestic and foreign consumers may suffer a loss in surplus as a result of emission controls, this study focuses on the change in domestic consumer surplus only. The variable, ΔCS_d, represents the change in domestic consumer surplus that results from the change in market equilibrium price and quantity occurring after the incurrence of regulatory control costs.

3.2.7.2 Change in Producer Surplus. The change in producer surplus is composed of two elements. The first element relates to output eliminated as the result of emission controls. The second element is associated with the change in price and cost of production for the new market equilibrium quantity. The total change in producer surplus is the sum of these two elements. After-tax measures of surplus changes are required to estimate the impact of air quality controls on producers' welfare. The after-tax surplus change is computed by multiplying the pre-tax surplus change by a factor of 1 minus the tax rate, or (1 - t), where t is the marginal tax rate. Every dollar of after-tax surplus loss represents a corresponding loss in tax revenues of an amount equal to $t/(1-t)$ dollars.

The lower output levels as a result of control costs cause producers to suffer a welfare loss in producer surplus. Affected Group IV facilities which continue producing after the incurrence of control costs realize a welfare gain on each unit of production produced attributable to the incremental increase in the market price. Producers will also experience a decrease in welfare per unit of production relating to the increased capital costs and operating cost of emission controls. The total change in producer surplus is specified by the following equation:

$$\Delta PS = [P_1\ Q_1^{S_d} - P_0 Q_0^{S_d} - \int_{Q_1^{S_d}}^{Q_0^{S_d}} (Q/\beta)^{\frac{1}{\gamma}}\ dQ - \sum_{i-1}^{M} C_i\ q_i] * (1-t)$$

Since domestic surplus changes are the object of interest, the welfare gain experienced by foreign producers due to higher prices is not considered. This procedure treats higher prices paid for imports as a dead-weight loss in consumer surplus. Higher prices paid to foreign producers represent simply a transfer of surplus from the United States to other countries from a world economy perspective, but a welfare loss from the perspective of the domestic economy.

3.2.7.3 Residual Effect on Society. The changes in economic surplus, as measured by the change in consumer surplus and producer surplus, must be adjusted to reflect the true change in social welfare resulting from the regulations. The additional adjustments relate to differences in tax effects, and to the difference between the private discount rate and the social discount rate.

Two adjustments are necessary to adjust the estimated changes in economic surplus for tax effects. The first relates to the per unit control cost, C_i that reflects after-tax control costs and is used to predict the post-control market equilibrium. The true cost of emission controls must be measured on a pre-tax basis.

A second tax-related adjustment is required because surplus changes reflect the after-tax welfare impacts of emission control costs on affected facilities. As noted previously, a one dollar loss in pre-tax surplus imposes an after-tax burden on the affected plant of an amount equal to (1 - t) dollars. Alternatively, a one dollar loss in after-tax producer surplus causes a complimentary loss of t/(1-t) dollars in tax revenue.

Economic surplus must also be adjusted because the private and social discount rates differ. The private discount rate is used to shift the supply curve of firms in the industry since this rate reflects the marginal cost of capital to affected firms. The economic costs of regulation must reflect the social cost of capital. The social discount rate reflects the social opportunity cost of resources displaced by investments in emission controls.

The total adjustment for the two tax effects and the social cost of capital is referred to as the residual change in economic surplus, or ΔRS. This adjustment is specified by the following equation:

$$\Delta RS = \sum_{i-1}^{M} (C_i - pc_i)q_i + \Delta PS \bullet [t/(1-t)]$$

where:

pc_i = the per unit cost of controls for each facility, assuming a tax rate of zero, and a discount rate of 7 percent.

All other variables have been previously defined.

3.2.7.4 Total Economic Costs. The total economic costs of the proposed regulations are the sum of the changes in consumer surplus, producer surplus, and the residual surplus. This relationship is defined in the following equations:

$$EC = \Delta CS_d + \Delta PS + \Delta RS$$

where:

EC = the economic cost of the proposed controls.

All other variables have been previously defined.

3.2.8 Labor Input and Energy Input Impacts

The estimates of the labor market and energy market impacts associated with the alternative standards are based on the baseline input-output ratios and the estimated changes in domestic production.

3.2.8.1 Labor Input Impacts. The labor market impacts are measured as the number of jobs lost due to domestic output reductions. The estimated number of job losses are a function of the change in level of production that is anticipated to occur as a result of the proposed emission controls. Employment information is not available on a resin-specific basis. For this reason, total production wages paid and hours worked are based upon the levels reported for SIC code 2821, Plastic Materials, Synthetic Resins, and Nonvulcanizable Elastomers. The ratio of production wages to total revenues for SIC code 2821 is calculated. This ratio is then multiplied by the decrease in value of domestic production to establish the wage decrease that is likely to occur as a result of the NESHAP. This decrease in production wages is divided by the average 1989 hourly wage and by 2,000 hours (average number of hours worked annually per employee) to estimate the transitional employee layoffs that are likely to result from the regulation. The loss in employment expressed in terms of number of workers is specified as follows:

$$\Delta L = [LC_0 * (P_0 * (Q_1^{S_d} - Q_0^{S_d})] / W_0 / 2000$$

where:

ΔL = the change in the employment level expressed in terms of number of workers,

LC_0 = the total production wages based on 1989 price levels and 1991 production levels, and

W_0 = the hourly wage for production workers in SIC code 2821 based on 1989 price levels.

The number 2,000 in the equation represents the number of hours worked annually by an average employee, the subscripts 0 and 1 represent pre-control and post-control values, respectively, and all other variables have been previously defined.

3.2.8.2 Energy Input Impacts. The reduction in energy inputs occurring as a result of the proposed NESHAP is calculated based on the expected reduction in expenditures for energy inputs attributable to post-NESHAP production decreases. The expected change in use of energy inputs is calculated as follows:

$$\Delta E = E_0 P_0 (Q_1^{S_d} - Q_0^{S_d})$$

where:

ΔE = the change in expenditures on energy inputs, *and*

E_0 = the baseline expenditure on energy input per dollar value of output reported for SIC code 2821.

All other variables are as previously defined.

3.2.9 Baseline Inputs

The partial equilibrium model used in this analysis requires, as data inputs, baseline values for variables and parameters that have been previously described to characterize each of the Group IV resin markets. These data inputs include the number of domestic facilities currently in operation, the annual capacity per facility, and the relevant control costs per facility. Table 3-1 lists the variable and parameter inputs to the model that vary for each Group IV industry. Some of the data inputs were unavailable for the individual products, or do not differ across Group IV resin industries. Table 3-2 lists variables and parameters that are assumed to be the same for each of the affected Group IV resin industries. Data regarding the market price, import ratio, export ratio, and price elasticity of demand for nitrile were unavailable. It has been assumed that the market

TABLE 3-1. PRODUCT-SPECIFIC BASELINE INPUTS

	Values by Group IV Resin Type					
Variable/Parameter	MBS	SAN	PET	ABS/MABS	Polystyrene	Nitrile
Price (P_0)[1]	$0.93	$0.39	$0.72	$0.44	$0.25	$0.44[3]
Domestic Output, (Q_0^S)[2]	50	82	2,987	576	2,189.8	15.9
Imports, (Q_0^{Sf})[2]	2.80	1.31	43.5	48	27.6	1.4[3]
Exports, (Q_0^{Df})[2]	3.78	18.60	190.8	91.6	163.1	2.4[3]
Demand Elasticity (ε)	-2.51	-1.61	-2.72	-1.83	-1.31	-1.83

NOTES: [1] Cents per kilogram, excluding taxes (1989$).
[2] Millions of kilograms per year (1991 production levels).
[3] The market price, import ratio, and export ratio are assumed to be the same as the ABS and MABS industries.

TABLE 3-2. BASELINE INPUTS FOR THE POLYMERS AND RESINS GROUP IV INDUSTRIES

Variable	Value
Supply Elasticity (γ)	4.77
Tax rate (t)	35%
Private Discount rate (r)	10%
Social Discount rate	7%
Equipment life (T)	10 years
Labor Cost Ratio (LC_0)[1]	7.13%
Energy Cost Ratio (E_0)[2]	3.10%
Wage (W)[3]	$28.47

NOTES: [1] Production wages per dollar value of shipments (1989$).
[2] Energy expenditures per dollar value of shipments (1989$).
[3] Per hour production wage for SIC code 2821 (1989$).

price, import ratio, export ratio, and price elasticity of demand for the ABS industry are representative use in the nitrile industry.

Tables 3-1 and 3-2 list the baseline parameters and variables used to characterize baseline market conditions. The baseline market prices and quantities for MBS, SAN, PET, ABS, and polystyrene were obtained from the U.S. Department of Commerce's International Trade Commission (ITC).[2] Imports and exports of MBS, SAN, and PET resins were obtained from the U.S. Department of Commerce's Bureau of the Census.[3] Trade data for ABS and polystyrene were obtained from Modern Plastics.[4] The prices are stated in cents per kilogram excluding taxes, and industry output is stated in millions of kilograms produced annually. The price elasticities of supply and demand were estimated econometrically and are discussed in Section *3.3, Industry Supply and Demand Elasticities*.

The marginal tax rate of 35 percent, private discount rate of 10 percent, and social discount rate of 7 percent are rates that have been assumed for the analysis as surrogates for the actual rates in the economy. The marginal tax rate of 35 percent reflects the 1993 marginal corporate tax rate for the highest income bracket. Since the affected firms are very large multi-product firms, this tax rate seems the most appropriate for this analysis. The 1993 Federal corporate tax rates vary from a high of 39 percent to a low of 34 percent for taxable income levels above $100,000 per year. No attempt has been made to incorporate State or local taxes into this estimate. The 7 percent social discount rate is consistent with the most current United States Office of Management and Budget (OMB) guidance.[5] The equipment life of 10 years was obtained from the engineering study of emission control costs conducted by an engineering contractor for EPA. This equipment life is applicable for most of the pollution control equipment considered in the analysis. The production wages per dollar value of shipments (LC), hours worked, wages, and the energy expenditure per value of shipments (E) were calculated from data obtained from the *Annual Survey of Manufactures* (ASM)[6], for calendar years 1989 and 1991. Data from the ASM which were used to derive these estimates include: the 1989 and 1991 annual values for production hours worked and production wages, 1989 and 1991 dollar value of domestic shipments, 1989 and 1991 price indices for value of domestic shipments, and the 1989 and 1991 total expenditures on energy. All of the data acquired from the ASM reflect those reported for SIC code 2821.

3.3 INDUSTRY SUPPLY AND DEMAND ELASTICITIES

3.3.1 Introduction

Demand and supply elasticities are crucial components of the partial equilibrium model used to quantify the economic impact of regulatory control cost measures on the affected Group IV industries. The price elasticities of demand and supply for each resin were unavailable from published sources. It was therefore determined that the price elasticity of demand and supply should be estimated econometrically for this analysis. The following sections present the analytical approach and the data employed to estimate the price elasticities of demand and supply used in the partial equilibrium analysis. The techniques utilized to estimate the price elasticity of demand and supply are consistent with economic theory and, at the same time, utilize the data available.

3.3.2 Price Elasticity of Demand

The price elasticity of demand, or own-price elasticity of demand, is a measure of the sensitivity of buyers of a product to a change in price of the product. The price elasticity of demand represents the percentage change in the quantity demanded resulting from each 1 percent change in the price of the product.

3.3.2.1 Approach. MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins are used as intermediate products to produce final goods. The demand for these products is therefore derived from the demand for these final products. Information concerning the end uses by resin type is provided in the *Industry Profile For the Polymer and Resins IV NESHAP Revised Report.*[7] According to the information contained in this profile report, MBS is used primarily as an input into PVC (polyvinyl chloride) production, which is then used as an input into production of building, construction, and packaging products. SAN is used primarily for consumer products including refrigerator shelves and dishwasher-safe housewares. PET's end uses are primarily as inputs for soft drink bottles, custom bottling, and magnetic film. ABS and nitrile resins are primarily used to product automotive parts and housewares. MABS' and polystyrene's primary end uses are as inputs to the manufacture of food and nonfood packaging. The methodology used to estimate the price elasticity of demand for each product will consider the relevant end use market for each resin.

The assumption was made that firms using MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins as inputs into their productive processes seek to maximize profits. The profit function for these firms may be written as follows:

$$\max_{Q,\ I} \pi = P_{FP} * f(Q,\ I) - (P * Q) - (P_{OI} * I)$$

where:

π = profit,

P_{FP} = the price of the final product or end-use product,

$f(Q, I)$ = the production function of the firm producing the final product,

P = the price of the Group IV resin,

Q = the quantity input use of the Group IV resin,

P_{OI} = a vector of prices of other inputs used to produce the final product, and

I = a vector of other inputs used to produce the final product.

All other variables have been previously defined.

The solution to the profit function maximization results in a system of derived demand equations for MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins. The derived demand equations are of the following form:

$$Q = g(P,\ P_{FP},\ P_{OI})$$

A multiplicative functional form of the derived demand equation is assumed because of the useful properties associated with this functional form. The functional form of the derived demand function is expressed in the following formula:

$$Q = AP^{\beta}P_{FP}^{\beta_{FP}}$$

where:

β = the price elasticity of demand for the Group IV resin, and

β_{FP} = the final product price elasticity with respect to the use of the Group IV resin.

All other variables have been previously defined. β, β_{FP}, and A are parameters to be estimated by the model. β represents the own price elasticity of demand. The price of other inputs (represented by P_{OI}) has been omitted from the estimated model, because data relevant to these inputs were unavailable. The implication of this omission is that the use of MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resin production is fixed by technology.

The market price and quantity sold of each Group IV resin are simultaneously determined by the demand and supply equations. For this reason, it is advantageous to apply a systems estimator to obtain unbiased and consistent estimates of the coefficients for the demand equations.[8] Two-stage least squares (2SLS) is the estimation procedure used in this analysis to estimate the demand equations for the Group IV resins. Two-stage least squares uses the information available from the specification of an equation system to obtain a unique estimate for each structural parameter. The predetermined, or exogenous, variables in the demand and supply equations are used as instruments. The supply-side variables used to estimate the demand functions include: the real capital stock variable for SIC code 2821 adjusted for capacity utilization (K), a technology time trend (t), and the weighted-average price index for the cost of labor and materials for SIC code 2821 ($P_{K,L}$).

3.3.2.2 Data. Data relevant to the econometric modeling of the price elasticity of demand for MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins, including the variable symbol, units of measure, and variable descriptions are listed in Table 3-3. Consistent time series price and quantity sold data for Group IV resins were not available in sufficient detail to estimate the price elasticity of demand for each product with this information. Time series price data were available for the ABS and polystyrene industries but were unavailable for the MBS, SAN, and PET industries. In lieu of this information, annual price and sales quantity data for Styrenic Plastics are considered as the price and quantity sold for MBS, SAN, and PET, respectively in the econometric estimation of the price elasticity of demand for each product. Since these Group IV resins are a subset of the Styrenic Plastics category of products, this price and sales information is relevant to the products being studied. A time series of domestic price and sales quantities were obtained from the ITC for Styrenic Plastics and ABS for 1970-1991 and for polystyrene from 1976-1991 to be used in the econometric estimation.[9] The final products produced with each Group IV resin differ, as previously discussed. A series of prices for these final products were sought. The price of construction and building, the

TABLE 3-3. DATA INPUTS FOR THE ESTIMATION OF DEMAND EQUATIONS FOR GROUP IV INDUSTRIES

Variable	Unit of Measure	Description
1. Time Trend - t	-	-
2. Price (Styrenic Plastics) - P[1]	price per kilogram	Annual Average Price
3. Sales Volume of Styrenic Plastics - Q[1]	millions of kilograms	Quantity sold of Styrenic Plastics
4. Price Final Goods - P_{FP}		
a. Building and Construction[2]	index	-
b. Refrigerators[3]	index	SIC code 3632
c. Soft Drink Manufacturing[3]	index	SIC code 3632
d. Plastic Products, NEC[3]	index	SIC code 2086
e. Plastic Pipe[3]	index	SIC code 3079
f. Motor Vehicle Parts and Accessories[3]	index	SIC code 3084
g. Plastic Foam Products[3]	index	SIC code 3714
h. Household Audio and Video Equip.[3]	index	SIC code 3086
i. Electric Housewares and Fans[3]	index	SIC code 3651
5. Cost of material inputs[3]	millions of dollars	SIC code 3634
6. Price index for material inputs[3]	index	SIC code 2821
7. Production Worker Wages[3]	millions of dollars	SIC code 2821
8. Production Worker Hours[3]	millions of hours	SIC code 2821
9. Real Capital Stock[3]	millions of 1987$	SIC code 2821
10. Capacity Utilization Factor[4]	percentage	SIC code 28
11. Implicit Price Deflator[5]	index	Base year is 1987

NOTES:
1. International Trade Commission.
2. 1993 Statistical Abstract.
3. Annual Survey of Manufactures.
4. Federal Reserve Board.
5. Business Statistics 1961-1991.

primary end-product uses for MBS, is relevant to the demand estimation for MBS. A time series of the price index for building and construction was acquired from the *1992 Statistical Abstract* for building and construction for the period 1970-1991.[10] Since SAN is primarily an input to the production of miscellaneous plastic products and refrigerator shelves, the following two alternative price indices were considered in the estimation of the price elasticity of demand for SAN: the price index for value of shipments for SIC code 3079, *Plastic Products, Not Elsewhere Classified*, and the price index for SIC code 3632, *Household Refrigerators and Home and Farm Freezers*. Time series price indices data were available from the ASM for these variables for the period 1970-1991.[11] The empirical results for the SAN demand model using SIC code 3079 were not successful and are neither used in the analysis nor reported. PET is used as a factor of production in soft drink bottling and magnetic film. A time series of the price index for value of domestic shipments for SIC code 2086, *Bottled and Canned Soft Drink and Carbonated Waters* was acquired from the ASM for the period 1970 through 1991.[11] In 1987, magnetic film production was separated into SIC code 3081, *Unsupported Plastic Sheet and Film*. However, insufficient time series data were available for this SIC code to be used in the model estimation. Prior to 1987, these products were classified as SIC code 3079 *Plastic Products, Not Elsewhere Classified*. The model estimation with price information for SIC code 3079 was unsuccessful, as previously discussed, and these results are neither used in the study nor reported. However, the model using the price index for value of domestic shipments for SIC code 2086 for the period 1970 through 1991 is utilized to estimate the price elasticity of demand for PET. Time series data were unavailable for the nitrile and MABS industries. For this reason the results of the analysis for the ABS industry is assumed to be applicable to these industries. The primary end product uses for ABS, MABS, and nitrile include consumer products, automotive components, miscellaneous plastic products, and pipes and fittings. Time series price data were obtained from the ASM for SIC code 3084, *Plastic Pipe*, SIC code 3714, *Motor Vehicle Parts and Accessories*, and SIC code 3079, *Plastic Products*, NEC. The models were estimated with each of these end-use products for 1970 through 1991. The model using prices of automotive parts (SIC code 3714) is used in the analysis. Other models estimated were unsuccessful. Finally, polystyrene is used primarily in miscellaneous packaging and electronics. Time series price data were obtained from the ASM for SIC code 3651, *Household Audio and Video Equipment,* SIC code 3634, *Electronic Housewares and Fans*, and SIC code 3079, *Miscellaneous Plastic Products*, NEC for 1976 through 1991. Econometric estimates were developed using each of the alternative end-use product price data. The model utilizing price data for SIC code 3634 is used in the analysis. Other models estimated were unsuccessful. All price data were deflated to reflect real values using the Implicit Gross Domestic Price Deflator obtained from *Business Statistics* for 1970 through 1991.[12] The real capital stock variable was adjusted to reflect varying annual capacity utilization using the annual capacity utilization rate for SIC code 28 obtained from the Federal Reserve Board for the years 1970 through 1991.[13]

3.3.3.2 Statistical Results. Two-stage least square econometric models were estimated for MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins, respectively, using the previously discussed data and techniques. The model results for the coefficients of the demand models for these seven Group IV resins are reported in Table 3-4.

TABLE 3-4. DERIVED DEMAND COEFFICIENTS

Product	Own Price β^1	End-Use $\beta_{FP}{}^1$
MBS	-2.51 (.803)	7.31 (2.222)
SAN	-1.61 (.607)	-.120 (.179)
PET	-2.72 (.793)	7.37 (2.131)
ABS/MABS/Nitrile	-1.83 (.277)	2.28 (.995)
Polystyrene	-1.31 (.473)	-.46 (.539)

NOTES: Standard errors are shown in parenthesis

Standard errors are shown in parenthesis. Each of the coefficients reported have the anticipated sign and are statistically significant with the exception of the end-use product coefficient for SAN and for polystyrene. These coefficient are not statistically significant and do not have the anticipated sign. Each of the models were adjusted to correct for first-order serial correlation using the Prais-Winsten algorithm.

The elasticity estimates for each of the Group IV resins reflect that the demand for each resin is elastic. Regulatory control costs are more likely to be paid by consumers of products with inelastic demand when compared to products with elastic demand, all other things held constant. Price increases for products with elastic price elasticity of demand lead to revenue decreases for producers of the product. Thus, one can predict that price increases resulting from implementation of regulatory control costs will lead to a decrease in revenues for firms in the affected Group IV industries.

A degree of uncertainty is associated with this method of demand estimation. The estimation is not robust since the model results vary depending upon the instruments used in the estimation process, and as a result of the correction methods for serial correlation. For these reasons, a sensitivity analysis of the price elasticity of demand estimates is presented using a range of elasticities that differ by a plus one and minus one standard deviation from those utilized in the analysis. A lower and upper bound estimate for MBS of -1.71 and -3.31, for SAN of -1.0 and -2.22, for PET of -1.93 and -3.51, for ABS/MABS/nitrile of -1.55 and -2.10, and for polystyrene of -.84 and -1.79 is assumed in this sensitivity analysis. The results of the sensitivity analysis are reported in Appendix A.

3.3.3 Price Elasticity of Supply

The price elasticity of supply, or own-price elasticity of supply, is a measure of the responsiveness of producers to changes in the price of a product. The price elasticity of supply indicates the percentage change in the quantity supplied of a product resulting from each 1 percent change in the price of the product.

3.3.3.1 Model Approach. Published sources of the price elasticity of supply using current data were not readily available. For this reason, an econometric analysis of the price elasticity of supply for the Polymers and Resins Group IV industries was conducted. The approach used to estimate the price elasticity of supply makes use of the production function. The theoretical methodology of deriving a supply elasticity from an estimated production function will be briefly discussed with the industry production function defined as follows:

$$Q^S = f\ (L,K,M,t)$$

where:

Q^S = the quantity of MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins produced by domestic Group IV facilities,

L = the labor input, or number of labor hours,

K = real capital stock,

M = the material inputs, and

t = a time variable to reflect technology changes.

In a competitive market, market forces constrain firms to produce at the cost minimizing output level. Cost minimization allows for the duality mapping of a firm's technology (summarized by the firm's production function) to the firm's economic behavior (summarized by the firm's cost function). The total cost function for a polymer and resin facility is as follows:

$$TC = h(C,K,t,Q^S)$$

where:

TC = the total cost of production, and

C = the cost of production (including cost of materials and labor).

All other variables have been previously defined.

This methodology assumes that capital stock is fixed, or a sunk cost of production. The assumption of a fixed capital stock may be viewed as a short-run modeling assumption. This assumption is consistent with the objective of modeling the adjustment of supply to price changes after implementation of controls. Firms will make economic decisions that consider those costs of production that are discretionary or avoidable. These avoidable costs include production costs, such as labor and materials, and emission control costs. In contrast, costs associated with existing capital are not avoidable or discretionary. Differentiating the total cost function with respect to $\boldsymbol{Q^S}$ derives the following marginal cost function:

$$MC = h'(C,K,t,Q^S)$$

where MC is the marginal cost of production and all other variables have been previously defined.

Profit maximizing competitive firms will choose to produce the quantity of output that equates market price, P, to the marginal cost of production. Setting the price equal to the preceding marginal cost function and solving for Q^S yields the following implied supply function:

$$Q^s = (P, P_L, P_M, K, t)$$

where:

P	=	the price of MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins,
P_L	=	the price of labor, and
P_M	=	the price of materials input.

All other variables have been previously defined.

An explicit functional form of the production function may be assumed to facilitate estimation of the model. For this analysis, the Cobb-Douglas, or multiplicative form, of the production function is postulated. The Cobb-Douglas production function has the convenient property of yielding constant elasticity measures. The functional form of the production function becomes:

$$Q_t = A\ K_t^{\alpha_K}\ t^{\lambda}\ L_t^{\alpha_L}\ M_t^{\alpha_M}$$

where:

Q_t	=	the sum of the industry output of MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins produced in year t,
K_t	=	the real capital stock in year t,
L_t	=	the quantity of labor hours used to produce Group IV resins in year t,
M_t	=	the material inputs in year t, and
A, α_K, α_L, α_M, λ	=	parameters to be estimated by the model.

This equation can be written in linear form by taking the natural logarithms of both sides of the equation. Linear regression techniques may then be applied. Using the approach described, the implied supply function may be derived as:

$$\ln = \beta_0 + \gamma \ln P + \beta_2 \ln K + \beta_3 \ln P_L + \beta_4 \ln P_M + \beta_5 \ln t$$

where:

P_L = the factor price of the labor input,

P_M = the factor price of the material input, and

K = fixed real capital.

The $\boldsymbol{\beta}_i$ and $\boldsymbol{\gamma}$ coefficients are functions of the $\boldsymbol{\alpha}_i$, the coefficients of the production function. The supply elasticity, $\boldsymbol{\gamma}$, is equal to the following:

$$\gamma = \frac{\alpha_L + \alpha_M}{1 - \alpha_L - \alpha_M}$$

It is necessary to place some restrictions on the estimated coefficients of the production function in order to have well-defined supply function coefficients. The sum of the coefficients for labor and materials should be less than one. Coefficient values for $\boldsymbol{\alpha}_L$ and $\boldsymbol{\alpha}_M$ that equal to one result in a price elasticity of supply that is undefined, and values greater than one result in negative supply elasticity measures. For these reasons, the production function is estimated with the restriction that the sum of the coefficients for the inputs equal one. This is analogous to assuming that the polymers and resins industry exhibits constant returns to scale, or is a long-run constant cost industry. This assumption seems reasonable on an *a priori* basis and is not inconsistent with the data.

3.3.3.3 Estimated Model. The estimated model reflects the production function for the MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resin industries, using annual time series data for the years from 1959 through 1991. The following model was estimated econometrically:

$$\ln Q_t = \ln A + \alpha_K \ln K + \lambda \ln t + \alpha_L \ln L + \alpha_M \ln M$$

where each of the variables and coefficients have been previously defined.

3.3.3.4 Data. The data used to estimate the model are enumerated in Table 3-5. This table contains a list of the variables included in the model, the units of measure, and a brief description of the data. The data for the price elasticity of supply estimation model includes: the value of domestic shipments in millions of dollars; the price index for value of domestic shipments (the value of domestic shipments deflated by the price index represent the quantity variable, Q_t or the dependent variable in the analysis); a technology time variable, t; real net capital stock adjusted for capacity utilization, K_t in millions of dollars; the number of production labor man-hours, L_t; the material inputs in millions of dollars, M_t; and the price index for value of materials. Data to estimate the production function on a resin-specific basis were unavailable; therefore, data for SIC code 2821 is utilized for each of the variables previously enumerated with the exception of the time variable and the capacity utilization factor, which is on a 2-digit SIC code level. The capital stock variable represents real net capital stock for SIC code 2821 adjusted for capacity utilization using the capacity utilization factor.

TABLE 3-5. DATA INPUTS FOR THE ESTIMATION OF THE PRODUCTION FUNCTION FOR GROUP IV INDUSTRIES

Variable	Unit of Measure	Description
Q_t	Millions of dollars	The value of shipments for SIC code 2821 deflated by the price index for value of shipments[1]
t	Years	technology time trend
K_t	Millions of 1987 dollars	Real capital stock for SIC code 2821 adjusted for capacity utilization[1,2]
L_t	Thousand of labor man hours	Production worker hours for SIC code 2821[1]
M_t	Millions of dollars	Dollar value of material input for SIC code 2821 deflated to real values using the materials price index[1]

NOTES: [1]Annual Survey of Manufactures.
[2]Federal Reserve Board.

The capital stock variable was the most difficult variable to quantify for use in the econometric model. Ideally, this variable should represent the economic value of the capital stock actually used by each facility to produce Group IV resins for each year of the study. The most reasonable data for this variable would be the number of machine hours actually used to produce Group IV resins each year. These data are unavailable. In lieu of machine hours data, the dollar value of net capital stock in constant 1987 prices, or real net capital stock, is used as a proxy for this variable. However, this data is flawed in two ways. First, the data represent accounting valuations of capital stock rather than economic valuations. This aberration is not easily remedied, but is generally considered unavoidable in most studies of this kind. The second flaw involves capital investment that is idle and not actually used in production in a particular year. This error may be corrected by adjusting the capital investment to exclude the portion of capital investment that is idle and does not contribute directly to production in a given year. In an effort to further refine the data, real capital stock was adjusted for capacity utilization. This refinement results in a data input that considers the percentage of real capital stock actually utilized in resin production each year.

3.3.3.5 Statistical Results. A restricted least squares estimator was used to estimate the coefficients of the production function model. A log-linear specification was estimated with the sum of the $\boldsymbol{\alpha}_i$ restricted to unity. This procedure is consistent with the assumption of constant returns to scale. The model was further adjusted to correct for first-order serial correlation using the Prais-Winsten algorithm. The results of the estimated model are presented in Table 3-6. All of the coefficients have the expected sign, but only the materials coefficient is significantly different from zero with a high degree of confidence.

TABLE 3-6. ESTIMATED SUPPLY MODEL COEFFICIENTS FOR GROUP IV INDUSTRIES

Variable	Estimated Coefficients[1]
t time	.0573 (.0497)
K_t Capital Stock	.1732 (.2382)
L_t Labor	.0252 (.1873)
M_t Materials	.8015 (.1230)

NOTES [1]Standard errors are shown in parenthesis.

Using the estimated coefficients in Table 3-6 and the formula for supply elasticity shown under Section 3.3.3.1, *Model Approach*, the price elasticity of supply for the MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins is derived to be 4.77. The calculation of statistical significance for this elasticity measure is not a straightforward calculation since the estimated function in non-linear. No attempt has been made to assess the statistical significance of the estimated elasticity. The corrections for serial correlation and the restricted model results yield the standard measures of goodness of fit (R^2) inaccurate. However the ordinary least squares estimated model that is unrestricted and unadjusted for serial correlation has an R^2 of 0.98.

3.3.3.6 Limitations of the Supply Elasticity Estimates. The estimated price elasticity of supply for the affected Group IV industries reflects that the resin manufacturing industry in the United States will increase production of these products by 4.77 percent for every 1.0 percent increase in the price of these products. The preceding methodology does not directly estimate the supply elasticities for the individual products due to a lack of necessary data. The assumption implicit in the use of this supply elasticity estimate is that the elasticities of the individual products will not differ significantly from the price elasticity of supply for all products classified under SIC code 2821. This assumption does not seem totally unreasonable since similar factor inputs are used to produce each of these resins.

The uncertainty of the supply estimate is acknowledged. The results of a sensitivity analysis of the price elasticity supply is included in Appendix A for a high and low estimate of the price elasticity of supply of 5.77 and 3.77, respectively.

3.4 CAPITAL AVAILABILITY ANALYSIS

It is necessary to estimate the impact of the proposed emission controls on the affected firms' financial performance and their ability to finance the additional capital investment in emission control equipment. The capital availability analysis has been conducted on a firm level, given that sufficient financial data were available on a firm level to do so.

One measure of financial performance frequently used to assess the profitability of a firm is net income before interest expense expressed as a percentage of firm assets, or rate of return on investment. The pre-control rate of return on investment (*roi*) is calculated as follows:

$$roi = \left[\sum_{i=1987}^{1991} \left(\frac{n_i}{a_i} \right) \right] / 5 \bullet 100$$

where n_t is income before interest payments and a_t is total assets. A five year average is used to avoid annual fluctuations that may occur in income data. The proposed regulations could potentially have an effect on income before taxes, n_t, for firms in the industry and on the level of assets for firms in the industry, a_t. The baseline average rate of return on investment for firms in the sample range from 1 percent for Elf Atochem to 13 percent for 3M Corporation. The post-control return on investment (*proi*) is calculated for each firm as follows:

$$proi = \left[\frac{\left(\sum_{i=1987}^{1991} n_i \right) / 5 + \Delta n}{\left(\sum_{i=1987}^{1991} a_i \right) / 5 + \Delta k} \right] \bullet 100$$

where:

proi = post-control return on investment,

Δn = change in income after taxes and before interest resulting from implementation of emission controls for each firm in the sample, and

Δk = change in investment or assets for each firm in the sample.

The change in a firm's net income, Δn_1, is calculated using the results of the partial equilibrium model. A firm's post-control net income has the following three components: (1) the change in revenue attributable to the change in price, (2) the change in cost attributable to the firm's incurrence of compliance costs, and (3) applicable taxes. The net effect of these three components determines the impact of the proposed NESHAP on firms' net income levels. The change in net income, or Δ n, for each firm is calculated as follows:

$$\Delta n_n = \{(\Delta P \bullet q_n) - (\Delta c_n \bullet q_n)\} \bullet (1-t)$$

where:

ΔP = the change in market price, or P_1 - P_o,

q_n = the level of output for firm n, and

Δc_n = total annualized per unit cost of compliance (including taxes) for firm n.

t = tax rate of 35 percent

An adjustment needs to be made for the marginal firm that will experience post-control changes in production. For each marginal MBS, SAN, PET, ABS, MABs, polystyrene, and nitrile resin firm, the change in net income is calculated as follows:

$$\Delta n = \{(\Delta P \bullet q_1 - P_o \bullet \Delta q) - (\Delta c_n \bullet q_1)\} \bullet (1-t)$$

where:

q_1 = firm's post control production, or q_o - $(Q_1^{Sd} - Q_0^{Sd})$,

P_o = baseline market price, and

Δq = decrease in domestic production, or $Q_1^{Sd} - Q_0^{Sd}$.

Some PET firms operate facilities that are predicted to cease producing PET based on the model results. If the firm ceases to produce PET, then the change in net income is computed as follows:

$$\Delta \pi = (-P_o \bullet q_o) \bullet (1 - t)$$

where:

q_o = post control production

P_o = the baseline market price

t = the corporate tax rate

The PET firms with facilities that are predicted to close will also experience decreases in avoidable costs. Such costs are not quantifiable and have been omitted from the analysis. This omission tends to overstate the adverse impacts on these marginal firms.

The ability of affected firms to finance the capital equipment associated with emission control is also relevant to the analysis. Numerous financial ratios can be examined to analyze the ability of a firm to finance capital expenditures. One alternative is a measure of historical profitability, such as rate of return on investment. The approach used to analyze this measure has been previously described. The bond rating of a firm is another indication of the credit worthiness of a firm, or the ability of a firm to finance capital expenditures with debt capital. Such data are unavailable for many of the firms subject to the regulation, and consequently, bond ratings are not analyzed. Ability to pay interest payments and coverage ratios are two other criteria sometimes used to assess the capability of a firm to finance capital expenditures. The data available to conduct the capital availability analysis based on these two criteria were also unavailable.

Finally, the degree of debt leverage or debt-equity ratio of a firm is considered in assessing the ability of a firm to finance capital expenditures. The pre-control debt-equity ratio is the following:

$$d/e = \frac{d_{1991}}{d_{1991} + e_{1991}}$$

where:

d/e = the debt equity ratio,

d = debt capital, and

e = equity capital.

Since capital information is less volatile than earnings information, it is appropriate to use the latest available information for this calculation. The baseline debt equity ratio for firms in the sample range from 11 percent for 3M Corporation to 93 percent for Fina (American Petrofina). If one assumes that the capital costs of control equipment are financed solely by debt, the debt-equity ratio becomes:

$$pd/e = \frac{d_{1990} + \Delta k}{d_{1990} + e_{1990} + \Delta k}$$

where:

pd/e = the post-control debt-equity ratio assuming that the control equipment costs are financed solely with debt.

Obviously, firms may choose to issue capital stock to finance the capital expenditure or to finance the investment through internally generated funds. Assuming that the capital costs are financed solely by debt may be viewed as a worse case scenario.

The methods used to analyze the capital availability do have some limitations. The approach matches 1991 debt and equity values with estimated capital expenditures for control equipment. Average 1987 through 1991 income and asset measures are matched with changes in income and capital expenditures associated with the control measures. The control cost changes and income changes reflect 1989 price levels. The financial data used in the analysis represents the most recent data available. It is inappropriate to simply index the income, asset, debt, and equity values to 1992 price levels for the following reasons. Assets, debt, and equity represent embedded values that are not subject to price level changes except for new additions such as capital expenditures. Income is volatile and varies from period to period. For this reason, average income measures are used in the study. Annualized compliance costs are overstated from a financial income perspective since these costs include a component for earnings, or return on investment, which tends to overstate the financial impacts of emission controls for firms in these industries. To the extent that the partial equilibrium model results are a worst-case scenario approach, the approach followed for financial impacts also overstates the negative impact of the proposed emission controls on the financial operations of the affected Group IV firms.

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4.0 CONTROL COSTS, ENVIRONMENTAL IMPACTS, AND COST-EFFECTIVENESS

4.1 INTRODUCTION

Inputs to the model outlined in the previous chapter include the quantitative data summarized in Chapter 2.0 and control cost estimates provided by EPA. This chapter summarizes the cost inputs used in this EIA that were provided on a facility level for each of the seven affected industries.

A formal Benefit Cost Analysis (BCA) requires estimates of economic costs associated with regulation, which do not correspond to emission control costs. This chapter presents the progression of steps which were taken to arrive at estimates of economic costs based on the emission control cost estimates. The environmental impacts associated with the chosen regulatory option in this analysis are summarized and the cost-effectiveness of the regulatory option is presented.

4.2 CONTROL COST ESTIMATES

Control cost estimates and emission reductions were provided by EPA's engineering contractor on a facility level for each affected emission point.[1,2] The cost estimates provided by EPA represent the impact of bringing each facility from existing control levels to the control level defined by each regulatory alternative. The emission points for which costs were provided include storage tanks, equipment leaks, wastewater streams, continuous stream process vents, and batch stream process vents. The control costs estimated for each resin facility can be divided into fixed and variable components. Fixed costs are constant over all levels of output of a process, and usually entail plant and equipment. Variable costs will vary as the rate of output changes. Annual and variable cost estimates include costs for monitoring, recordkeeping, and reporting (MRR) requirements. The costs were calculated for new and existing emission sources. New source costs represent the control of new process units and equipment built (or reconstructed or replaced) in the first five years after promulgation based on available industry growth rates.[3]

Table 4-1 presents the national annualized cost estimates for controlling existing sources and newly constructed emission points in the fifth year after promulgation of the Polymers and Resins Group IV NESHAP. Emission control costs are the annualized capital and annual operating and maintenance costs of controls based on the assumption that all affected resin facilities install controls. Costs are provided by emission point for the MACT floor level of control. The total national annualized cost for implementation of the regulatory alternative is approximately $12.2 million (including MRR costs) for existing sources and a savings of nearly $3.8 million for sources built in the first five years after promulgation of the regulation. There is no new construction projected for the MABS or nitrile industries. Table 4-1 also presents the HAP emission reductions associated with control at the four emission points and the calculated cost-effectiveness of each control method. The HAP emission reductions were calculated based on the application of sufficient controls to each emission point to bring the point into compliance with the regulatory alternative. The cost-effectiveness of the predicted HAP emission reduction ranges from a savings of $384.3 to a cost of $28,647.8 per megagram, and an average of $413.9 per megagram for the proposed NESHAP.

Table 4-2 presents the total investment capital costs by emission point associated with the regulatory alternative for each of the seven industries. Total capital investment costs are estimated to be $111 million for new and existing sources for the seven affected industries five years subsequent to promulgation of the regulation.

For use as inputs to the economic model, annualized costs were summed on a facility level for each of the 75 affected facilities. The control costs associated with each of the industries and emission points are discussed separately below. SAN costs were provided for continuous and batch stream process vents, and an AMSAN/ASA facility that produces SAN for captive use in the production of ABS. PET costs were provided by TPA continuous streams, TPA batch streams, DMT continuous streams, and DMT batch

TABLE 4-1. SUMMARY OF GROUP IV NESHAP COSTS IN THE FIFTH YEAR BY RESIN INDUSTRY AND EMISSION POINT[1]

Group IV Industry by Emission Point	Annual Fifth Year Costs (1989 Dollars per Year)			Annual HAP Emission Reduction (Mg/yr)	Cost-Effectiveness ($/Mg)
	Existing Sources	New Construction	Total		
A. MBS[2]					
Equipment Leaks	$47,285	$47,048	$94,333	211.5	$446.0
Miscellaneous Process Vents	$180,602	$236,280	$416,882	24.3	$17,155.6
Wastewater Systems	$143,239	$143,239	$286,478	10.0	$28,647.8
Storage Tanks	$0	$0	$0	0.0	$0.0
Total MBS	$371,126	$426,567	$797,693	245.8	$3,245.3
B. SAN[2]					
Equipment Leaks	$137,108	$220	$137,328	143.3	$958.3
Miscellaneous Process Vents	$0	$0	$0	0.0	$0.0
Wastewater Systems	$281,018	$113,171	$394,189	49.0	$8,044.7
Storage Tanks	$0	$0	$0	0.0	$0.0
Total SAN	$418,126	$113,391	$531,517	192.3	$2,764.0
C. PET[3]					
Equipment Leaks	$2,935,942	$2,318,967	$5,254,909	4,071.61	$1,290.6
Miscellaneous Process Vents	$313,381	$758,276	$1,071,657	684.44	$1565.7
Wastewater Systems	$5,749,586	($9,653,905)	($3,904,319)	12,621.23	($309.3)
Storage Tanks	$64,678	$157,724	$222,402	113.33	$1,962.42
Total PET	$9,063,587	($6,418,938)	$2,644,649	17,490.61	$151.2
D. ABS[2]					
Equipment Leaks	$168,089	$69,607	$237,695	404.0	$588.4
Miscellaneous Process Vents	$1,712,377	$1,779,934	$3,492,311	330.3	$10,573.5
Wastewater Systems	$0	$0	$0	0.0	$0.0
Storage Tanks	$0	$59,059	$59,059	4.2	$13,995.1
Total ABS	$1,880,465	$1,908,600	$3,789,065	738.5	$5,130.7

TABLE 4-1 (continued)

Group IV Industry by Emission Point	Annual Fifth Year Costs (1989 Dollars per Year)			Annual HAP Emission Reduction (Mg/yr)	Cost-Effectiveness ($/Mg)
	Existing Sources	New Construction	Total		
E. MABS[2]					
Equipment Leaks	$4,797	$0	$4,797	2 5	$1,918.8
Miscellaneous Process Vents	($79)	$0	($79)	38.0	($2.1)
Wastewater Systems	$0	$0	$0	0.0	$0.0
Storage Tanks	$0	$0	$0	0.0	$0.0
Total MABS	$4,718	$0	$4,718	40.5	$116.6
F. Polystyrene[2]					
Equipment Leaks	$579,031	$91,188	$670,218	1,303 4	$514.2
Miscellaneous Process Vents	($74,900)	($1,494)	($76,394)	198.8	($384.3)
Wastewater Systems	$0	$0	$0	0.0	$0 0
Storage Tanks	$0	$0	$0	0.0	$0 0
Total Polystyrene	$504,131	$89,694	$593,825	1,502.2	$395.3
G. Nitrile[2]					
Equipment Leaks	$6,164	$0	$6,164	6.8	$906.5
Miscellaneous Process Vents	$767	$0	$767	3.4	$223.7
Wastewater Systems	$0	$0	$0	0 0	$0 0
Storage Tanks	$0	$0	$0	0.0	$0.0
Total Nitrile	$6,931	$0	$6,931	10.2	$677.5
TOTAL FOR REGULATORY ALTERNATIVE	$12,249,084	($3,880,686)	$8,368,398	20,220.11	$413.9

NOTE. [1]Costs reflect absolute regulatory costs rather than incremental costs.
[2]Assumes regulatory Alternative 1 is chosen.
[3]Assumes regulatory Alternative 2 is chosen.

TABLE 4-2. SUMMARY OF TOTAL GROUP IV NESHAP CAPITAL COSTS BY RESIN INDUSTRY AND EMISSION POINT[1]

	Total Capital Costs (1989 Dollars)		
Group IV Industry and Emission Point	Existing Sources	New Construction	Total
A. MBS			
Equipment Leaks	$174,426	$157,174	$331,600
Miscellaneous Process Vents	$93,204	$106,394	$199,598
Wastewater Systems	$279,051	$279,051	$558,102
Storage Tanks	$0	$0	$0
Total MBS	$546,681	$542,619	$1,089,300
B. SAN			
Equipment Leaks	$504,790	$0	$504,790
Miscellaneous Process Vents	$0	$0	$0
Wastewater Systems	$579,252	$259,217	$838,469
Storage Tanks	$0	$0	$0
Total SAN	$1,084,042	$259,217	$1,343,259
C. PET			
Equipment Leaks	$6,076,491	$4,876,206	$10,952,697
Miscellaneous Process Vents	$273,155	$442,362	$715,517
Wastewater Systems	$86,827,321	$0	$86,827,321
Storage Tanks	$266,078	$508,750	$774,828
Total PET	$93,443,045	$5,827,318	$99,270,363
D. ABS			
Equipment Leaks	$201,546	$98,161	$299,707
Miscellaneous Process Vents	$4,004,211	$3,419,086	$7,423,297
Wastewater Systems	$0	$0	$0
Storage Tanks	$0	$172,276	$172,276
Total ABS	$4,205,757	$3,689,523	$7,895,280
E. MABS			
Equipment Leaks	$0	$0	$0
Miscellaneous Process Vents	$89,673	$0	$89,673
Wastewater Systems	$0	$0	$0
Storage Tanks	$0	$0	$0

TABLE 4-2 (continued)

Group IV Industry and Emission Point	Total Capital Costs (1989 Dollars) Existing Sources	New Construction	Total
Total MABS	$89,673	$0	$89,673
F. Polystyrene			
Equipment Leaks	$933,194	$199,010	$1,132,204
Miscellaneous Process Vents	$243,527	$2,045	$245,572
Wastewater Systems	$0	$0	$0
Storage Tanks	$0	$0	$0
Total Polystyrene	$1,176,721	$201,055	$1,377,776
G. Nitrile			
Equipment Leaks	$0	$0	$0
Miscellaneous Process Vents	$8,770	$0	$8,770
Wastewater Systems	$0	$0	$0
Storage Tanks	$0	$0	$0
Total Nitrile	$8,770	$0	$8,770
TOTAL FOR REGULATORY ALTERNATIVE	$100,554,689	$10,519,732	$111,074,421

NOTE. [1]Costs reflect absolute regulatory costs rather than incremental costs.

streams. The costs for controlling ABS and polystyrene facilities were provided for continuous and batch stream process vents. PET facilities are the only facilities for which additional control on storage tanks is required by the proposed regulation.

The methodologies used to estimate the costs for the expected regulatory alternative are the same as the methodologies used to estimate the costs of the HON rule.[4] For storage tanks, required control measures range from floating roofs to closed vent systems routed to a control device. Costs are zero for each MBS and SAN facility since all tanks are currently meeting the HON requirements.[5] For PET processes, costs for storage tank provisions are identical for each process at a given facility. It was assumed that the storage tanks are shared among the four types of processes. In determining a facility's total cost, therefore, storage tank impacts were counted only once to avoid overstating a facility's compliance cost impacts.[5] For equipment leaks, facilities have several compliance options. Facilities are required to develop and implement leak detection and repair programs or to install certain types of emission-reducing, or emission-eliminating, equipment. Costs for equipment leak provisions were based on the calculation used in the HON. For process vents, costs were provided for continuous streams and for batch streams. For batch processes that vent less than 500 hours per year, the regulatory alternative is based on EPA's draft CTG for Batch Processes.[6] This approach determines whether control is required based on vent stream characteristics. For wastewater, the NESHAP provisions require that wastewater be kept in tanks, impoundments, containers, drain systems, and other vessels that do not allow exposure to the atmosphere until it is recycled or treated to reduce HAP concentration. Costs for wastewater provisions were developed using HON methodologies.

4.3 ESTIMATES OF ECONOMIC COSTS

Air quality regulations affect society's economic well-being by causing a reallocation of productive resources within the economy. Resources are allocated away from the production of goods and services (MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins) to the production of cleaner air. Estimates of the economic costs of cleaner air require an assessment of costs to be incurred by society as a result of emission control measures. By definition, the economic costs of pollution control are the opportunity costs incurred by society for productive resources reallocated in the economy to pollution abatement. The economic costs of the regulation can be measured as the value that society places on goods and services not produced as a result of resources being diverted to the production of improved air quality. The conceptually correct valuation of these costs requires the identification of society's willingness to be compensated for the foregone consumption opportunities resulting from the regulation. In contrast to the economic cost of regulation, emission compliance costs consider only the direct cost of emission controls to the industry affected by the regulation. Economic costs are a more accurate measure of the costs of the regulation to society than an engineering estimate of compliance costs. However, compliance cost estimates provide an essential element in the economic analysis.

Economic costs are incurred by consumers, producers, and society at large as a result of pollution control regulations. These costs are measured as changes in consumer surplus, producer surplus, and residual surplus to society. Consumer surplus is a measure of well-being or of the welfare of consumers of a good and is defined as the difference between the total benefits of consuming a good and the market price paid for the good. Pollution control measures will result in a loss in consumer surplus due to higher prices paid for Group IV resins and to the deadweight loss in surplus caused by reduced output of these seven resins in the post-control market.

Producer surplus is a measure of producers' welfare that reflects the difference between the market price charged for a product and the marginal cost of production. Pollution controls will result in a change in producer surplus that consists of three components. These components include: surplus gains relating to increased revenues experienced by firms in the Group IV industries attributable to higher post-control prices, surplus losses associated with increased costs of production for annualized emission control costs, and surplus losses due to reductions in post-control output. The net change in producer surplus is the sum of these surplus gains and losses.

Additional adjustments or changes in the residual surplus to society are necessary to reflect the economic costs to society of pollution controls, and these adjustments are referred to as the change in residual surplus to society. Specifically, adjustments are necessary to consider tax gains or losses associated with the regulation and to adjust for differences between the social discount rate and the private discount rate. Since control measures involve the purchase of long-lived assets, it is necessary to annualize the cost of emission controls. Annualization of costs require the use of a discount rate or the cost of capital. The private cost of capital (assumed to be 10 percent) is the relevant discount rate to use in estimating annualized compliance costs and market changes resulting from the regulation. Firms in the MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile industries will make supply decisions in the post-control market based upon increases in the costs of production. The private cost of capital more accurately reflects the capital cost to firms associated with the pollution controls. Alternatively, the social costs of capital (assumed to be 7 percent) is the relevant discount rate to consider in estimating the economic costs of the regulation.[7] The economic cost of the regulation represents the cost of the regulation to society, or the opportunity costs of resources displaced by emission controls. A risk-free discount rate, or the social discount rate, better reflects the capital cost of the regulation to society.

The sum of the change in consumer surplus, producer surplus and residual surplus to society constitutes the economic costs of the regulation. Table 4-3 summarizes the economic costs associated with the regulatory alternative. The economic cost for the seven affected industries combined is $9.8 million for existing sources (1989$). The economic costs for new and existing sources five years subsequent to promulgation of the regulation may be estimated by adding engineering control costs for new sources to the economic costs of existing sources. Economic costs of the regulation in five years are estimated to be 5.9 million annually for existing and new sources (1989$).

4.4 ESTIMATED ENVIRONMENTAL IMPACTS

Table 4-4 reports estimates of annual emission reductions associated with the chosen alternative. The HAP emission reductions were calculated based on the application of sufficient controls to each emission point to bring each point into compliance with the regulatory alternative. The estimate of total HAP emission reductions is 20,220.11 Mg per year.

TABLE 4-3. ANNUAL ECONOMIC COST ESTIMATES FOR THE POLYMERS AND RESINS GROUP IV REGULATION BASED ON EXISTING SOURCE COSTS[1,2]
(1989 Dollars)

Group IV Industry	Change in Consumer Surplus	Change in Producer Surplus	Change in Residual Surplus	Total Loss In Surplus
MBS	($437,482)	$43,232	$23,279	($370,971)
SAN	($681,344)	$286,402	$206,606	($188,336)
PET	($17,543,692)	$10,084,464	$0	($7,459,228)
ABS/MABS	($1,796,680)	$94,334	$232,852	($1,469,494)
Polystyrene	($1,732,072)	$884,124	$515,993	($331,955)
Nitrile	($4,726)	($1,429)	($319)	($6,474)
TOTAL	($22,195,996)	$11,391,127	$978,411	($9,826,458)

NOTE: [1]Brackets indicate economic costs.

TABLE 4-4. ESTIMATED ANNUAL REDUCTIONS IN EMISSIONS AND COST-EFFECTIVENESS ASSOCIATED WITH THE CHOSEN REGULATORY ALTERNATIVE

Group IV Industry	HAP Emission Reduction (Megagrams/Yr)	HAP Cost Effectiveness* ($/Year)
MBS	245.8	$3,245
SAN	192.3	$1,569
PET	17,490.61	$59
ABS/MABS	779	$4,336
Polystyrene	1,502.2	$281
Nitrile	10.2	$634
TOTAL	20,220.11	$294

NOTES. *Cost-effectiveness is computed as estimated annualized economic costs for new and existing sources divided by estimated emissions reduced. Comparisons are made between the regulatory alternative and baseline conditions.

4.5 COST EFFECTIVENESS

Economic cost effectiveness is computed by dividing the annualized economic costs by the estimated emission reductions. The proposed NESHAP has a calculated total cost effectiveness of $294 per megagram of HAP reduced for new and existing sources.

Generally, a dominant alternative results in the same or higher emission reduction at a lower cost than all other alternatives. Because this analysis evaluated only one alternative, however, there is no basis for comparison.

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5.0 PRIMARY ECONOMIC IMPACTS AND CAPITAL AVAILABILITY ANALYSIS

5.1 INTRODUCTION

Estimates of the primary economic impacts resulting from implementation of the NESHAP and the results of the capital availability analysis are presented in this chapter. Primary impacts include changes in the market equilibrium price and output levels, changes in the value of shipments or revenues to domestic producers, and plant closures. The capital availability analysis assesses the ability of affected firms to raise capital and the impacts of control costs on firm profitability.

5.2 ESTIMATES OF PRIMARY IMPACTS

The partial equilibrium model is used to analyze the market outcome of the proposed regulation. As outlined in Chapter 3 of this report, the purchase of emission control equipment will result in an upward vertical shift in the domestic supply curve for each of the seven affected Group IV markets. The height of the shift is determined by the after-tax cash flow required to offset the per unit increase in production costs. Since the control costs vary for each of the affected facilities, the post-control supply curve is segmented, or a step function. Since the underlying production costs for each facility are unknown, a worst case assumption was necessary. The facilities with the highest control costs per unit of production were assumed to also have the highest pre-control per unit cost of production. Thus, firms with the highest per unit cost of emission control are assumed to be marginal in the post-control market.

Foreign demand and supply are assumed to have the same price elasticities as domestic demand and supply, respectively. The United States had a positive trade balance for MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resins in 1991. Net exports are therefore positive for each Group IV resin in the baseline market models.

Foreign and domestic post-control supply are added together to form the total post-control market supply. The intersection of this post-control supply with market demand will determine the new market equilibrium price and quantity in each Group IV industry.

Table 5-1 presents the primary impacts predicted by the partial equilibrium model. The anticipated per kilogram price increases are $0.009, $0.01, $0.006, $0.008, $0.0008, and $0.0003 for MBS, SAN, PET, ABS/MABS, polystyrene, and nitrile resins, respectively. The percentage increases for each Group IV resin range from a high of 2.8 percent for SAN to a low of 0.07 percent for nitrile. Production is expected to decrease by 1.4 million kilograms, 3.8 million kilograms, 72.2 million kilograms, 23.7 million kilograms, 10.23 million kilograms, and 0.03 million kilograms for the MBS, SAN, PET, ABS/MABS, polystyrene, and nitrile industries, respectively. These results represent an overall decrease in domestic production ranging from 0.17 percent to 4.6 percent.

The value of domestic shipments, or revenues, for domestic producers is expected to decrease for each affected Group IV industry. The predicted decreases in annual revenues for individual products are $0.86 million for MBS, $0.62 million for SAN, and $33.8 million for PET, $6.17 million for ABS/MABS, $720 thousand for polystyrene, and $7 thousand nitrile resins annually (1989 dollars). The percentage decreases range from a low of 0.10 percent for nitrile to a high of 2.43 percent for ABS/MABS. Economic theory predicts that revenue decreases are expected to occur when prices are increased for products which have an elastic price elasticity of demand, holding all other factors constant. This revenue decrease results because the percentage increase in price is less than the percentage decrease in quantity for goods with elastic demand. The estimated revenue decreases in each of the Group IV industries follows this theory.

It is anticipated that there will not be any MBS, SAN, ABS/MABS, polystyrene, or nitrile facility closures as a result of the proposed NESHAP. However, the model predicts that approximately five PET facilities may cease to produce PET or close. These facilities may close for operation or, if the firm is a multi-product firm, may cease to produce PET. As stated earlier in this chapter, those facilities with the highest per unit control costs are assumed to be marginal in the post-control market. The analysis of the PET industry

TABLE 5-1. SUMMARY OF PRIMARY ECONOMIC IMPACTS OF POLYMERS AND RESINS GROUP IV NESHAP

	Estimated Impacts[4]			
Group IV Industry	Price Increases[1]	Production Decreases[2]	Value of Domestic Shipments[3]	Facility Closures
MBS				
Amount	$0.009	(1.4)	($0.86)	None
Percentage	1.0%	(2.8%)	(1.9%)	
SAN				
Amount	$0.010	(3.8)	($0.62)	None
Percentage	2.8%	(4.6%)	(1.9%)	
PET				
Amount	$0.006	(72.2)	($33.80)	Five
Percentage	0.87%	(2.42%)	(1.57%)	
ABS/MABS				
Amount	$0.008	(23.7)	($6.17)	None
Percentage	1.76%	(4.12%)	(2.43%)	
Polystyrene				
Amount	$0.0008	(10.23)	($0.72)	None
Percentage	0.34%	(0.47%)	(0.13%)	
Nitrile				
Amount	$0.0003	(0.03)	($0.007)	None
Percentage	0.07%	(0.17%)	(0.10%)	

NOTES. [1]Prices are shown in price per kilogram (1989 dollars).
[2]Annual production quantities are shown in millions of kilograms.
[3]Values of domestic shipments are shown in millions of 1989 dollars.
[4]Brackets indicate decreases or negative values.

indicates that the marginal firms are small producers of PET. As a result, small industry decreases in production will cause these firms to cease to produce PET. Firms that have post-control supply prices that exceed the market equilibrium price are assumed to close or cease to produce PET resins. This assumption is consistent with the theory of perfect competition which presumes that all firms in the industry are price takers. In reality, firms with the highest per unit control costs may not have the highest underlying cost of production as postulated in the analysis. This is a worst-case assumption that is likely to bias the results and as a result, overstate the number of plant closures and other adverse effects of the proposed emission controls.

Of further note is the uncertainty associated with the estimates of facility-level production quantities for PET facilities. PET melt-phase production has been eliminated from the overall production of the industry based on the fact that PET melt-phase resin is an intermediate product used as an input into other PET production. If some firms produce PET melt-phase as a commodity to be sold to other PET producers, the individual facility production may be understated while industry totals are correct. Additionally, actual production data on a facility level were unavailable. The individual facility production levels used in this analysis are based upon facility-level capacity in 1991 and total 1991 industry production. The individual facility production was calculated by multiplying each facility's production capacity by the ratio of total industry production to total industry capacity for 1991. To the extent that actual facility capacity utilization differs from that of the whole industry, the estimated impacts for individual facilities may be either understated or overstated. An alternative model estimating market impacts based on industry average price increases was considered to offer additional information regarding the likely primary impacts of proposed regulations for PET producers. The results of this model are reported in Appendix B.

In addition, industry-specific data were not available for the MABS industry. For this reason, the MABS and ABS industries are analyzed as one industry. The MABS production and control costs represent only a fraction of the industry totals for MABS and ABS. Since MABS and ABS have a high degree of similarity, it is reasonable to model these industries jointly.

The estimated primary impacts reported for the Group IV industries depend upon the set of parameters used in the partial equilibrium model. Two of the parameters, the price elasticity of demand and the price elasticity of supply, have some degree of estimation uncertainty. For this reason, a sensitivity analysis was conducted. The results of these analyses are presented in Appendix A. Sensitivity analyses were performed for low- and high-end estimates of demand and supply elasticities, respectively. In general, the sensitivity analysis shows that the estimated primary impacts are relatively insensitive to reasonable changes of price elasticity of demand and price elasticity of supply estimates.

5.3 CAPITAL AVAILABILITY ANALYSIS

The capital availability analysis involves examining pre- and post-control values of selected financial ratios. The ratios selected for use in this analysis are the rate of return on investment and the debt-equity ratio. These financial statistics provide insight into the ability of affected firms to raise the necessary capital to finance the investment in emission control equipment. Data were available to estimate these ratios for 18 of the 28 affected firms. This analysis does not include the following firms: American Polymers, BASF, BF Goodrich, Dart Container Corporation, Hoechst-Celanese, Huntsman Chemical, Kama, Kaneka, Novacor Chemical, and YKK.

For the remaining firms, net income was averaged for the five-year period from 1987 through 1991 to avoid annual fluctuations that may occur in income due to changes in the business cycle. Debt and equity capital are not subject to annual fluctuations, and, as a result, the most recent data available (1990 or 1991) was used in this analysis. Tables 5-2 and 5-3 show the estimated impact on financial ratios for firms in these industries. The total capital investment in control equipment was applied to current debt-equity ratios for 16 affected firms. Table 5-2 shows the baseline and post-control debt-equity ratios for each of the firms included in this analysis. The effects of investment in control equipment on these firms' equity ratios are minimal, and average ratios presented a range of effects from no change to 0.39 percent. Due to the confidentiality of firm-specific control cost estimates, PET producer financial ratios are presented in the table as an aggregate average. The percent changes in the debt-to-equity ratio for individual PET firms range from a low of no percentage change to a high of an increase of 1.5 percent in the ratio for one firm producing PET.

TABLE 5-2. POST-NESHAP EFFECTS ON FIRMS' DEBT-EQUITY RATIOS

Firm	Long-Term Debt-Equity Ratios (%)			
	Baseline	Post-NESHAP	Difference in Ratios	Percentage Change (%)
Amoco	28.2%	28.2%	0.00	0.00%
ARCO	39.8%	39.8%	0.00	0.00%
BP Chemicals	43.4%	43.4%	0.00	0.00%
Chevron	28.2%	28.2%	0.00	0.00%
Dow Chemical	66.8%	66.8%	0.00	0.00%
Fina	93.1%	93.1%	0.00	0.00%
General Electric	58.7%	58.7%	0.01	0.02%
Monsanto	36.3%	36.3%	0.01	0.03%
Rohm & Haas	35.1%	35.1%	0.02	0.05%
Scott	54.1%	54.1%	0.00	0.00%
Average PET PRODUCERS[1]	33.2%	33.4%	0.2	0.39%

NOTE: [1] Includes 3M Corporation, Allied Signal, Inc., ICI, Kodak, Shell, and Wellman.

TABLE 5-3. POST-NESHAP EFFECTS ON FIRMS' RETURN ON INVESTMENT LEVELS

Firm	Net Income to Assets Ratio (%)			
	Baseline	After Tax Post-NESHAP	Difference in Ratios	Percentage Change (%)
Amoco	5.48%	5.48%	0.00	0.00%
ARCO	11.19%	11.19%	0.00	0.03%
BP Chemicals	3.99%	3.99%	0.00	0.00%
Chevron	3.92%	3.92%	0.00	0.00%
Dow Chemical	8.74%	8.74%	0.00	0.00%
Elf Atochem	1.01%	0.98%	(0.02)	(1.84%)
Fina	4.05%	4.05%	0.00	(0.02%)
General Electric	3.06%	3.06%	0.00	(0.10%)
Monsanto	6.69%	6.69%	(0.01)	(0.11%)
Rohm & Haas	9.84%	9.84%	0.00	0.02%
Scott	3.78%	3.78%	0.00	0.01%
Average PET PRODUCERS[1]	7.25%	7.21%	(0.04)	(0.55%)

NOTE: [1] Includes, 3M Corporation, Allied Signal, DuPont, ICI, Kodak, Shell, and Wellman.

The effect of the proposed NESHAP on rates of return on investment was analyzed for 18 affected firms. The results of this analysis are shown in Table 5-3. As described in Section 3.4, the effect of the proposed regulation on net income includes the net effect of new market prices on revenue and the incurrence of control costs. For marginal firms, the effect on net income also incorporates the loss in revenue due to post-NESHAP decreases in production. The effect of the proposed regulation on firms' asset levels is equal to the capital investment necessary for the purchase of control equipment. The proposed NESHAP is not expected to have a significant effect on the return on investment for any of the firms in the sample. The effect of the proposed NESHAP on the rate of return on investment for these firms range from no change to a decrease of 1.84 percent. The financial ratios for the PET industry are presented as an aggregate due to confidentiality of firm-specific data. The individual PET firm financial impact ranges from an increase of 0.61 percent to a decrease of 1.26 percent. Both the debt-equity ratios and rates of return on investment remain virtually unchanged as a result of the proposed emission controls.

5.4 LIMITATIONS

Several qualifications of the primary impact results presented in this chapter are required. A single national market for a homogenous product is assumed in the partial equilibrium analysis. There may, however, be some regional trade barriers that would protect individual Group IV resin producers. The analysis also assumes that the facilities with the highest control costs are marginal in the post-control market. Facilities that are marginal in the post-control market for PET have per unit control costs that significantly exceed the average. This may either be the result of the engineering method used to assign costs to individual facilities, or may be due to the uncertainty surrounding the estimates of PET facility-level production. The result of the foregoing list of qualifications is overstatement of the impacts of the chosen alternative on the market equilibrium price and quantity, revenues, and plant closures. Finally, some facilities may find it profitable to expand production in the post-control market. This would occur when a firm found its post-control incremental unit costs to be smaller than the post-control market price. Expansion by these firms would result in a smaller decrease in output and increase in price than would otherwise occur.

The results of the sensitivity analysis of demand and supply elasticities are reported in Appendix A. These results show slightly less adverse impacts on producers when demand is less elastic, or when supply is less elastic, in terms of reduction in market output and reduction in value of domestic shipments. The results of the economic analysis are therefore relatively insensitive to reasonable variations in the price elasticity of demand or the price elasticity of supply inputs.

The capital availability analysis also has limitations. First, future baseline performance may not resemble past levels. Additionally, the tools used in the analysis are limited in scope.

5.5 SUMMARY

The estimated impacts of the proposed emission controls are relatively small. Predicted price increases in Group IV resins range from a low of 0.07 percent for nitrile to a high of 2.8 percent for the SAN industry. Production decreases range from a low of 0.17 percent for the nitrile industry to a high of 4.6 percent for the SAN industry. The value of domestic shipments, or revenues to domestic producers, for the MBS, SAN, PET, ABS/MABS, polystyrene, and nitrile resins are anticipated to decrease $0.86, $0.62, $33.8, $6.17, $0.72, and $0.007 million annually (1989$). Emission control costs are small relative to the financial resources of affected producers, and on average, Group IV resin producers should not find it difficult to raise the capital necessary to finance the purchase and installation of emission controls.

6.0 SECONDARY ECONOMIC IMPACTS

6.1 INTRODUCTION

In addition to impacts on price, production, and revenue, implementation of emission controls is likely to have secondary impacts including changes in labor inputs, changes in energy inputs, balance of trade impacts, and regional effects. The potential changes in employment, use of energy inputs, balance of trade, and regional impact distribution are presented individually below.

6.2 LABOR MARKET IMPACTS

The estimated labor impacts associated with the proposed NESHAP are based on the results of the partial equilibrium analyses of the Group IV resin industries, and are reported in Table 6-1. The number of workers employed by firms in SIC code 2821 is estimated to decrease by approximately 85 workers as a result of the proposed emission controls. These job losses include 2 workers for MBS and SAN, respectively, 65 workers in the PET industry, 13 in the ABS/MABS industries, 3 in the polystyrene industry, and less than one in the nitrile industry. These job losses are considered transitional in nature. The estimated loss in number of workers results primarily from projected reductions in levels of production reported in Chapter 5 for each of the seven Group IV resins. Gains in employment anticipated to result from operation and maintenance of control equipment have not been included in the analysis due to the lack of reliable data. Estimates of employment losses do not consider potential employment gains in industries that produce substitute resins. Similarly, losses in employment in industries that use Group IV resins as inputs or in industries that provide complement goods are not considered. The changes in employment reflected in this analysis are only direct employment losses due to reductions in domestic production of the Group IV resins.

TABLE 6-1. SUMMARY OF SECONDARY IMPACTS OF POLYMERS AND RESINS GROUP IV NESHAP

Group IV Industry	Estimated Impacts[1] Labor Input[2]	Energy Input[3]	Foreign Trade[4]
MBS			
Amount	(2)	($0.04)	(0.22)
Percentage	(2.8%)	(2.85%)	(22.7%)
SAN			
Amount	(2)	($0.05)	(0.98)
Percentage	(4.6%)	(2.5%)	(5.7%)
PET			
Amount	(65)	($1.61)	(6.3)
Percentage	(2.4%)	(1.1%)	(4.4%)
ABS/MABS			
Amount	(13)	($0.32)	(7.0)
Percentage	(4.1%)	(1.93%)	(19.2%)
Polystyrene			
Amount	(3)	($0.079)	(1.17)
Percentage	(0.47%)	(0.21%)	(0.87%)
Nitrile			
Amount	(0.015)	($0.0004)	(0.008)
Percentage	(0.17%)	(0.18%)	(0.84%)

NOTES: [1]Brackets indicate decreases or negative values.
[2]Indicates estimated reduction in number of jobs.
[3]Reduction in energy use in millions of 1989 dollars.
[4]Reduction in net exports (exports less imports) in millions of kilograms.

The loss in employment is relatively small in terms of number of jobs lost. The magnitude of predicted job losses directly results from the relatively small estimated decrease in production and the relatively low labor intensity in the polymers and resins industry.

6.3 ENERGY INPUT MARKET

The method used to estimate reductions in energy input use relates the baseline energy expenditures to the level of production. An estimated decrease in annual energy use of $0.04, $.005, $1.61, $0.32, $0.079, and $0.0004 (1989$) annually for the MBS, SAN, PET, ABS/MABS, polystyrene, and nitrile resin industries, respectively is expected as a result of the emission controls. The estimated impacts on energy use by Group IV industries are reported in Table 6-1. As production decreases, the amount of energy input utilized by each affected industry also declines. The estimated changes in energy use do not consider the increased energy use associated with operating and maintaining emission control equipment. Insufficient data were available to consider such changes in energy costs.

6.4 FOREIGN TRADE

The implementation of the proposed NESHAP will increase the costs of production for domestic Group IV resin producers relative to foreign producers, all other factors being equal. This change in the relative price of imports will cause domestic imports of Group IV resins to increase and domestic exports of Group IV resins to decrease. The overall balance of trade for Group IV resins is currently positive (exports exceed imports). The proposed NESHAP is likely to cause the balance of trade to become less positive. The estimated impacts on net exports for the seven Group IV industries range from 0.008 million kilograms annually for the nitrile industry to 7.0 million kilograms for ABS/MABS industries. The predicted changes in the trade balance for each Group IV industry are reported in Table 6-2.

TABLE 6-2. FOREIGN TRADE (NET EXPORTS) IMPACTS

	Estimated Impacts[1]		
Group IV Industry	Amount[2]	Percentage	Dollar Value of Net Export Change[3]
MBS	(0.22)	(20.42%)	($0.20)
SAN	(0.98)	(5.7%)	($0.21)
PET	(6.3)	(4.4%)	($3.63)
ABS/MABS	(7.0)	(19.2%)	($2.81)
Polystyrene	(1.17)	(0.87%)	($0.18)
Nitrile	(0.008)	(0.84%)	($0.003)

NOTES [1] Brackets indicate reductions or negative values.
[2] Millions of kilograms
[3] Millions of dollars ($1989)

6.5 REGIONAL IMPACTS

No significant regional impacts are expected to result from implementation of the proposed NESHAP. The estimated impacts of the regulation do not adversely impact one region of the country relative to another.

6.6 LIMITATIONS

The estimates of the secondary impacts associated with the emission controls are based on changes predicted by the partial equilibrium model for each of the seven industries. The limitations described in Section 5.4 of the previous chapter are also applicable to the secondary economic impacts reported in this chapter. As previously noted, the employment losses do not consider potential employment gains for operating the emission control equipment. Likewise, the gains or losses in markets indirectly affected by the regulations, such as substitute product markets, complement products markets, or in markets that use Group IV resins as inputs to production, have not been considered. It is important to note that the potential job losses predicted by the model are only those which are attributable to the estimates of production losses in the MBS, SAN, PET, ABS, MABS, polystyrene, and nitrile resin industries.

6.7 SUMMARY

The estimated secondary economic impacts are relatively small. Approximately 85 job losses may occur nationwide. Energy input reductions are estimated to be approximately $2.1 million annually (1989$). A decrease in net exports of 15.7 million kilograms annually of Group IV resin products is predicted. No significant regional impacts are expected.

7.0 POTENTIAL SMALL BUSINESS IMPACTS

7.1 INTRODUCTION

The Regulatory Flexibility Act requires that special consideration be given to the effects of all proposed regulations on small business entities. The Act requires that a determination be made as to whether the subject regulation will have a significant impact on a substantial number of small entities. Four main criteria are frequently used for assessing whether the impacts are significant. EPA frequently uses one or more of the following criteria to determine the potential for a regulation to have a significant impact on small firms:

- Annual compliance costs (annualized capital, operating, reporting, etc.) expressed as a percentage of cost of production for small entities for the relevant process or product increase significantly;
- Compliance costs as a percentage of sales for small entities are significantly higher than compliance costs as a percent of sales for large entities;
- Capital costs of compliance represent a significant portion of capital available to small entities, considering internal cash flow plus external financing capabilities; and
- The requirements of the regulation are likely to result in closure of small entities.

7.2 METHODOLOGY

Data are not readily available to compare compliance costs to either production costs or to the capital available to small firms. The information necessary to make such comparisons are generally considered proprietary by small business firms. In order to determine if the potential for small business impacts is significant for the proposed Group IV NESHAP, this analysis will focus on the remaining two criteria: the potential for closure, and a comparison of compliance costs as a percentage of sales. EPA's most recent guidance on implementing the Regulatory Flexibility Act provides that *any* number of small entities is considered to be substantial. The potential for closure, and cost-to-sales ratios, are analyzed for this analysis based on available data. EPA, however, is responsible for determining whether the results presented in this chapter indicate that further analysis of the impact on small business affected by the Group IV NESHAP is warranted.

7.3 SMALL BUSINESS CATEGORIZATION

Consistent with SBA size standards, a resin producing firm is classified as a small business if it has less than 750 employees. A firm must also be unaffiliated with a larger business entity to be considered a small business entity. Information necessary to determine whether any affected Group IV firms were small businesses was obtained from national directories of corporations. Based upon the SBA size criterion, only two firms, American Polymers and Kaneka Texas Corporation, employ less than 750 workers.

7.4 SMALL BUSINESS IMPACTS

Kaneka Texas is an MBS producer, and since the results of the partial equilibrium analysis lead to the conclusion that no MBS facilities are at risk of closure, this criterion for adverse small business effects is not met. American Polymers is a producer of polystyrene pellets. The results of the analysis estimate that no facilities are at risk of closure.

Information was available to calculate compliance costs to be incurred by American Polymers and Kaneka Texas as a percentage of sales. In 1992, Kaneka's sales were $71 million. Total compliance cost estimates for this firm based on 1991 production is $824, or 0.001 percent of total sales. In 1992, American Polymers had sales of $50 million. The cost of controlling American Polymer's polystyrene facility based on 1991 production is $1,495, or 0.003 percent of total sales. Because these two percentages are minimal, the conclusion is drawn that a significant number of small businesses are not adversely affected by the proposed NESHAP.

APPENDIX A
SENSITIVITY ANALYSIS

The sensitivity analysis contained in this Appendix explores the degree to which the results presented earlier in this report are sensitive to the estimates of the price elasticities of demand and supply which were used as inputs to the model. The analysis of the price elasticity of demand will presume that the supply elasticity is 4.77 as hypothesized in the partial equilibrium model. Alternatively, the sensitivity analysis of the price elasticity of supply will assume that the demand elasticity estimates postulated in the model and listed under the *Elasticity Measure* column in Table A-1 remain unchanged for each of the Group IV resins.

The results presented in this report are based upon price elasticities of demand estimates for MBS, SAN, PET, ABS/MABS, polystyrene, and nitrile resins that differ by one standard error from those used in the model. Table A-1 presents the alternative measures of price elasticities of demand for each Group IV resin.

The results of the sensitivity analysis relative to demand elasticity estimates are presented in Tables A-2 and A-3. Table A-2 reports results under the low-end estimate of the price elasticity of demand scenario, and Table A-3 reports results under the high-end measure of the price elasticity of demand scenario.

TABLE A-1. PRICE ELASTICITY OF DEMAND ESTIMATES

Group IV Industry	Elasticity Measure	High Estimate	Low Estimate
MBS	-2.51	-3.31	-1.71
SAN	-1.61	-2.22	-1.0
PET	-2.72	-3.51	-1.93
ABS/MABS	-1.83	-2.10	-1.55
Polystyrene	-1.31	-1.79	-0.84
Nitrile	-1.83	-2.10	-1.55

TABLE A-2. SENSITIVITY ANALYSIS FOR ESTIMATED PRIMARY IMPACTS: LOW-END PRICE ELASTICITY OF DEMAND SCENARIO[1]

Group IV Industry	Market Price Change (%)	Market Output Change (%)	Change in the Value of Shipments (%)
MBS	1.1%	(2.2%)	(1.2%)
SAN	3.0%	(3.3%)	(0.3%)
PET	1.0%	(1.94%)	(1.0%)
ABS/MABS	1.8%	(3.8%)	(2.0%)
Polystyrene	0.4%	(0.3%)	(0.03%)
Nitrile	0.07%	(0.16%)	(0.08%)

NOTES: [1] Brackets indicate decreases or negative values

TABLE A-3. SENSITIVITY ANALYSIS FOR ESTIMATED PRIMARY IMPACTS: HIGH-END PRICE ELASTICITY OF DEMAND SCENARIO[1]

Group IV Industry	Market Price Change (%)	Market Quantity Change (%)	Change in the Value of Shipments (%)
MBS	0.9%	(3.2%)	(2.4%)
SAN	2.5%	(5.7%)	(3.3%)
PET	0.8%	(2.8%)	(2.0%)
ABS/MABS	1.7%	(4.4%)	(2.8%)
Polystyrene	0.3%	(0.6%)	(0.3%)
Nitrile	0.07%	(0.19%)	(0.12%)

NOTES: [1] Brackets indicate decreases or negative values.

The results of the low-end demand elasticity scenario differ very little from the reported model results presented in Chapter 5. The signs of the changes in price, quantity, and value of shipments are unchanged, and the relative size of the changes are not significantly different. The results of this analysis tend to present relatively more favorable results for the affected industries. The scenario for the high-end elasticity also does not differ significantly from the previously reported results for price increases and production decreases.

The results of the sensitivity analyses under high- and low-end price elasticities of supply scenarios are reported in Table A-4 and Table A-5, respectively. The high-end estimate used in this analysis was 5.77, and the low-end estimate of the price elasticity of supply used in this analysis was 3.77. Again, the results do not differ greatly from those used in the partial equilibrium model. The results under the low-end supply elasticity scenario are slightly more favorable to the Group IV industries than those previously reported in Chapter 5.

TABLE A-4. SENSITIVITY ANALYSIS FOR ESTIMATED PRIMARY IMPACTS: HIGH-END PRICE ELASTICITY OF SUPPLY SCENARIO

Group IV Industry	Market Price Change (%)	Market Quantity Change (%)	Change in the Value of Shipments (%)
MBS	1.0%	(3.0%)	(2.0%)
SAN	2.9%	(4.8%)	(2.1%)
PET	0.9%	(2.4%)	(1.6%)
ABS/MABS	1.8%	(4.5%)	(2.7%)
Polystyrene	0.4%	(0.5%)	(0.1%)
Nitrile	0.08%	(0.2%)	(0.1%)

NOTES: [1] Brackets indicate decreases or negative values.

TABLE A-5. SENSITIVITY ANALYSIS FOR ESTIMATED PRIMARY IMPACTS: LOW-END PRICE ELASTICITY OF SUPPLY SCENARIO

Group IV Industry	Market Price Change (%)	Market Quantity Change (%)	Change in the Value of Shipments (%)
MBS	0.9%	(2.5%)	(1.6%)
SAN	2.6%	(4.3%)	(1.8%)
PET	0.8%	(2.2%)	(1.4%)
ABS/MABS	1.6%	(3.7%)	(2.1%)
Polystyrene	0.3%	(0.4%)	(0.1%)
Nitrile	0.07%	(0.2%)	(0.1%)

NOTES. ' Brackets indicate decreases or negative values

In summary, the results of these sensitivity analyses do not indicate that the model results are sensitive to reasonable changes in the price elasticities of demand or supply. This conclusion provides support for greater confidence in the reported model results.

APPENDIX B
ALTERNATIVE PET MODEL

Appendix B reports the primary and secondary market impacts of the proposed regulatory alternative for the PET industry assuming that all facilities face identical average per unit emission control costs. The results of this alternative model are presented to address the issue of uncertainty concerning the individual PET facility production levels. In general, the primary and secondary market impacts are significantly lowered when the assumption is made that each facility faces the same industry average per unit emission control costs. The primary market impacts and the secondary market impacts of this alternative average cost PET model are presented in Tables B-1 and B-2, respectively. No facility closures are predicted when identical average control costs are assumed. Impacts on price, output, and domestic value of shipment (or revenue) decreases for the PET industry are less than 1 percent. Employment losses decline to 20 for this industry while energy use reductions and trade effects are minor. Based upon the results of this analysis, it is reasonable to conclude that the regulatory impacts are minor when the assumption is made that all producers face identical average per unit emission control costs.

TABLE B-1. PRIMARY IMPACTS FOR THE PET INDUSTRY ASSUMING INDUSTRY AVERAGE PER UNIT CONTROL COSTS

Primary Impact Type	Amount or Percentage Change[4]
Price[1]	
Amount	$.0019
Percentage	0.26%
Quantity - domestic sales[2]	
Amount	(21.9)
Percentage	(0.73%)
Value of Domestic Sales[3]	
Amount	($10.22)
Percentage	(0.48%)
Facility Closures	None

Notes. [1] Prices are shown in dollars per kilogram (1989$).
[2] Quantities are shown in millions of kilograms.
[3] Value of domestic shipments are shown in millions of 1989 dollars.
[4] Negative amounts are shown in brackets.

TABLE B-2. SECONDARY IMPACTS FOR THE PET INDUSTRY ASSUMING INDUSTRY AVERAGE PER UNIT CONTROL COSTS

Secondary Impact Type	Amount or Percentage Change[5]
Labor market job losses[1]	
Amount	20 job losses
Percentage	(0.73%)
Energy expenditure decreases[2]	
Amount	($0.49)
Percentage	(0.33%)
Foreign Trade Impacts:	
Change in net exports quantity[3]	(1.89)
Change in the dollar value of net exports[4]	($1.09)

Notes: [1] Number of job losses are rounded to the nearest whole number.
[2] Energy expenditure decreases are shown in millions of 1989 dollars
[3] Change in net export quantity is shown in millions of kilograms.
[4] Change in the dollar value of net exports is shown in millions of 1989 dollars.
[5] Negative values are shown in brackets.

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16. ABSTRACT

An economic analysis of the industries affected by the Polymers and Resins IV National Emissions Standard for Hazardous Air Pollutants (NESHAP) was completed in support of this proposed standard. The industries for which economic impacts were computed were the epoxy resins and wet strength resins industries.

The faciities in these industries must control various HAP emissions by the levels of control required in the standard. Several types of economic impacts, among them product price changes, output changes, job impacts, and effects on foreign trade, were computed for the selected regulatory alternatives.

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