ECONOMIC IMPACT ANALYSIS FOR THE POLYMERS AND RESINS GROUP I NESHAP

REVISED DRAFT REPORT

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ACRONYMS AND ABBREVIATIONS

ASM	*Annual Survey of Manufactures*
BCA	Benefit Cost Analysis
BR	polybutadiene rubber
CAA	Clean Air Act
DOC	U.S. Department of Commerce
EIA	economic impact analysis
EPA	U.S. Environmental Protection Agency
EPI	epichlorohydrin elastomers
EPD	ethylene-propylene copolymers
EPDM	ethylene-propylene rubber
EPI	epichlorohydrin elastomers
GDP	gross domestic product
HAPs	hazardous air pollutants
HNBR	hydrogenated butyl rubber
HON	Hazardous Organic NESHAP
IISRP	International Institute of Synthetic Rubber Producers
ITC	International Trade Commission
MACT	maximum achievable control technology
MRR	monitoring, recordkeeping, and reporting
NBL	nitrile-butadiene latex
NBR	nitrile-butadiene rubber
NESHAP	national emission standard for hazardous air pollutants
RFA	Regulatory Flexibility Act
SBA	U.S. Small Business Administration
SBL	styrene-butadiene latex
SBR	styrene-butadiene rubber
SIC	Standard Industrial Classification
TPEs	thermoplastic elastomers
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 final Polymers and Resins Group I National Emission Standard for Hazardous Air Pollutants (NESHAP) on the behavior of the regulated synthetic rubber (elastomer) 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 35 affected facilities. This analysis compares the quantitative economic impacts of regulation to baseline industry conditions which would occur in the absence of regulation. The economic impacts of regulation are estimated for each of the affected industries, using costs which were supplied on a facility level.

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 I source category, based on different control options for the emission points within elastomer facilities which emit HAPs. This economic analysis analyzes the potential impacts of regulation on the following eleven affected synthetic rubber industries:

- butyl rubber;
- ethylene - propylene rubber (EPDM);
- epichlorohydrin rubber (EPI);
- halobutyl rubber;
- Hypalon:
- nitrile-butadiene latex (NBL);
- nitrile-butadiene rubber (NBR);
- Neoprene;

- styrene butadiene latex (SBL);
- styrene butadiene rubber (SBR); and
- polybutadiene rubber (BR).

Throughout this report, the term, Group I industries, refers collectively to all of the industries listed above. 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 the markets for each of the Group I elastomers. The probability of synthetic rubber 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 potential 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 I NESHAP operate facilities that produce butyl rubber, EPDM, EPI, halobutyl rubber, Hypalon, NBL, NBR, Neoprene, SBL, SBR, or BR. The production of these synthetic rubbers is categorized under Standard Industrial Classification (SIC) code 2822. Synthetic rubbers are formed through the vulcanization process, which converts a rubber hydrocarbon from a soft thermoplastic into a strong thermoset with specific elasticity and yield properties.

The principle use of the synthetic rubbers in Group I is as an input to tire production, which accounts for 60 percent of the use of domestically produced synthetic rubbers. Butyl rubber, SBR, and BR are synthetic rubbers whose primary use is for tire manufacture. These three elastomers are characterized by resistance to cracking and abrasion, and stability over time. The remaining eight elastomers are used as inputs to the production of many diverse types of products, including components for machinery and equipment, wire covering, construction products, and consumer items. Group I elastomers are frequently in competition with each other for end uses. EPDM is a low cost elastomer with a wide range of applications, among which automotive and appliance uses have been particularly significant. NBR is the preferred elastomer for gasoline hoses, gaskets, and printing rolls. Neoprene differs from BR, SBR, butyl rubber and EPDM because it is costlier and does not possess characteristics which make it favorable for use in automobile tires. Its primary use is in hose applications. Hypalon is frequently used as a substitute for most of the other standard elastomers, such as uses which demand resistance to heat and oil. EPI is used primarily in the production of automotive parts including hoses and gaskets.

The proposed regulation will affect 35 synthetic rubber facilities, which are owned and operated by 18 firms. Synthetic rubber facilities are mainly owned by oil and chemical companies, rubber product manufacturers, or independents. Butyl rubber, Hypalon, and EPI are supplied by only one firm. The markets for the remaining elastomers are fairly unconcentrated.

ES.3 CONTROL COSTS AND COST-EFFECTIVENESS

The Polymers and Resins Group I 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 which was chosen by EPA. The chosen regulation is the same as the Hazardous Organic NESHAP (HON) rule for all of the emission points within Group I elastomer facilities. For existing sources, the MACT floor was based on the CAA stipulation that the minimum standard represent the average emission limitation achieved by the best performing 12 percent of existing sources. No new source costs were included in this analysis given that little new source construction is likely in this industry within the next five years.

Control costs were developed for the following major emission points within elastomer facilities: equipment leaks, front- and back-end 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 I 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 total investment capital costs and national annualized cost estimates for controlling existing sources. These costs were prepared by the engineering contractor for use in the EIA. Costs are provided by industry for the MACT floor level of control. The total national annualized cost for implementation of the regulatory alternative is approximately \$21 million [including monitoring, reporting, and recordkeeping (MRR) costs], and the total capital cost estimate is approximately \$26 million for the 11 affected industries five years subsequent to 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 $1,710 to $9,205 per megagram, or an average of $3,311 per megagram of HAP reduced for the proposed NESHAP.

ES.4 ECONOMIC METHODOLOGY OVERVIEW

In this study, data inputs are used to construct a separate, pre-control baseline equilibrium market model of ten of the eleven affected industries. Hypalon was not modeled due to the fact that emission control costs including MRR are estimated to be zero for this industry. The baseline models of the markets for these ten synthetic rubbers provide the basic framework necessary to analyze the impact of proposed control costs on these industries. The *Industry Profile for the Polymers and Resins I 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 are evaluated within the context of the market model to estimate the impacts of regulatory control measures on

TABLE ES-1. SUMMARY OF GROUP I NESHAP COSTS IN THE FIFTH YEAR BY ELASTOMER INDUSTRY

Group I Industry	Fifth Year Capital Costs (1989 Dollars)	Annual Fifth Year Costs (1989 Dollars)	Annual HAP Emission Reduction (Mg/yr)	Cost-Effectiveness ($/Mg)
Butyl Rubber	$691,158	$1,458,870	596	$2,448
EPDM	$5,956,585	$4,589,591	2,087	$2,199
EPI	$491,203	$296,582	124	$2,392
Halobutyl Rubber	$328,055	$572,946	335	$1,710
Hypalon	$0	$0	0	$0
NBL	$464,737	$291,467	140	$2,082
NBR	$397,265	$675,971	365	$1,852
Neoprene	$560,205	$959,728	354	$2,711
SBL	$1,480,479	$1,212,387	583	$2,080
SBR	$3,941,869	$2,190,864	238	$9,205
BR	$11,780,263	$8,745,806	1,519	$5,758
TOTAL FOR REGULATORY ALTERNATIVE	$26,091,819	$20,994,211	6,341	$3,311

each of the Group I 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 synthetic rubber 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.

ES.5 PRIMARY REGULATORY IMPACTS

Primary regulatory impacts include estimated increases in the market equilibrium price of each Group I elastomer, decreases in the market equilibrium domestic output or production of each elastomer, changes in the value of domestic shipments, and facility closures. The analysis was conducted separately for each of the ten affected industries. No impacts have been reported for the Hypalon industry since no emission control costs are anticipated for this industry. The primary regulatory impacts are summarized in Table ES-2.

As shown in Table ES-2, the estimated price increases for each of the Group I industries range from a low of $0.002 per kilogram for halobutyl to a high of $0.022 per kilogram for EPI, based upon 1989 price levels. These predicted price increases represent percentage increases ranging from a low of 0.18 percent for NBL to a high of 2.5 percent for butyl rubber. Domestic production will decrease for each of the Group I synthetic rubbers in amounts ranging from 0.08 million kilograms for EPI to 24.53 million kilograms for BR. This estimated percentage decrease in annual production for each of the elastomers varies from a low of 0.69 percent for NBL to a high of 4.95 percent for butyl rubber.

TABLE ES-2. SUMMARY OF PRIMARY ECONOMIC IMPACTS OF POLYMERS AND RESINS GROUP I NESHAP

	Estimated Impacts[4,5]			
Group I Industry	Price Increases[1]	Production Decreases[2]	Value of Domestic Shipments[3]	Facility Closures
Butyl				
Amount	$0.009	(2.96)	($0.55)	None
Percentage	2.50%	(4.95%)	(2.58%)	
EPDM				
Amount	$0.019	(3.25)	($2.01)	None
Percentage	0.87%	(1.21%)	(0.35%)	
EPI				
Amount	$0.022	(0.08)	($0.08)	None
Percentage	0.82%	(1.28)%	(0.47%)	
Halobutyl				
Amount	$0.002	(1.18)	($0.22)	None
Percentage	0.68%	(1.37%)	(0.70%)	
NBL				
Amount	$0.004	(0.20)	($0.34)	None
Percentage	0.18%	(0.69%)	(0.51%)	
NBR				
Amount	$0.007	(0.74)	($1.15)	None
Percentage	0.31%	(1.17%)	(0.87%)	
Neoprene				
Amount	$0.008	(1.69)	($0.34)	None
Percentage	1.12%	(1.51%)	(0.41%)	
SBL				
Amount	$0.009	(2.91)	($0.82)	None
Percentage	0.64%	(0.80%)	(0.16%)	
SBR				
Amount	$0.005	(10.22)	($8.88)	None
Percentage	0.40%	(1.58%)	(1.18%)	
BR				
Amount	$0.020	(24.53)	($15.24)	None
Percentage	1.91%	(4.52%)	(2.70%)	

NOTES:
[1] Prices are shown in price per kilogram ($1989).
[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.
[5] Hypalon is omitted from the analysis because compliance costs are estimated to be zero.

The predicted change in the dollar value of domestic shipments or revenue to producers in the Group I source category is anticipated to decrease for the ten elastomer industries. Annual revenue decreases range from $0.08 million annually for EPI to $15.24 million annually for BR. Percentage decreases in revenues vary from 0.16 percent for SBL to 2.70 percent for polybutadiene rubber. These revenue decrease estimates are also based upon 1989 price levels.

No predicted facility closures are anticipated for the Polymers and Resins Group I industries. The closure analysis was conducted based on the assumption that those facilities with the highest control cost per unit are marginal in the post-control marketplace. This is a worst-case assumption, and will, in general, tend to overestimate the number of facility closures.

ES.6 SECONDARY REGULATORY IMPACTS

Secondary impacts of the Polymers and Resins Group I 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-3.

Labor market losses resulting from the NESHAP are estimated to be approximately 100 jobs for all of the Group I industries in total. This estimate reflects the reductions in jobs predicted to result from the anticipated reduction in annual production of these Group I elastomers. 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. Additionally, the number of workers per industry was unavailable, and estimates were generated based on the labor associated with SIC code 2822, *Synthetic Rubbers*.

Annual reductions in energy use as a result of the regulations are expected to amount to a savings of $1.36 million (1989 dollars) annually. Net annual exports are predicted to decrease by a total of 14 million kilograms annually. These decreases in net exports represent a range of 0.68 percent for EPDM to a high of 58.3 percent for NBR.

TABLE ES-3. SUMMARY OF SECONDARY ECONOMIC IMPACTS OF THE POLYMERS AND RESINS GROUP I NESHAP

	Estimated Impacts[1,5]		
Group I Industry	Labor Input[2]	Energy Input[3]	Net Exports[4]
Butyl			
Amount	(2)	($0.05)	(1.41)
Percentage	(4.95%)	(2.2%)	(27.05%)
EPDM			
Amount	(13)	($0.31)	(1.19)
Percentage	(1.21%)	(0.68%)	(1.59%)
EPI			
Amount	(0.40)	($0.01)	(0.03)
Percentage	(1.28%)	(0.66%)	(2.50%)
Halobutyl			
Amount	(1)	($0.02)	(0.56)
Percentage	(1.34%)	(0.61%)	(7.43%)
NBL			
Amount	(1)	($0.02)	(0.05)
Percentage	(0.69%)	(0.28%)	(34.38%)
NBR			
Amount	(3)	($0.07)	(0.20)
Percentage	(1.17%)	(0.48%)	(58.34%)
Neoprene			
Amount	(2)	($0.06)	(0.69)
Percentage	(1.51%)	(0.89%)	(2.00%)
SBL			
Amount	(8)	($0.18)	(0.79)
Percentage	(0.80%)	(0.35%)	(2.79%)
SBR			
Amount	(22)	($0.53)	(2.46)
Percentage	(1.58%)	(0.77%)	(2.35%)
BR			
Amount	(48)	($0.11)	(6.80)
Percentage	(4.23%)	(2.12%)	(9.23%)

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) are expressed in millions of kilograms.
[5] Hypalon is omitted from the analysis.

Regional effects are expected to be minimal since the affected facilities are dispersed throughout the United States. Given that the market impacts are predicted to be minimal in most cases, it follows that no region of the country will be significantly adversely affected by the regulation.

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 I elastomers) 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 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 $15 million ($1989) are anticipated for the chosen alternative and are shown by industry in Table ES-4. 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.

ES.8 POTENTIAL SMALL BUSINESS IMPACTS

The RFA requires that a determination 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 I producers are large chemical companies, and, consequently, significant small business impacts are not expected to result from implementation of the Polymers and Resins Group I NESHAP. Based on available employment data for each of the 18 affected firms, five firms classify as small businesses. Of these, three are unaffiliated with a larger business firm. Costs expressed as a percentage of sales for these three firms do not indicate that the NESHAP will result in adverse economic impacts.

TABLE ES-4. ANNUAL ECONOMIC COST ESTIMATES FOR THE POLYMERS AND RESINS GROUP I REGULATION[1]

(millions of 1989 dollars)[2]

Group I Industry	Change in Consumer Surplus	Change in Producer Surplus	Change in Residual Surplus	Total Loss In Surplus
Butyl Rubber	($0.48)	($0.59)	($0.29)	($1.36)
EPDM	($3.61)	$0.27	$0.46	($2.88)
EPI	($0.11)	($0.11)	($0.03)	($0.25)
Halobutyl Rubber	($0.19)	($0.24)	($0.11)	($0.54)
NBL	($0.12)	($0.12)	($0.04)	($0.28)
NBR	($0.41)	($0.17)	($0.07)	($0.65)
Neoprene	($0.64)	($0.01)	$0.02	($0.63)
SBL	($2.97)	$1.30	$0.78	($0.89)
SBR	($2.52)	$0.57	$0.50	($1.45)
BR	($9.12)	$1.56	$1.38	($6.18)
Total	($20.17)	$2.46	$2.60	($15.11)

NOTES: [1] Hypalon is omitted from the analysis.
[2] Brackets indicate economic costs.

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 specific types of synthetic rubbers (elastomers). These affected industries are categorized within the Polymers and Resins Group I source category. This report evaluates the economic impact of the standard on the industries manufacturing the following synthetic rubbers:

- butyl rubber;
- ethylene - propylene rubber (EPDM);
- epichlorohydrin rubber (EPI);
- halobutyl rubber;
- Hypalon:
- nitrile-butadiene latex (NBL);
- nitrile-butadiene rubber (NBR);
- Neoprene;
- styrene butadiene latex (SBL);
- styrene butadiene rubber (SBR); and
- polybutadiene rubber (BR).

This analysis was conducted to satisfy the requirements of Section 317 of the CAA which mandates that EPA 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 eleven affected industries included in this analysis. Chapter 2 also presents an identification of affected synthetic rubber facilities, a characterization of market structure, separate discussions of the factors which 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 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 the industry's labor inputs, energy use, balance of trade, and regional markets. Lastly, Chapter 7 specifically addresses the potential impacts of regulation on affected firms which classify as small businesses based on the standards set by the U.S. Small Business Administration (SBA). 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 models.

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 I synthetic rubber 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 which produces HAPs.

The NESHAP considered in this EIA requires controls on the following emission points in synthetic rubber-producing facilities: storage tanks, equipment leaks, front- and back-end process vents, and wastewater collection and treatment systems. EPA chose one regulatory alternative for each of the regulated industries. The results of a detailed economic impact analysis for each of them are presented in this report.

EPA provided cost estimates for controls deemed appropriate as options for each affected elastomer-producing process at existing facilities. EPA determined that no new source costs will be included in this analysis, based on an industry source which reported that no industry growth or capacity expansion is expected to occur in the United States within the next 10 years[1]. Costs represent the impact of bringing each facility from existing control levels to the control level defined by the regulatory alternative for each emission point. The proposed Group I regulatory alternative chosen for this analysis closely resembles the HON rule.[2] The provisions of the single regulatory alternative developed for storage tanks, wastewater streams, and equipment leaks are identical to those required by Part 63 of the HON rule. The process vent provisions also resemble the HON with the exception of provisions for some vents. For batch processes and back-end process vents, the regulatory alternative is based on EPA's draft CTG for Batch Processes.[3] In either situation, the applicability of control requirements is based on vent stream characteristics. For the regulatory alternative examined in this EIA, costs were provided on a facility level.

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3. U.S. Environmental Protection Agency. "Control of Volatile Organic Compound Emissions from Batch Processes." Draft Document. EPA-453/R-93-017. Research Triangle Park, NC. November 1993.

2.0 INDUSTRY PROFILE

2.1 INTRODUCTION

This chapter focuses on the markets for Group I elastomers. 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) which were used to conduct the EIA. The general outlook for the affected Group I industries is also discussed in this chapter.

Section 2.2 describes the elastomer production process, and identifies the unique market characteristics of each elastomer. Section 2.2 also identifies the affected elastomer 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 a discussion of the outlook for Group I synthetic rubbers based on both a literature search for published forecasts, and on anticipated future conditions in the market as determined by the industry data contained in this chapter.

2.2 IDENTIFICATION OF AFFECTED FIRMS AND FACILITIES

This section reviews the products and processes of the affected synthetic rubber industries. The affected firms are identified by capacity, employment, and location of facilities. An EIA requires that affected facilities in the industry be classified by some production factor or other descriptive characteristic. Throughout this section, capacity will be used as a measure of size, since it is the one characteristic that is consistently available for each synthetic rubber producer. (In this report, the term firm refers to the company or producer, while facility refers to the actual rubber production site or plant.)

2.2.1 *General Process Description*

Synthetic rubber production requires the synthesis of monomers (derived from petrochemicals), followed by their polymerization. This process results in an aqueous suspension of rubber particles, or the latex, which may then be processed into marketable, dry, raw rubber. Synthetic rubbers are usually compounded with various additives and then molded, extruded, or calendared into the desired solid form. A percentage of elastomer production is also supplied in the form of water dispersions, called latexes (primarily used in foam rubber). HAP emission sources in synthetic rubber facilities include: equipment leaks, process vents, wastewater, and storage tanks.[1] It is important to note that elastomer production sites subject to this standard may be collocated with other production facilities that are, or will be, subject to MACT standards other than the Group I NESHAP. For example, a refining facility, chlorine plant, SOCMI facility, or non-elastomer polymer facility could be located on the same site as Group I production units.

2.2.2 *Product Description*

The affected Group I elastomers are classified as synthetic rubbers which have specific elasticity and yield properties. Synthetic rubbers are either used as stand-alone products, or are compounded with natural rubber, other thermoplastic materials, or additives, depending on the desired end-use characteristics. This section describes the properties of each elastomer individually and identifies its primary end uses.

2.2.2.1 *Butyl Rubber*. In addition to butyl rubber, this category includes chlorobutyl rubber, bromobutyl rubber, and halobutyl rubber. Butyl rubbers are copolymers of isobutylene isoprene, and are among the most widely used synthetic elastomers worldwide. Characteristics of butyl rubber include low permeability to gases and high resistance to tear and aging. Eighty percent of butyl rubber produced is used as an input to the production of tires, tubes, and tire products. Butyl rubber is also used in the production of inner tubes because of its low air permeability. The remaining 20 percent of butyl rubber is used in the production of automotive and mechanical goods, adhesives and caulks, and also for various other uses, including pharmaceutical stoppers.

2.2.2.2 *Styrene-Butadiene Rubbers and Latexes*. SBR is produced in the largest volume of all the synthetic rubbers. Its chemical properties include favorable performance in extreme temperatures, resistance to cracking and abrasion, and stability over time. The dominance of SBR among synthetic rubber types is attributable to the following two market conditions: availability and processability. The availability of styrene and butadiene in fossil hydrocarbons make these two inputs an abundant source of synthetic rubber, and styrene and butadiene can be combined into rubber compounds which are easily processed into tire molds. Types of SBR differ in the ratios of styrene to butadiene, their content of additives, or the type of polymerization process used during the manufacturing process. The substitutability of SBR with natural rubber is primarily determined by the fluctuating prices of each, and by the properties required in the end product.

As with butyl rubber, the primary use of SBR is in the production of tires, although the percentage of SBR used for tires is lower than that of butyl rubber. Additional end use categories for SBR include mechanical goods, automotive parts, floor tiles, and shoe soles. Approximately 10 percent of SBR produced is in latex form (SBL), which is used for carpet backing, nonwoven materials, and paper coatings. Latexes typically have a higher percentage of styrene than SBR and are also used in the construction industry.

2.2.2.3 *Polybutadiene Rubber*. BR is formed from butadiene which undergoes emulsion polymerization. After SBR, polybutadiene rubber is the synthetic rubber produced in the second highest volume. The use of polybutadiene in tires is due to its resistance to abrasion, high resiliency, favorable temperature flexibility, and resistance to tread cracking. BR may also be blended with natural rubber to improve abrasion resistance. Similar to butyl rubber and SBR, the primary use of BR is for tires and tire products (68 percent). BR is also used as a styrene resin modifier, in the production of ABS for example, as well as for an input to the manufacture belts and hoses.

2.2.2.4 *Ethylene-Propylene Rubber*. The ethylene-propylene category includes both ethylene-propylene copolymers (EPD), and ethylene-propylene terpolymers (EPDM). EPDM is produced from the polymerization of ethylene and propylene. EPDM is characterized by poor adhesion and slow curing, which makes blending with other rubbers difficult. Advantages to using EPDM include low cost, resistance to cracking, and low temperature flexibility. After SBR and BR, EPDM is third in terms of production volume of all the synthetic rubbers. EPDM compounds have been developed for a great variety of applications, among which automotive and appliance uses have been particularly significant. End uses include roofing membranes, impact modifiers, oil additives, automobile parts, gaskets and seals, and hoses and belts. The wide range of uses of this elastomer is attributable to its multifunctional nature.

2.2.2.5 *Nitrile Butadiene Rubber*. NBR is a copolymer of acrylonitrile and butadiene. Its most significant characteristic is its resistance to oil. NBR is the preferred product for gasoline hoses, gaskets, and printing rolls. Many of the properties of nitrile rubber are directly related to the proportion of acrylonitrile in the rubber. NBR is used in many hose applications where oil, fuel, chemicals, and solutions are transported. In powder form, NBR is used in cements, adhesives, and brake linings, and in plastics modification. NBR is also used in belting and cable, in addition to its uses in O-rings and seals, adhesives and sealants, sponges, and footwear.

2.2.2.6 *Neoprene*. Polychloroprene, also known as Neoprene, is produced from chloroprene through an emulsion process. Neoprene differs from BR, SBR, butyl rubber, and EPDM because it is costlier and does not possess characteristics which make it favorable for use in automobile tires. Its flexibility, high resistance to oils, strength, and resistance to abrasion, however, make it suitable for other diverse uses. Neoprene is similar to NBR in end uses, given that the primary use is for hoses and belts, with the remainder allocated among mechanical, adhesive, and wire and cable end uses. Manufacturers of shoes, aircraft, automobiles, furniture, building products, and industrial components rate Neoprene adhesives as a versatile material for adhesive purposes. The oldest use of Neoprene is as a jacket for electrical conductors in such products as appliances and telephone wires. In latex form, Neoprene is used to manufacture household and industrial gloves.

2.2.2.7 *Hypalon*. Chlorosulfonated polyethylene, also known by the trade name Hypalon, is formed solely from polyethylene through a chlorination and chlorosulfonation process. Although a breakdown of Hypalon among end uses was not available, it is used as a substitute for most of the other standard elastomers, including uses which demand resistance to heat and oil. Uses of Hypalon include coatings for roofs and tarpaulins, hose construction, wire coverings, industrial rolls, and sporting goods.

2.2.2.8 *Epichlorohydrin Elastomers*. The production of EPI uses epichlorohydrin, ethylene oxide, and allyl glycetal ether, which are combined in a polymerization process. Information on epichlorohydrin elastomers was limited. Its primary use is as an automotive rubber, for applications including gaskets and hoses.

2.2.3 *Affected Elastomer Facilities, Employment, and Location*

The NESHAP will affect 35 facilities, which are owned and operated by 18 firms. SBR production as a whole (SBR and SBL) includes the highest number of producers of any of the other rubber types in Group I. Table 2-1 shows the distribution of production capacity among the producers of SBR and SBL. The top four firms share 70 percent of the total industry SBR capacity. Uniroyal Goodrich Tire Company and The Goodyear Tire & Rubber Company own 32 percent and 37 percent of SBR capacity, respectively. The remaining 5 SBR manufacturers operate between 3 percent and 11 percent of industry capacity. The SBL market is less concentrated than that of SBR. Reichhold Chemical is the dominant firm, with 29 percent of industry capacity; Dow Chemical owns the next highest percentage at only 23 percent of capacity.

The production capacity for BR manufacturers is listed by firm and facility location in Table 2-2. The capacity for producing polybutadiene rubber is shared by four firms. The market concentration in this industry subcategory is more concentrated than in the SBR industry. The Goodyear Tire & Rubber Company owns the highest degree of production capacity, with 50 percent of the total. The second largest producer is Bridgestone/ Firestone Inc., with 26 percent of industry capacity. The top two firms in the polybutadiene rubber industry share 76 percent of capacity, indicating a high level of market concentration.

TABLE 2-1. STYRENE BUTADIENE RUBBER (SBR) AND LATEX (SBL) MANUFACTURERS AND CAPACITY, 1992 [1] [2] [3]

	Capacity (Million kilograms)			
Company	SBR	Percentage of Total	SBL	Percentage of Total
American Synthetic Rubber Co.	41	3.6%		
BASF Corp.			88	13.4%
Bridgestone/Firestone Inc.	120	10.5%		
Copolymer Rubber & Chemical Corp.	45	3.9%		
Dow Chemical	33	2.9%	154	23.4%
Gencorp			62	9.4%
General Tire	117	10.2%		
The Goodyear Tire & Rubber Company	428	37.3%	52	7.9%
Hampshire Chemical			2	0.3%
Reichhold Chemicals			193	29.4%
Rhone-Poulenc, Inc.			36	5.5%
Rohm & Haas			70	10.7%
Uniroyal Goodrich Tire Co. (Ameripol Synpol)	362	31.6%		
Total	1,146	100.0%	656	100.0%

TABLE 2-2. POLYBUTADIENE RUBBER MANUFACTURERS AND CAPACITY, 1991[1 2 3]

Company	Facility Location	Capacity (Million kilograms)	Percentage of Total (%)
American Synthetic Rubber Corp.	Louisville, KY	119	13.3%
Bridgestone/Firestone Inc.	Lake Charles, LA	122	
	Orange, TX	111	
BRIDGESTONE TOTAL		233	25.9%
The Goodyear Tire & Rubber Company	Beaumont, TX	449	50.0%
Miles Inc. (Polysar Rubber Division)	Orange, TX	97	10.8%
Total		897	100.0%

Table 2-3 presents a similar industry breakdown for ethylene-propylene rubber manufacturers. This industry subsegment is the least concentrated subsegment of those in Group I. Copolymer Rubber & Chemical Corporation and Uniroyal Chemical Company are the top two firms by production capacity ownership, with 30 percent and 22 percent of industry capacity, respectively. Exxon Corporation owns the third highest percentage of capacity with 21 percent. The remaining 27 percent of capacity is shared by the other two producers.

Table 2-4 shows the relative size of the five nitrile butadiene rubber manufacturers and the two NBL manufacturers. Copolymer Rubber Corporation and Goodyear Tire & Rubber are the two main competitors in the NBR market, sharing 63 percent of total industry capacity. Zeon is the other major player, with 21 percent of capacity. Reichhold Chemical owns 95 percent of the total national NBL production, with the remaining 5 percent owned by Hampshire Chemical.

The producers of Neoprene are shown by facility in Table 2-5. DuPont is the primary producer with 81 percent of industry capacity at 2 facilities. Miles Inc. is the other producer with the remaining 19 percent of industry capacity. Each of the remaining rubbers (butyl rubber, EPI, halobutyl rubber, and Hypalon) are produced by only one firm.

On a firm level, employment data were available for each of the 18 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 I NESHAP on small firms is to assign the appropriate definition of a small entity in the Polymers and Resins Group I industry. The U.S. Small Business Administration (SBA) defines small businesses in SIC code 2822 as employing a work force of 750 employees or less.[4]

TABLE 2-3. ETHYLENE-PROPYLENE RUBBER MANUFACTURERS AND CAPACITY, 1991[1 2 3]

Company	Facility Location	Capacity (Million kilograms)	Percentage of Total (%)
Copolymer Rubber & Chemical Corp.	Addis, LA	121	30.4%
E.I. Du Pont de Nemours, Inc.	Beaumont, TX	73	18.2%
Exxon Corporation	Baton Rouge, LA	85	21.2%
Miles Inc. (Polysar Rubber Division)	Orange, TX	32	8.1%
Uniroyal Chemical Company, Inc.	Geismar, LA	88	22.1%
Total		399	100.0%

TABLE 2-4. NITRILE BUTADIENE RUBBER AND LATEX MANUFACTURERS AND CAPACITY, 1991[1 2 3]

	Capacity (Million kilograms)			
Company	NBR	Percentage of Total	NBL	Percentage of Total
Copolymer Rubber & Chemical Corp.	36	26.1%		
The Goodyear Tire & Rubber Company	51	37.0%		
Hampshire Chemical			5	5.0%
Miles Inc. (Polysar Rubber Division)	2	1.4%		
Reichhold Chemicals			103	95.0%
Uniroyal Chemical Company, Inc.	20	14.5%		
Zeon	29	21.0%		
Total	141	100.0%	108	100.0%

TABLE 2-5. NEOPRENE MANUFACTURERS AND CAPACITY, 1991[1 2 3]

Company	Facility Location	Capacity (Million Kilograms)	Percentage of Total (%)
DuPont	La Place, LA	39	
	Louisville, KY	75	
	DUPONT TOTAL	114	81%
Miles Inc.	Houston, TX	27	19%
Total		141	100%

Table 2-6 lists 1991 employment levels for each of the affected firms. Of these firms, only five employ a workforce of less than 1,000. Of these five, Ameripol Synpol and American Synthetic Rubber Corporation are affiliated with large business entities. Because only three firms qualify as small businesses, an RFA may be unnecessary. 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. The results of examining the effects of the Group I NESHAP on these five small firms is presented in Chapter 7.0.

The distribution of affected facilities is shown on a regional and State basis in Figure 2-1. Certain industry characteristics are evident from the regional categorization in this figure. Of the 35 affected facility locations, 50 percent are located in the South Central 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 number of facilities are Texas, Louisiana, and Kentucky. Table 2-7 provides a summary of the national production capacity by firm, location, and synthetic rubber type. Each firm in the table is identified by facility location and corresponding 1991 production capacity, where available. Only domestic facilities are included in the table, since only firms located in the United States will be forced to incur the costs of pollution control equipment after promulgation of the NESHAP. The majority of facilities in the Polymers and Resins I source category produce styrene-butadiene latex. In terms of capacity, styrene-butadiene rubber is the synthetic rubber with the second highest production capacity.

2.3 MARKET STRUCTURE

The purpose of this section is to characterize the market structures in the Group I 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 affected Group I industries is provided by an assessment of the number of firms operating resin facilities, vertical integration, and diversification.

TABLE 2-6. 1991 EMPLOYMENT LEVELS OF POLYMERS AND RESINS GROUP I FIRMS[5 6]

Firm Name	Number of Employees
American Synthetic Rubber Corp.	340
Ameripol Synpol	850
BASF Corp.	133,759
Bridgestone/Firestone Inc.	53,500
Copolymer (DSM)	732*
Dow Chemical	62,100
E.I. Du Pont de Nemours, Inc.	124,916
Exxon Corp.	104,000
Gencorp	13,900
General Tire Inc./Dynagen	9,600
The Goodyear Tire & Rubber Company	107,671
Hampshire Chemical	750*
Miles Inc. (Polysar Rubber Division)	1,200
Reichhold Chemicals, Inc.	9,500
Rhone-Poulenc, Inc.	9,300
Rohm & Haas	12,872
Uniroyal Chemical Company, Inc.	3,000
Zeon	400*

NOTES: *Those firms with asterisks are defined as small businesses for SIC code 2822.

TABLE 2-7. GROUP 1 MANUFACTURERS BY RUBBER TYPE AND CAPACITY, 1991[1,2,3]

Company	Facility Location	Rubber Type and Annual Capacity (Million kilograms)[a]									
		Butyl Rubber	SBR[b]	SBL	BR[b]	EPDM[b]	NBR	Neoprene	Hypalon	EPI	NBL
American Synthetic Rubber Corp.	KY		41		119[c]						
BASF Corp.	TN (2 locations)			88							
Bridgestone/Firestone Inc.	LA		120		122						
	TX				111						
	Total Capacity				233						
Copolymer Rubber & Chemical Corp.	LA (Baton Rouge)		45			121	36[c]				
	LA (Addis)										
Dow Chemical	CA			84							
	CT			20							
	GA		33	22							
	MI			28							
	TX			0.8							
	Total Capacity			154							
E.I. Du Pont de Nemours, Inc.	TX					73			29		
	LA							39			
	KY							75			
	Total Capacity							114			
Exxon Corporation	TX	121									
	LA	98				85					
Gencorp	OH			62							
General Tire Inc.	TX		117								
The Goodyear Tire & Rubber Company	TX (Houston)		428				51[c]				
	TX (Beaumont)				449[c]						
	GA			52							
Hampshire Chemical	KY			2							5
Miles Inc. (Polysar Rubber Division)	TX (Houston)							27			
	TX (Orange)				97	32	2				
Morton International, Inc.	MS										
Reichhold Chemicals, Inc.	DE			149							99
	GA			44							4
	Total Capacity			193							103
Rhone-Poulenc, Inc.	NC			36							

TABLE 2-7 (continued).

Company	Facility Location	Rubber Type and Annual Capacity (Million kilograms)[a]									
		Butyl Rubber	SBR[b]	SBL	BR[b]	EPDM[b]	NBR	Neoprene	Hypalon	EPI	NBL
Uniroyal Chemical Company, Inc.	LA					88					
	OH						20				
Uniroyal Goodrich Tire Co. (Ameripol Synpol)	TX		362								
Unocal Corp. (Rohm & Haas)	CA			70							
	NC			52							
Zeon	MS									8.5	
	KY						29				
	TX										
Total Capacity		219	1,146	709	897	399	141	141	29	8.5	108
Total Number of Facilities		2	7	15	5	5	5	3	1	1	3

NOTES: [a] Rubber types have been abbreviated as follows: SBR = styrene-butadiene rubber, SBL = styrene-butadiene latex, BR = polybutadiene rubber, EPI = epichlorohydrin elastomers, NBR = nitrile butadiene rubber, EPDM = ethylene-propylene rubber, NBL = nitrile butadiene latex.

[b] SBR, EPDM, and BR capacities are based on net rubber (oil content is included, but carbon black and other fillers are excluded).

[c] Capacity is also utilized to produce SBR.

N/A = Not available.

2.3.1 *Market Concentration*

Market concentration in an industry is an indication of the control that firms have over their pricing policies. Market concentration is typically expressed as the percentage of industry output controlled by the largest firms; however, for Polymers and Resins Group I, the necessary production data on a firm level by rubber type were not accessible. For this analysis, therefore, market concentration in each of the Group I industries was assessed in terms of production capacity rather than by a specific measure of elastomer output. Because butyl rubber, halobutyl rubber, Hypalon, and EPI are each produced by only one firm, market concentration will not be considered for these four industries.

Uniroyal Goodrich and Goodyear Tire & Rubber dominate the market for SBR, with the remainder of production capacity allocated among 5 producing firms. Market concentration among SBL producers is more highly concentrated in the hands of fewer producers. Reichhold Chemical is the primary producer of SBL, operating 29 percent of total national SBL capacity. The remaining SBL capacity is owned and operated by 7 other firms. The majority of the national polybutadiene production capacity is owned by the Goodyear Tire & Rubber Company with 50 percent of the total, with the second largest producer being Bridgestone/Firestone Inc. with 26 percent of industry capacity. The remaining 24 percent of BR capacity is shared by 4 other firms.

The EPDM industry is the least concentrated industry in the Group I source category. Capacity is shared by 5 producers, with no one firm dominating the market. The market for NBR is dominated two firms which collectively operate 63 percent of total industry capacity. The Goodyear Tire & Rubber owns 37 percent of national capacity, followed by Copolymer Rubber & Chemical Corporation which operates 26 percent of total capacity. Zeon Chemicals is the other major producer with 21 percent of total national capacity. The major player in the NBL market is Miles Chemical with 95 percent of industry capacity. Lastly, of the two firms in the Neoprene industry, DuPont controls 81 percent of total industry capacity.

2.3.2 *Industry Integration and Diversification*

Synthetic rubber facilities are mainly owned by oil and chemical companies, rubber product manufacturers (tires, for example), or independents. The majority of affected Group I firms 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 the production of the chemical inputs which are manufactured for captive use in rubber production. Other firms produce the rubbers being profiled in this report for captive use as an input into rubber products, such as automobile tires. For example, as was shown in Table 2-1, the largest SBR producers are Uniroyal Goodrich Tire Company and The Goodyear Tire & Rubber Company. Each of these firms is a significant player in the global tire market. The world tire industry is currently characterized by overcapacity, lower profits than the historical average, and increased competition for market share.[7] As of December 1990, six producers controlled 80 percent of global tire production, a fact which reflects the high levels of consolidation in the past decade. In the past 2 years, further consolidation has taken place. Goodyear, which is one of only two remaining domestic tire producers, controls 28 percent of worldwide tire production. Goodyear also operates 52 percent of domestic polybutadiene rubber capacity. (The majority of SBR and polybutadiene produced is used in tire manufacturing.) This indicates that any potential effect of the Group I NESHAP on the polymers and resins industry would also have a related and potentially significant effect on the global tire industry. Firms that are vertically integrated could therefore be indirectly affected by the NESHAP in the factor and product markets for various rubbers, particularly if demand for synthetic rubber decreases and production in the tire market, for example, suffers as a result. Domestic tire producers, in particular, could be adversely affected.

For the larger firms in this industry, horizontal integration exists to the extent that these firms operate several plants which manufacture one or more Group I elastomers. Table 2-7 provided an indication of the horizontal integration of the industry, as represented by the number of companies that either operate several SBR facilities, for example, or supply more than one Group I elastomer. Of the 18 firms in the industry, 12 operate more than one plant. The major firms operate several plants, and the largest, Dow, operates plants in five States. Of those firms producing more than one synthetic rubber type, the Goodyear Tire & Rubber Company and Miles Inc. each manufacture four of the synthetic rubbers in the Group I source category.

Diversification indicates the extent to which a firm has developed other revenue-producing operations, in this case, in addition to synthetic rubber production. Many of the firms in the synthetic rubber industry comprise larger corporations with a variety of product areas. Several are large players in the oil industry, including Exxon and Unocal. E.I. Du Pont is a major firm in the chemical industry. Other synthetic rubber producers are part of several other industries, such as Dow Chemical. Given that many of the major firms in this industry 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 examines the financial performance of a sample of affected Group I firms. The financial data presented here were obtained by request from Dun and Bradstreet's Supplier Evaluation Reports.[8] Although Dun and Bradstreet provided financial data for all 18 affected firms, the data reported for two firms were either too sparse for inclusion in the sample, or the categories reported were inconsistent with the data provided for the other firms. To supplement the Dun and Bradstreet data, information was obtained from a sample of the firms' annual reports.

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 2-8 presents net income to assets ratios which were averaged from 1987 to 1991 for each firm. Also presented are long-term debt to long-term debt plus equity ratios for the most current year for which data were available. Net income to assets ratios are provided for 16 of the 18 affected firms, and range from minus 6 percent for

TABLE 2-8. FINANCIAL STATISTICS FOR AFFECTED FIRMS[8]

Company	Net Income to Assets 1987 to 1991 Average (%)	Long Term Debt to LT Debt and Equity (%)
American Synthetic Rubber Company	3.7%	66.3%
BASF Corporation	18.4%	N/A
Bridgestone/Firestone Inc.	(6.4%)	68.1%
Copolymer (DSM)	2.1%	N/A
Dow Chemical	8.7%	62.7%
E.I. DuPont de Nemours, Inc.	2.7%	60.7%
Exxon Corporation	5.9%	20.4%
Gencorp	3.5%	61.8%
General Tire Inc./Dynagen	3.4%	N/A
Goodyear Tire & Rubber Company	4.2%	46.6%
Miles Inc.	2.2%	53.1%
Reichhold Chemicals, Inc.	1.3%	N/A
Rhone-Poulenc, Inc.	11.5%	32.2%
Rohm & Haas	9.8%	35.1%
Uniroyal Chemical Company	10.4%	N/A
W. R. Grace (Hampshire Chemical)	3.5%	46.7%

NOTE: N/A = not available.

Bridgestone/Firestone to 12 percent for Rhone-Poulenc. Long-term debt to equity ratios are provided for 11 of the 18 firms, and range from 20 percent for Exxon Corporation to 68 percent for Bridgestone/Firestone. A financial impact analysis and capital availability analysis was completed based on the results of the partial equilibrium analysis to determine 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 the Group I 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 this section is on overall industry supply and the existing conditions in the marketplace.

2.4.1 *Supply Trends*

In recent years, overall domestic production of synthetic rubbers has remained below the peak levels it reached in 1988. Synthetic rubber production fell in 1991 for the third consecutive year. These low production levels have been attributed to a decrease in domestic automobile production, low levels of economic activity, and higher import levels of automobile parts and other rubber products. Figure 2-2 shows the production levels from 1985 to 1991 for the three major synthetic rubber types classified in the Group I source category. The overall growth rate for SBR during this time period was 18 percent. Because SBR relies mainly on the tire industry for profits, producers have been harder hit by lower automotive production than the other, more diversified Group I rubbers.

The growth rate for BR between 1985 and 1991 was 28 percent. Butyl rubber production data were reported in a category which encompasses butyl rubber, Neoprene, Hypalon, polyisoprene, silicon, and other synthetic elastomers. The production levels of this elastomer category have fluctuated during this 7-year period, and are currently at 1988 levels. Butyl rubber production, in particular, has declined due to a decrease in demand from the inner tube market.

Figure 2-3 shows similar production data for NBR and EPDM. The production of EPDM increased fairly consistently during the 1980s, which was due to its increased use in wire and cable insulation, roofing membranes, viscosity additives, automobile parts, and impact modifiers for thermoplastics.[10] Overall, NBR has shown very little growth during this time period.

2.4.2 *Supply Determinants*

Synthetic rubber production decisions are primarily a function of input prices, production costs, elastomer prices, existing capacity levels, and international trade trends. Decisions made by producers include determining which processors and markets to continue to serve and which facilities to continue operating. Variations of synthetic rubbers are constantly being developed to satisfy the changing needs of the rubber industry and its customers, and to provide greater raw material stability and upgraded performance properties to meet new demands in end products. Profits depend on the productivity of the elastomer production site. In the short run, a producer will manufacture a particular synthetic rubber depending on the capacity of the facility and the cost of production. The marginal costs of production of each elastomer will determine any future changes in production.

Generally speaking, synthetic rubber production is capital intensive, requiring relatively complex production equipment and technology. The input cost that has the greatest impact on the production decisions of producers in the rubber industry is that of crude oil, since synthetic rubbers are derived from petroleum feedstock. Butadiene is a primary feedstock to the production of five of the major Group I rubbers: SBR, SBL, NBL, BR, and NBR. Historically, the price of butadiene has been affected by the price of crude oil. In recent years, synthetic rubber producers have been simultaneously faced with rising feedstock costs and an inability to increase synthetic rubber prices accordingly because of the high levels of price competition.[11]

Existing Federal, State, and local regulations can also have an impact on the quantity of elastomers supplied by domestic 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 for each Group I

industry incorporates 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 each affected industry.

Although it is beyond the scope of this profile to review all State and local regulations, some Federal regulations are important to note here. The NESHAP for benzene will impact styrene producers, for example, to the extent that benzene prices will have a direct effect on the production costs of styrene producers. Styrene is a primary input to SBR and SBL production and any styrene price increases would therefore increase production costs of both of these elastomers. In addition, the petroleum refining NESHAP will affect firms in Group I industries which are also producers of petroleum products, including, for example, Exxon Corporation. Because synthetic rubbers are produced from petrochemical feedstocks, any impact on petroleum product prices will influence the affected Group I facilities. Similarly, the NESHAPs for other groups in the Polymers and Resins categories are also likely to affect many firms in Group I, which are diversified and produce several types of polymers and resins.

Competition takes place in the synthetic rubber market on two levels: among producers of the same elastomer type, and among various synthetic rubbers with similar characteristics. In choosing the appropriate rubber for a given application, end users consider performance and elastomer price. In addition to competing with each other, Group I elastomers also compete with natural rubber in certain end uses. Although natural rubber is unable to compete with specialty elastomers designed for a particular use, its ease of processability and relatively low cost make it a substitute for several of the synthetic rubbers in Group I. As stated earlier in this chapter, the largest volume of rubber is used for tire manufacturing. The polymers used in tires include: natural rubber, SBR, polybutadiene, butyl, and some EPDM. For use in a tire, the demands placed on the rubber type include resistance to cracks and abrasion, flexibility, and stability over time. SBR, polybutadiene, and natural rubber each meet these requirements after the vulcanization process.

The tradeoff between SBR and natural rubber for use in tire manufacturing has typically been one of economics. SBR has more favorable abrasion resistance than natural rubber, but is poorer in heat buildup. In certain instances, for example, in heavy-duty truck and bus tires, natural rubber is preferred over SBR because of such properties as crack resistance. Because of a market switch to radial tires, the percentage share of natural rubber relative to the percentage share of elastomers in the rubber market has increased. Generally speaking, the advantage of synthetic rubber over natural rubber is the existence of ample production capacity, widespread uses, and processing advantages.

Both Neoprene and natural rubber are options in end uses which demand flexibility and resilience. Natural rubber competes with Neoprene for use in bridge bearings. For products with lower quality including footwear, garden hoses, and mats, SBR and natural rubber are competitors, and both can be mixed with high levels of reclaimed rubber to decrease production costs. In these applications where SBR and natural rubber are more interchangeable, pricing plays a more significant role.

EPDM, butyl, Neoprene, EPI, and Hypalon are each resistant to ozone effects. SBR, BR, NBR, and natural rubber are non-ozone resistant, but can be blended with other materials to achieve this property. SBR and natural rubber are not suitable for uses which demand oil resistance, such as special grades of hose, for example. Neoprene, NBR, and EPI are suitable in these uses. In cases where extreme heat resistance is required, EPDM, butyl, Hypalon, Neoprene, and NBR are suitable. For uses which require low temperature flexibility, EPDM, polybutadiene, natural rubber, and SBR are best.

The compounding process allows for any of the eleven synthetic rubbers in this report to be modified to achieve a suitable property. Changes in demand specifications can significantly affect the synthetic rubber market, which is characterized by similar products with diverse chemical properties. NBR and Neoprene have both been negatively affected by weak automobile sales, while increased demand for EPDM has been triggered by a necessity for high-performance, cost-effective rubber components. EPDM has a more favorable cost performance ratio than NBR or Neoprene and, as a result, market growth is predicted for EPDM in developing countries which are in a period of industrialization.[11] (EPDM prices hover around 45 cents per kilogram, while competing elastomers are typically higher.)

In addition to competing with each other, the commodity rubbers in Group I also compete with specialty rubbers, which include thermoplastic elastomers (TPEs), silicones, and fluorocarbons. In 1991, specialty rubbers supplied about 8 percent of domestic rubber demand, an increase of 5 percent from 1990.[12] Benefits of TPEs include easier processability and recyclability. The costs of manufacturing TPEs are also lower than for vulcanizing the thermoset rubbers. In addition to the economic advantages of TPEs, another favorable characteristic is that these elastomers can be designed to meet specific user criteria. TPEs are not well-suited for use in tires, since they do not possess the wide temperature performance range of most Group I rubbers, nor are the TPEs able to resist deformation at high temperatures. As a result, the share of the tire market held by Group I elastomers is sheltered from competition from TPEs. In 1991, the allocation of North American rubber use among the three rubber categories was as follows: synthetic rubber, 68 percent; natural rubber, 24 percent, and TPEs, 8 percent.[13] The International Institute of Synthetic Rubber Producers (IISRP) projects that SBR, BR, NBR, Neoprene, and natural rubber will each lose market share as thermoplastics use increases. EPDM is the only Group I rubber whose market share is expected to grow.[14] The end-use markets in which TPEs compete with natural and synthetic rubbers are shoe soles, polymer modifiers, adhesives, and automotive parts.

Several Group I producers, however, also operate TPE capacity. Du Pont, for example, is the sole supplier of Neoprene but also produces EPDM, several TPEs, and inputs to TPEs. Although thermoset plastics are less expensive per kilogram than TPEs, the production process for TPEs is less complex and has lower overall process costs. As Group I firms expand into the TPE market, one possibility is that capacity for synthetic rubbers will be idled as TPE production becomes more profitable. In general, TPEs are most likely to replace Group I elastomers in applications where the same performance properties are either not necessary, or can be sacrificed in order to cut costs.

2.4.3 *Exports of Group I Elastomers*

Some measure of the extent of foreign competition can be obtained by comparing exports with domestic production. The Foreign Trade Division of the United States Bureau of the Census collects trade by polymer type according to a commodity coding system. In 1991, exports of all synthetic rubbers accounted for 22 percent of domestic production. In 1991, exports of butyl rubber were 1.4 million kilograms, or 20 percent of domestic production, while exports of NBR comprised 24 percent of domestic production. Exports of polybutadiene rubber totalled 101 million kilograms in 1991 which represented 27 percent of domestic production, and exports of EPDM comprised 29 percent of domestic production. SBR exports were 152 million kilograms in 1991, or 23 percent of production, and SBL exports were 22 percent of domestic production. (Neoprene, Hypalon, and EPI are not published as line items by the Bureau of the Census.)[15]

2.5 MARKET DEMAND CHARACTERISTICS

The purpose of this section of the chapter is to characterize the demand side of the Group I industries. 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 Group I Elastomers*

In general, the primary use of Group I elastomers is as an input into the production of tires. Globally, tires accounted for 60 percent of synthetic rubber use in 1991. The categorization of the remaining 40 percent of synthetic rubber production into distinct end uses is complex. The Group I elastomers are used as input for many diverse types of products, including components for machinery and equipment (for example, belting and hoses), wire covering, construction (including roofing materials), and consumer items. Synthetic rubbers are also used for waterproofing, sealing, and electrical and thermal insulation.

In addition to the automotive market, other major end-use markets for synthetic rubbers include construction products, industrial use, and miscellaneous applications, such as footwear, adhesives, sealants, and electrical products. Market conditions affecting demand have developed in the non-tire markets as well. Environmental concerns, and particularly new technology, have generated the need for more resilient end-use products, causing one elastomer to gain market share at the expense of another. In the manufacture of automobile and electrical parts in 1986, for example, SBR began to lose sales to thermoplastic blends and EPDM, which possessed better heat resistance properties.

2.5.2 *Demand Determinants*

The bulk of synthetic rubber produced is sold by the producer to another manufacturer for use in a manufacturing process (or construction) or for incorporation into some other product. Consequently, demand levels are mainly determined by the overall conditions in the industries which use Group I rubbers as inputs. The demand for Group I synthetic rubbers 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 elastomers demand is referred to as the *price elasticity of demand*, which is explored later in this report. Due to the inherent substitutability among the synthetic rubber types in Group I, price is often a significant demand determinant. Historical price trends from 1987 to 1991 are shown in constant dollars in Figure 2-4. Increased competition from TPEs in recent years has contributed to downward pressure on prices. Polybutadiene and NBR prices have declined since 1987, and price levels for the other Group I elastomers have experienced yearly fluctuations over this time period.

In addition to price, the consumption of Group IV resins is determined by general economic conditions and the health of end use markets. Overall, the depressed conditions of both the global and domestic economies have had negative effects on synthetic rubber markets. The rate of growth in real GDP from 1981 to 1992 was 28.4 percent overall, an average annual growth rate of 2.4 percent for this 12-year period, while the growth rate from year to year has ranged from a decrease of 1.2 percent to an increase of 6.2 percent during this period. Since synthetic rubbers are tied directly to manufacturing industries, slow GDP growth generally results in low growth levels for the synthetic rubber market.

The demand levels for synthetic rubber have historically followed a cyclical pattern which reflects overall economic conditions and mirrors the fluctuations in demand for domestically produced tires, automobiles, and other automotive products. Tires and tire products, for example, have historically accounted for roughly half of the synthetic rubbers

consumed in the United States, but changes in tire technology, such as smaller tires and improved tire life, have in turn reduced the demand for butadiene-based elastomers. Two factors negatively influencing demand are the growth in popularity of imported cars (which come equipped with foreign-made tires) and the significant upturn in sales of imported replacement tires, whose low cost adversely affects sales of retreaded tires.

Figure 2-5 presents the 10-year trends for the two major end uses of Group I rubbers: tires and automotive components. Tire production has been relatively stable after increasing during the early 1980s. In contrast, automobile production has experienced more volatile production levels, and has been declining since 1988. The recent declines in both end-use industries can be attributed to the trend of consumers using their automobiles over a longer time period, and purchasing replacement tires for existing vehicles.

2.5.3 *Past and Present Consumption*

Overall, sales levels for Group I elastomers have been in a slow growth period since 1987, with the exception of SBR, which has shown more significant growth. Figure 2-6 presents historical sales trends for the years 1987 through 1991 for the four main rubber types, as well as a category encompassing all other elastomers. Each of the rubber types has maintained relatively stable sales levels over this period, with the exception of SBR, whose sales have increased 33 percent.

2.5.4 *Imports of Group I Elastomers*

Imports as a percentage of domestic consumption range from 2 to 31 percent for Group I elastomers. Trade data for EPI, Hypalon, and Neoprene were not available from the U.S. Bureau of the Census. In 1991, imports of butyl rubber were only 1.3 million kilograms, 2 percent of domestic consumption. As a percentage of domestic consumption, NBR imports were 17.4 million kilograms, or 23 percent of domestic NBR sales in 1991. In 1991, imports of polybutadiene were 71 million kilograms and accounted for 31 percent of domestic polybutadiene sales. EPDM imports were 13 million kilograms in 1991, which accounted for 7 percent of consumption. SBL imports were 25.5 million kilograms

in 1991, or 11 percent of domestic SBL consumption. Imports of SBR were 55.6 million kilograms, which represented 9 percent of domestic consumption in 1991.[20]

2.6 MARKET OUTLOOK

This section presents quantitative capacity growth forecasts available from the literature for each affected Group I industry. Forecasts are important to the EIA since future market conditions contribute to the potential impacts of the NESHAP which are assessed for the fifth year after regulation.

As discussed in Section 2.4, the domestic *supply* of these synthetic rubbers will be influenced by technology, production costs, and price. One of the underlying conditions that will ultimately affect the supply outlook for synthetic rubber, given increased regulations, is the industry's projected production capacity. Given that current capacity utilization is only at 69 percent of total capacity because of low production and high prices, little expansion is planned in the next five years.[21]

Due to low levels of automobile production, synthetic rubber output has been falling for the past three years. Overall, synthetic rubber producers are faced with weak demand in end-use markets, increasing feedstock costs, and environmental regulation. Performance requirements from the automotive industry are also changing in response to new fuel efficiency and emission standards.

The IISRP has projected positive, but low, levels of demand growth for each of the Group I elastomers through 1997.[22] These demand projections are shown in Table 2-9. With the exception of EPDM, which has an annual growth projection of 4 percent, demand for each of the Group I rubbers is projected to grow between 0.5 percent and 2 percent per year. In contrast, the demand for TPEs is projected to grow 7 percent annually between 1992 and 1997.

TABLE 2-9. SYNTHETIC RUBBER DEMAND FORECASTS (MILLION KILOGRAMS)[22]

	1992	1993	Average Annual Growth: 1992-1997
SBR	806.0	833.0	1.6%
SBL	60.5	61.5	1.8%
Polybutadiene	473.0	484.0	2.0%
EPDM	207.5	221.0	4.0%
Neoprene	75.5	76.5	0.5%
NBR	112.4	113.7	0.8%
Other Synthetics	384.8	396.1	2.2%

These low demand forecasts for Group I rubbers are based on slow growth in the tire and automotive markets. Demand growth for polybutadiene, whose end uses are heavily reliant on the health of the automotive market, is at a low 2 percent. Its use as an impact modifier and a polymer additive will result in a modest increase in sales.[23] The future growth predicted for EPDM demand is based on its increased use in roofing membranes. Although the current lag in housing construction in the United States has negatively affected EPDM demand, its use outside of North America is expected to increase.

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3.0 ECONOMIC METHODOLOGY

3.1 INTRODUCTION

The purpose of this chapter is to outline 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 eleven affected Group I 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 eleven affected industries are also presented.

3.2.1 *Partial Equilibrium Analysis*

A partial equilibrium analysis was used to estimate the economic impacts of the regulatory options for each Group I industry. 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: 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.[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 Group I industries 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 Group I industries range from one to eight. Ignoring other factors, these firms are likely to be characterized as pure monopolists or oligopolists. However, the products produced by these firms have close substitutability with other products produced in the marketplace. Thus, the affected firms producing Group I elastomers face competition not only from other firms producing the same rubbers, and also from firms producing other products 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 elastomer as an input to production.

In some end uses, Group I elastomers compete with each other. Butyl rubber, Hypalon, and EPI, for example, which are each produced by one firm, are substitutes for most of the other standard Group I elastomers, particularly in uses which demand resistance to heat and oil. The presence of close substitutes in the marketplace yields the option of modeling industries with one producer as pure monopolist unsatisfactory. Further adequate modeling of oligopoly markets requires more in-depth economic behavior information than is currently available, or within the scope of this analysis. It is reasonable to conclude that the affected Group I 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 output (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 economic losses and shut down. Since a significant portion of the emission control cost estimates considered 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 the Group I 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 these markets will clear, or achieve an equilibrium. Since engineering control costs were estimated to be zero for the single firm producing Hypalon, this industry will be omitted from the analysis. 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 I elastomer demanded by domestic consumers annually,

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

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

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

P = the price of the Group I elastomer,

ε = the price elasticity of demand for the Group I elastomer, and

γ = the price elasticity of supply for the Group I elastomer.

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 Group I elastomers, 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,
t = the marginal corporate income tax rate,
S = a capital recovery factor,
D = annual depreciation (straight line depreciation is assumed), and
k = the investment cost of emission controls.

Thus, the model assumes that individual elastomer 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, *D* and *S*, which represent depreciation and the capital recovery factor, 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 I elastomer 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 ten Group I industries). The baseline product cost curves for each Group I industry are 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. This 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:

$C\,(C_i, q_i)$ = 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 I elastomer, respectively.

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

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

The impact of the proposed control standards on market equilibrium price and output are 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 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 assumed to be 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 Group I elastomers being analyzed has elastic demand (with the exception of SBL that has demand elasticity of -0.99), 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 market price of each Group I elastomer, 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 price elasticity of demand for SBL is very close to being unitary elastic. The volume and dollar value of imports is expected to rise for SBL while the dollar value of exports should change insignificantly. Thus it is likely that the dollar value of net exports will decline for SBL also.

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,

ΔVNX = the change in the dollar value of net exports, and

ΔNX = the volume change in 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 I facility will close if its post-control supply price exceeds the post-control market equilibrium price. Since most of the affected firms produce diversified products, closure of a facility in the analysis simply means that the firm is likely to cease production of a particular Group I elastomer, or to eliminate one line of production. The closure analysis does not provide an indication that the firm itself will shut down, or that an individual facility would necessarily shut down.

3.2.7 *Changes in Economic Welfare*

Regulatory control requirements will result in changes in the market equilibrium price and quantity of synthetic rubbers produced and sold. These changes in the market equilibrium price and quantity will affect the welfare of consumers of products manufactured with Group I elastomers, 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 deadweight loss, associated with the reduction in the amount of Group I elastomers sold due to higher prices charged for these synthetic rubbers. 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. While the total change in consumer surplus is pertinent from the perspective of the world economy, ΔCS_d , the change in consumer surplus, is relevant to the domestic economy, since it is the welfare impacts to the domestic economy that are most relevant to this analysis.

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 I facilities which continue producing after the incurrence of emission control costs realize a welfare gain on each unit produced as a result of 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 refinements 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 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 an amount equal to 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 each affected Group I 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 Group I 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 regulation 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 the level of production that is anticipated to occur as a result of the emission controls. Employment information is not available on a synthetic rubber-specific basis. For this reason, total production wages paid and hours worked are based upon the levels reported for SIC code 2822, *Synthetic Rubbers (Vulcanizable Elastomers)*. The ratio of production wages to total revenues for SIC code 2822 is calculated. This ratio is then multiplied by the decrease in value of domestic production for each industry 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 2822 based on 1989 price levels.

In the above equation, the number 2,000 represents the number of hours worked annually by an employee, 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 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 2822.

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 I elastomer markets. (Hypalon is omitted from the analysis based upon emission control cost estimates of zero for the one producer in this industry.) 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 I industry. Some of the data inputs were unavailable for the individual synthetic rubber types, or do not differ across Group I elastomer types. Table 3-2 lists variables and parameters that are assumed to be the same for each of the affected Group I industries.

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 each Group I synthetic rubber were obtained from the U.S. Department of Commerce's International Trade Commission (ITC).[2] Imports and exports of each Group I elastomer were obtained from the U.S. Department of Commerce's Bureau of the Census.[3] 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

TABLE 3-1. PRODUCT-SPECIFIC BASELINE INPUTS

Variable/Parameter	Values by Group I Industry									
	Butyl	EPDM	EPI	HBR[3]	NBL	NBR	Neoprene	SBL	SBR	BR
Price (P_0)[1]	$0.36	$2.14	$2.63	$0.36	$2.34	$2.11	$0.75	$1.38	$1.16	$1.04
Domestic Output (Q_0^S)[2]	59.8	270	6.38	86	28.3	63	112	365	647	543
Imports (Q_0^{Sf})[2]	19.1	17.0	0.96	27.5	6.7	15	8.3	38.6	47.1	60.6
Exports (Q_0^{Df})[2]	24.3	91.4	2.31	34.9	6.9	15.4	42.8	66.9	151.8	134.3
Demand Elasticity (ε)	-1.17	-1.23	-1.17	-1.17	-2.78	-2.78	-1.17	-0.99	-3.58	-2.04

NOTES:
[1] Cents per kilogram, excluding taxes (1989$).
[2] Millions of kilograms per year (1991 production levels).
[3] Denotes halobutyl rubber.

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

Variable	Value
Supply Elasticity (γ)	1.49
Tax rate (t)	35%
Private Discount rate (r)	10%
Social Discount rate	7%
Equipment life (T)	10 years
Labor Cost Ratio (LC_0)[1]	10.98%
Energy Cost Ratio (E_0)[2]	4.46%
Wage (W)[3]	$29.38

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 2822 (1989$).

for the actual rates in the economy. The marginal tax rate of 35 percent reflects the 1993 marginal corporate rate for the highest income bracket. Since the affected firms are primarily large multi-product firms, this tax rate seems the most appropriate for this analysis. No attempt has been made to incorporate State or local taxes into this estimate. Additionally, the rates vary from 34 percent to 39 percent for taxable income levels above $100,000 per year. It is reasonable to assume all of the firms subject to the regulation have taxable income exceeding $100,000 per year. The 7 percent social discount rate is consistent with the most current United States Office of Management and Budget (OMB) guidance.[4] 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), for calendar years 1989 and 1991.[5] 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 values reported for SIC code 2822, *Synthetic Rubbers (Vulcanizable Elastomers)*.

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 I industries. The price elasticities of demand and supply for each elastomer were unavailable from published sources. It was therefore determined that the price elasticities 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 elasticities of demand and supply are consistent with economic theory and, at the same time, utilize the available data.

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*. Group I synthetic rubbers 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 rubber type is provided in the *Industry Profile for the Polymer and Resins I NESHAP*.[6] According to the information contained in this profile report, these Group I elastomers are used primarily as inputs to the production of tires, automotive hoses and other automotive parts, building and construction products, and miscellaneous plastic products. Butyl rubber, BR, and SBR are used primarily as an input into tire production, while EPDM is used primarily for building and construction materials. EPI, halobutyl rubber, Neoprene, and SBL have end uses primarily as inputs for miscellaneous rubber products. Finally, NBL and NBR are used to manufacture components for automobiles. In particular, NBR is used to produce hoses that are components of automobiles and other transportation vehicles. The methodology used to estimate the price elasticity of demand for each elastomer will consider the relevant end use market for each rubber type.

The assumption was made that firms using Group I rubbers as inputs into their productive processes seek to maximize profits. The profit function for these firms may be written as follows:

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

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 I elastomer,

Q = the quantity input use of the Group I elastomer,

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 each Group I synthetic rubber. The derived demand equations are of the following form:

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

where:

P = the price of the Group I elastomer,
P_{FP} = the price of the final product, and
P_{OI} = the price of other inputs.

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 I elastomer, and
β_{FP} = the final product price elasticity with respect to the use of the Group I elastomer.

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 prices of other inputs (represented by P_{OI}) have been omitted from the estimated model because data relevant to these inputs were unavailable. The implication of this omission is that the use of Group I elastomers is fixed by technology.

The market price and quantity sold of each Group I synthetic rubber 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.[7] Two-stage least squares (2SLS) is the estimation procedure used in this analysis to estimate the demand equations for the Group I elastomers. 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

2822 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 2822 ($P_{K,L}$).

3.3.2.2 *Data*. Data relevant to the econometric modeling of the price elasticity of demand for each Group I synthetic rubber, including the variable symbol, units of measure, and variable descriptions are listed in Table 3-3. These data were available from the ITC. The data from ITC contain insufficient consistent time series data to estimate the price elasticity of demand for butyl, EPI, halobutyl, NBL, and Neoprene. ITC reports production of these synthetic rubbers in a classification that will be referred to as Other Elastomers. Demand elasticities were estimated econometrically for EPDM, NBR, SBL, SBR, BR,and Other Elastomers using time series price and domestic demand quantity data. A time series of domestic price and sales quantities were obtained for these six synthetic rubber categories from the ITC for the analysis for the years 1970 through 1991.[8]

The final products produced with each Group I elastomer differ, as previously discussed. A series of prices for these final products was sought. Since some of the products are inputs in the production of miscellaneous rubber products, the price index for value of shipments for SIC code 3069, *Fabricated Rubber Products, Not Elsewhere Classified* is relevant to the demand determination, and was obtained from the U.S. Department of Commerce. A subcategory of Group I elastomers are used to produce tires and components for automobiles, so the price index for SIC code 3011, *Tires and Inner Tubes* and SIC code 3052, *Rubber and Plastic Hose and Belting* were also obtained. Time series price indices data were available from the ASM for these variables for the period 1970 through 1991.[9] Three alternative specifications of the Other Elastomers category were attempted using the price indices for SIC code 3011, SIC code 3069, and

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

Variable	Unit of Measure	Description
1. Time Trend - t	-	-
2. Price (Synthetic rubber type) - P[1]	price per kilogram	Annual Average Price
3. Sales Volume of Synthetic rubber type - Q[1]	millions of kilograms	Quantity sold of Synthetic rubber type
4. Price Final Goods - P_{FP}		
a. Fabricated Rubber Products[2]	index	SIC code 3069
b. Tires and Inner Tubes[2]	index	SIC code 3011
c. Rubber and Plastic Hose, Belting[2]	index	SIC code 3052
5. Cost of material inputs[2]	millions of dollars	SIC code 2822
6. Price index for material inputs[2]	index	SIC code 2822
7. Production Worker Wages[2]	millions of dollars	SIC code 2822
8. Production Worker Hours[2]	millions of hours	SIC code 2822
9. Real Capital Stock[2]	millions of 1987$	SIC code 2822
10. Capacity Utilization Factor[3]	percentage	SIC code 28
11. Implicit Price Deflator[4]	index	Base year is 1987

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

SIC code 3052, respectively. Only the empirical results for the Other Elastomers classification using the price index for tires (SIC code 3011) as an end-product was successful. These results are reported, and have been used in this analysis. Since the Other Elastomer category is a composite of a number of elastomers, and since the primary use for all elastomers is for tire production, it is reasonable that the tire end-use predominates this category.

All price data were deflated to reflect real values using the Implicit Gross Domestic Price Deflator obtained from *Business Statistics* for 1970 through 1991.[10] 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.[11]

3.3.2.3 *Statistical Results*. Two-stage least square econometric models were estimated for EPDM, NBR, SBL, SBR, BR, and Other Elastomers, respectively, using the previously discussed data and techniques. The model results for the coefficients of the demand models for these six Group I industry categories are reported in Table 3-4. Standard errors are shown in parentheses. The Other Elastomers category is applicable to butyl, EPI, halobutyl, and Neoprene. Each of the coefficients reported have the anticipated sign and are statistically significant with the exception of the end-use product coefficient for NBL/NBR that is not statistically significant but does have the anticipated sign. Each of the models were adjusted to correct for first-order serial correlation using the Prais-Winsten algorithm. The NBR, NBL, SBR, and Other Elastomers models were also corrected for heteroscedasticity.

The own-price elasticity estimates for each of the Group I elastomers reflect that the demand for each synthetic rubber type is elastic with the exception of SBL which approaches unitary elasticity. 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 I industries. The change in revenue for SBL should approach zero.

TABLE 3-4. DERIVED DEMAND COEFFICIENTS

Product	Own Price β[1]	End-Use β_{FP}[1]
EPDM	-1.23	3.13
	(0.670)	(1.90)
NBR/NBL	-2.78	2.76
	(0.908)	(2.96)
SBL	-0.99	2.13
	(0.181)	(1.11)
SBR	-3.58	5.82
	(0.863)	(0.255)
BR	-2.04	3.08
	(0.326)	(0.450)
Other Elastomers[2]	-1.17	2.11
	(0.550)	(0.995)

NOTES:

[1] Standard errors are shown in parentheses.

[2] Applicable to butyl rubber, EPI, halobutyl, and Neoprene.

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 EPDM of -0.56 and -1.9, for NBR/NBL of -1.87 and -3.69, for SBL of -0.81 and -1.17, for SBR of -2.72 and -4.44, for BR of -1.71 and -2.37, and for Other Elastomers of -0.62 and -1.72 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 I 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 each Group I elastomer produced by domestic 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 Group I facility is defined 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. 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 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 the Group I elastomer,
P_L = the price of labor, and
P_M = the price of materials.

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 Group I synthetic rubbers produced in year t,

K_t = the real capital stock in year t,

L_t = the quantity of labor hours used to produce Group I synthetic rubbers in year t,

M_t = the material inputs in year t, and

$A, \alpha_K, \alpha_L, \alpha_M, \lambda$ = 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 β_i and γ coefficients are functions of the α_i, the coefficients of the production function. The supply elasticity, γ, 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 synthetic rubber 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 available data.

3.3.3.3 *Estimated Model*. The estimated model reflects the industry production function for the Group I synthetic rubber 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 (value of domestic shipments deflated by the price index represent the quantity variable, $\mathbf{Q}_t$ or the dependent variable in the analysis); a

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

Variable	Unit of Measure	Description
Q_t	Millions of dollars	The value of shipments for SIC code 2822 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 2822 adjusted for capacity utilization[1,2]
L_t	Thousand of labor man hours	Production worker hours for SIC code 2822[1]
M_t	Millions of dollars	Dollar value of material input for SIC code 2822 deflated to real values using the materials price index[1]

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

technology time variable, $\boldsymbol{t}$; real net capital stock adjusted for capacity utilization, $\boldsymbol{K_t}$ in millions of dollars; the number of production labor manhours, $\boldsymbol{L_t}$; the material inputs in millions of dollars, $\boldsymbol{M_t}$; and the price index for value of materials. Data to estimate the production function on a rubber-specific basis were unavailable; therefore, data for SIC code 2822 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 2822 adjusted for capacity utilization using the capacity utilization factor.

The capital stock variable represents 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 synthetic rubbers for each year of the study. The most reasonable data for this variable would be the number of machine hours actually used to produce the synthetic rubbers 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, these data are 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 is 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 annually in synthetic rubber production.

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,

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

Variable		Estimated Coefficients[1]
t	time	-0.022 (0.033)
K_t	Capital Stock	.401 (0.087)
L_t	Labor	0.149 (0.101)
M_t	Materials	0.450 (0.065)

NOTES: [1] Standard errors are shown in parentheses.

but only the capital stock and materials coefficient are significantly different from zero with a high degree of confidence.

Using the estimated coefficients in Table 3-6 and the formula for supply elasticity shown in *Section 3.3.3.1, Model Approach*, the price elasticity of supply for the Group I industries is derived to be 1.49. The calculation of statistical significance for this elasticity measure is not a straightforward calculation since the estimated function is 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 0.96.

3.3.3.6 *Limitations of the Supply Elasticity Estimates*. The estimated price elasticity of supply for the affected Group I industries reflects that the synthetic rubber manufacturing industry in the United States will increase production of these products by 1.49 percent for every 1 percent increase in the price of these products. The preceding methodology does not directly estimate the supply elasticities for the individual elastomers 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 categorized under SIC code 2822. This assumption does not seem unreasonable since similar factor inputs are used to produce each of these synthetic rubbers.

The uncertainty of the supply elasticity estimate is acknowledged. To take this uncertainty into account, a sensitivity analysis of the price elasticity supply was conducted. The results of a sensitivity analysis of the price elasticity of supply are presented in Appendix A for a high-end and low-end estimate of the price elasticity of supply of 2.49 and 0.49, respectively.

3.4 CAPITAL AVAILABILITY ANALYSIS

The capital availability analysis outlined in this section is designed to evaluate the impact of the emission controls on the affected firms' financial performance and their ability to finance the additional capital investment in emission control equipment. Sufficient financial data were available to conduct this analysis on a firm level.

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_i is income before interest payments and a_i is total assets. A five year average is used to avoid annual fluctuations that may occur in income data. The regulations could potentially have an effect on income before taxes, n_i, for firms in the industry and on the level of assets for firms in the industry, a_i. The baseline average rate of return on investment for firms in the sample range from minus 6 percent for Bridgestone/Firestone to 18 percent for BASF. The post-control return on investment (*proi*) is calculated for each firm as follows:

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

where:

proi = post-control return on investment,

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

$\vartriangle k$ = change in investment or assets for each firm in the sample.

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

$$\Delta n_n = (\Delta P \bullet q_n) - (\Delta c_n \bullet q_n)$$

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.

An adjustment needs to be made for the marginal firm which will experience post-control changes in production. For each marginal Group I firm, the change in net income is calculated as follows:

$$\Delta n = (\Delta P \bullet q_1 - P_o \bullet \Delta q) - (\Delta c_n \bullet q_1)$$

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 $Q_1^{Sd} - Q_0^{Sd}$.

The change in net income is adjusted to appropriately consider tax effects of changes in income. For affected firms which operate more than one affected facility, the effects of compliance costs on net income and assets were aggregated to a firm level.

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, these measures 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 ratios for Group I firms range from 20 percent for Exxon Corporation to 68 percent for Bridgestone/Firestone. 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 perform this capital availability analysis 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 represent 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.

The methodology used in this analysis reflects a conservative approach to analyzing the changes likely in financial ratios for the affected Group I firms. The potential for decreases in the cost of production to occur for some firms after implementation of emission controls has not been considered. Production costs which may decrease under post-control conditions include labor input and energy input cost decreases. Annualized compliance costs are overstated from a financial income perspective, since these costs include a component for earnings, or return on investment. In general, the approach followed tends to overstate the negative impact of the proposed emission controls on the financial operations of the affected Group I industries.

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4.0 CONTROL COSTS, ENVIRONMENTAL IMPACTS, 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 which were provided on a facility level for each of the affected Group I 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. 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, and front- and back-end process vents. The control costs estimated for each elastomer 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 existing emission sources only given that little new source construction is likely in these industries within the next five years.

Table 4-1 presents the national annualized cost estimates for controlling existing sources for each of the regulated industries in the fifth year after promulgation of the NESHAP.[1] Emission control costs are the annualized capital and annual operating and maintenance costs of controls based on the assumption that all affected synthetic rubber facilities install controls. The engineering contractor established a baseline level of control for each facility, determined which facilities would be required to install controls to meet the provisions of the regulatory alternative, and estimated the cost of the anticipated controls. The single facility in the Hypalon subcategory would not require any additional control to meet the level of control. For this reason, Hypalon is not included in the EIA results presented later in this report. The controls associated with each of the emission points in the remaining Group I industries are discussed separately below.

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.[2] For storage tanks, required control measures range from floating roofs to closed vent systems routed to a control device. 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. The affected facilities that produce styrene-butadiene rubber by emulsion and Hypalon are in compliance with HON equipment leak provisions. Therefore, no emission reductions are achieved, or equipment leak control costs incurred, at facilities producing these two types of elastomers. Emission reductions and compliance costs for which additional control is necessary were calculated as the incremental emission reductions and costs between the existing control program and the HON level. Costs for equipment leak provisions were based on the calculation used in the HON. For process vents, the proposed provisions also resemble the HON. Control may be in the form of a 98 percent reduction in emissions using add-on control, or a process change that alters the vent stream characteristics. For three subcategories (styrene-butadiene rubber by emulsion,

TABLE 4-1. SUMMARY OF GROUP I NESHAP COSTS IN THE FIFTH YEAR BY ELASTOMER INDUSTRY[1]

Group I Industry	Fifth Year Capital Costs (1989 Dollars)	Annual Fifth Year Costs (1989 Dollars)	Annual HAP Emission Reduction (Mg/yr)	Cost-Effectiveness ($/Mg)
Butyl Rubber	$691,158	$1,458,870	596	$2,448
EPDM	$5,956,585	$4,589,591	2,087	$2,199
EPI	$491,203	$296,582	124	$2,392
Halobutyl Rubber	$328,055	$572,946	335	$1,710
Hypalon	$0	$0	0	$0
NBL	$464,737	$291,467	140	$2,082
NBR	$397,265	$675,971	365	$1,852
Neoprene	$560,205	$959,728	354	$2,711
SBL	$1,480,479	$1,212,387	583	$2,080
SBR	$3,941,869	$2,190,864	238	$9,205
BR	$11,780,263	$8,745,806	1,519	$5,758
TOTAL FOR REGULATORY ALTERNATIVE	$26,091,819	$20,994,211	6,341	$3,311

styrene-butadiene and polybutadiene rubber by solution, and ethylene-propylene rubber), the regulatory alternative for back-end process vents is an emission limit based on production levels. The regulatory alternative for back-end process vents at all other subcategories is not expected to require additional control beyond the baseline.[3] 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 also developed using HON methodologies.

As shown in Table 4-1, the total nationwide annualized cost for implementation of the regulatory alternative is $21 million for the 10 affected synthetic rubber industries, excluding Hypalon (and including MRR costs). The majority of these costs are estimated for controlling HAP emissions occurring as the result of the production of EPDM, or the production of BR/SBR by a solution process. Table 4-1 also presents the HAP emission reductions associated with control at the four emission points and the calculated cost-effectiveness for each industry. The cost effectiveness of this regulation ranges from $1,710 per megagram to $9,205 per megagram, or an average of $3,311 per megagram of HAP reduced. Table 4-1 also shows the total investment capital costs by Group I industry. Total capital investment costs are estimated to be $26 million for existing sources five years subsequent to promulgation of the NESHAP.

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 (Group I elastomers) 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 I elastomers and to the deadweight loss in surplus caused by reduced output of these elastomers 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 I 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 Group I 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. 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 4-2 summarizes the economic costs associated with the regulatory alternative. The total economic cost for all of the affected industries combined is $15 million (1989 $).

4.4 ESTIMATED ENVIRONMENTAL IMPACTS

The primary purpose of the NESHAP is to reduce HAP emissions from Group I facilities. Table 4-3 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 6,341 Mg per year. This represents a nearly 50 percent reduction from the industry baseline.

4.5 COST EFFECTIVENESS

Economic cost effectiveness is computed by dividing the annualized economic costs by the estimated emission reductions. The NESHAP has a calculated total cost effectiveness of $2,384 per megagram of HAP reduced.

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.

TABLE 4-2. ANNUAL ECONOMIC COST ESTIMATES FOR THE POLYMERS AND RESINS GROUP I REGULATION

(millions of 1989 dollars)

Group I Industry	Change in Consumer Surplus*	Change in Producer Surplus*	Change in Residual Surplus*	Total Loss In Surplus*
Butyl Rubber	($0.48)	($0.59)	($0.29)	($1.36)
EPDM	($3.61)	$0.27	$0.45	($2.89)
EPI	($0.11)	($0.11)	($0.03)	($0.25)
Halobutyl Rubber	($0.19)	($0.24)	($0.11)	($0.54)
NBL	($0.12)	($0.12)	($0.04)	($0.28)
NBR	($0.41)	($0.17)	($0.07)	($0.65)
Neoprene	($0.64)	($0.01)	$0.02	($0.63)
SBL	($2.97)	$1.30	$0.78	($0.89)
SBR	($2.52)	$0.57	$0.50	($1.45)
BR	($9.12)	$1.56	$1.38	($6.18)
Total	($20.17)	$2.46	$2.59	($15.12)

NOTE: *Brackets indicate economic costs.

TABLE 4-3. ESTIMATED ANNUAL REDUCTIONS IN EMISSIONS AND COST-EFFECTIVENESS ASSOCIATED WITH THE CHOSEN REGULATORY ALTERNATIVE

Group I Industry	HAP Emission Reduction (Megagrams/Yr)	HAP Cost Effectiveness* ($/Year)
Butyl Rubber	596	$2,282
EPDM	2,087	$1,385
EPI	124	$2,016
Halobutyl Rubber	335	$1,612
NBL	140	$2,000
NBR	365	$1,781
Neoprene	354	$1,780
SBL	583	$1,527
SBR	238	$6,092
BR	1,519	$4,068
Total	6,341	$2,384

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

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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 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 affected Group I market. 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 Group I facilities, the post-control supply curve is segmented, or a step function. Underlying production costs for each facility are unknown; therefore, 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 each of the Group I synthetic rubbers in 1991. Net exports are therefore positive for each Group I industry 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 I industry.

Table 5-1 presents the primary impacts predicted by the partial equilibrium model. The range of anticipated price increases vary from a low of $0.002 for halobutyl to a high of $0.022 for EPI per kilogram produced. The percentage price increases for each Group I elastomer range from a high of 2.5 percent for butyl to a low of 0.31 percent for NBR. Production is expected to decrease by 47.76 million kilograms for all Group I elastomers collectively, decreases in domestic production ranging from 0.69 percent for NBL to 4.95 percent for butyl rubber.

The value of domestic shipments, or revenues, for domestic producers is expected to decrease for each affected Group I industry by a total of $29.6 million for all Group I industries combined. The predicted decreases in annual revenues for individual products range from a low of $0.08 million for EPI to a high of $15.24 for BR (1989 dollars). The percent changes range from a low of 0.35 percent for EPDM to a high of 2.7 percent for BR. 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. A 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 I industries follows this trend. It is anticipated that none of the affected facilities will close or shut down as a result of the NESHAP.

The estimated primary impacts reported for the Group I elastomers depend on 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

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

	Estimated Impacts[4,5]			
Group I Industry	Price Increases[1]	Production Decreases[2]	Value of Domestic Shipments[3]	Facility Closures
Butyl				
Amount	$0.009	(2.96)	($0.55)	None
Percentage	2.50%	(4.95%)	(2.58%)	
EPDM				
Amount	$0.019	(3.25)	($2.01)	None
Percentage	0.87%	(1.21%)	(0.35%)	
EPI				
Amount	$0.022	(0.08)	($0.08)	None
Percentage	0.82%	(1.28)%	(0.47%)	
Halobutyl				
Amount	$0.002	(1.18)	($0.22)	None
Percentage	0.68%	(1.37%)	(0.70%)	
NBL				
Amount	$0.004	(0.20)	($0.34)	None
Percentage	0.18%	(0.69%)	(0.51%)	
NBR				
Amount	$0.007	(0.74)	($1.15)	None
Percentage	0.31%	(1.17%)	(0.87%)	
Neoprene				
Amount	$0.008	(1.69)	($0.34)	None
Percentage	1.12%	(1.51%)	(0.41%)	
SBL				
Amount	$0.009	(2.91)	($0.82)	None
Percentage	0.64%	(0.80%)	(0.16%)	
SBR				
Amount	$0.005	(10.22)	($8.88)	None
Percentage	0.40%	(1.58%)	(1.18%)	
BR				
Amount	$0.020	(24.53)	($15.24)	None
Percentage	1.91%	(4.52%)	(2.70%)	

NOTES: [1] Prices are shown in price per kilogram ($1989).
[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.
[5] Hypalon is omitted from the analysis.

analyses are contained 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. (Each of these ratios are explained in detail in Section 3.4.) Net income was averaged for a five-year period (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; therefore, the most recent data available (1990 or 1991) was used in this analysis.

These financial statistics provide insight regarding firms' abilities to raise capital to finance the investment in emission control equipment. Tables 5-2 and 5-3 show the estimated impact on financial ratios for the industry. The total capital investment in control equipment was applied to current debt-equity ratios for the affected firms. Sufficient long-term debt and equity data were available for 11 of the 18 affected firms. Firms which are not represented in Table 5-2 include: BASF, DSM Copolymer, General Tire, Reichhold Chemical, Uniroyal, Ameripol Synpol, and Zeon Chemical. Table 5-2 shows the baseline and post-control debt-equity ratios for each of the firms in the sample. The effects of investment in control equipment on these firms' equity ratios are minimal, with the percentage increases in the debt-to-equity ratios ranging from no change for several firms to 1.5 percent for American Synthetic Rubber.

The effect of the NESHAP on rates of return on investment was analyzed for 16 affected firms. Each affected firm is included in this analysis with the exception of Zeon Chemical and Ameripol Synpol for which the necessary time-series income and assets data were not available. The results of this analysis are shown in Table 5-3. As described in Section 3.4, the effect of the 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-

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

	Long-Term Debt-Equity Ratios (%)			
Firm	Baseline	Post-NESHAP	Difference in Ratios	Percentage Change (%)
American Synthetic Rubber	66.3%	67.3%	0.97	1.46%
Bridgestone/Firestone	68.1%	68.4%	0.37	0.55%
Dow	62.7%	62.7%	0.00	0.00%
DuPont	60.7%	60.7%	0.01	0.02%
Exxon	20.4%	20.4%	0.00	0.01%
Gencorp	61.8%	61.8%	0.03	0.05%
Goodyear	46.6%	46.6%	0.02	0.03%
Miles	53.1%	53.1%	0.01	0.02%
Rhone-Poulenc	32.2%	32.2%	0.00	0.01%
Rohm & Haas	35.1%	35.1%	0.00	0.01%
W.R. Grace	46.7%	46.7%	0.00	0.00%

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

	Net Income to Assets Ratio (%)			
Firm	Baseline	After-Tax Post-NESHAP	Difference in Ratios	Percentage Change (%)
American Synthetic Rubber*	3.7%	4.7%	1.04	28.22%
BASF	18.4%	18.4%	0.00	0.01%
Bridgestone/Firestone	(6.4%)	(6.8%)	(0.35)	(5.44%)
Dow Chemical	8.7%	8.7%	(0.01)	(0.11%)
DSM Copolymer	2.1%	2.1%	0.00	(0.13%)
DuPont	2.7%	2.7%	0.00	(0.12%)
Exxon	5.9%	5.9%	0.00	(0.03%)
Gencorp	3.5%	3.5%	0.01	0.18%
General Tire*	3.4%	2.5%	(0.89)	(26.07%)
Goodyear	4.2%	4.3%	0.03	0.74%
Miles	2.2%	2.1%	(0.08)	(3.50%)
Reichhold	1.3%	1.3%	(0.01)	(0.41%)
Rhone-Poulenc	11.5%	11.4%	0.00	0.04%
Rohm & Haas	9.8%	9.9%	0.02	0.18%
Uniroyal	10.4%	10.5%	0.04	0.38%
W.R. Grace	3.5%	3.5%	0.04	0.11%

NOTES: *These 2 firms are subsidiaries of larger firms. The financial data used in this analysis represent data for the subsidiary company.

NESHAP decreases in production. The effect of the regulation on firms' asset levels is equal to the capital investment necessary for the purchase of control equipment. Table 5-3 shows the incremental change in net income-to-assets ratios after incurrence of NESHAP costs, as well as the percentage change in return on investment for each firm. Incremental changes in net income-to-assets ratio range from a decrease of 0.89 percentage points to an increase of 1.04 percentage points. Effects range from a negative percentage change of 26.07 percent for General Tire to a positive percentage change of 28.22 percent for American Synthetic Rubber. Although both of these firms are subsidiaries of larger firms, the data used in this analysis reflect data for the affected subsidiary only. Several firms are expected to experience a positive financial impact as a result of the regulations. This occurs primarily as a result of the estimated per unit price increase for the industry exceeding the firm's per unit compliance cost. The results of the financial impact and capital availability analyses are consistent with the worst-case assumption made in the model that facilities with the highest control costs per unit of production are assumed to also have the highest pre-control per unit costs of production. Facilities with the highest per unit costs relative to the expected increase in market price, therefore, are predicted to experience the most significant adverse post-NESHAP impacts. The results in Table 5-3 are consistent with assumptions made in the partial equilibrium model.

In analyzing the financial performance and resources of the affected firms, however, it is important to keep in mind the scope of their activities. The major portion of revenues generated by these firms do not derive from Group I elastomer production. For example, BASF is primarily a chemical corporation which produces industrial organics. BASF's polymers division, while vertically integrated, accounted for only 15.7 percent of all BASF sales revenues for 1992. Dow Chemical owns 91 percent of SBR production capacity. In their annual report, SBR production is included in their "value added industrial specialties" category. All products produced in this category accounted for 24 percent of Dow sales for 1991. Du Pont reports show that sales from their polymers division have represented 12 percent of gross sales for the past three years. Goodyear does not provide industry segmented revenues, although its principal business is identified as "the development, manufacture, distribution, and sale of tires." Although Goodyear owns 26 percent of SBR production capacity and 39.2 percent of polybutadiene capacity, synthetic rubber is listed in its 1992 annual report as a tertiary source of sales revenue. Given Goodyear's significant degree of vertical integration, much of the synthetic rubber Goodyear produces is captively consumed by their tire production sector.

5.4 LIMITATIONS

Several qualifications of the primary impact results 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 I elastomer producers. The analysis also assumes that the facilities with the highest control costs are marginal in the post-control market. The result of these qualifications is overstatement of the impacts of the chosen alternative on the market equilibrium price and quantity, and revenues. 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.

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 price increases for each Group I industry range from a low of $0.002 per kilogram for halobutyl to a high of $0.022 per kilogram for EPI, based upon 1989 price levels. These predicted price increases represent percent increases ranging from a low of 0.18 percent for NBL to a high of 2.5 percent for butyl rubber. Domestic production will decrease for each of the Group I synthetic rubbers in amounts ranging from 0.08 million kilograms for EPI to 24.53 million kilograms for BR. This estimated percent decrease in annual production for each of the elastomers varies from a low of 0.69 percent for NBL to a high of 4.95 percent for butyl rubber. Emission control costs are small relative to the financial resources of affected producers, and on average, Group I 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 in the following sections.

6.2 LABOR MARKET IMPACTS

The estimated labor impacts associated with the NESHAP are based on the results of the partial equilibrium analyses of each Group I industry, and are reported in Table 6-1. The number of workers employed by firms in SIC code 2822 is estimated to decrease by approximately 100 workers as a result of the proposed emission controls. These job losses should be considered transitory in nature. The estimated loss in number of workers is the result of the projected reductions in levels of production reported in Chapter 5 for each of the Group I elastomers. 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 substitutes for Group I elastomers. Similarly, losses in employment in industries that use Group I synthetic rubbers 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 the domestic production levels of Group I elastomers.

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

	Estimated Impacts[1,4]	
Group I Industry	Labor Input[2]	Energy Input[3]
Butyl		
Amount	(2)	($0.05)
Percentage	(4.95%)	(2.2%)
EPDM		
Amount	(13)	($0.31)
Percentage	(1.21%)	(0.68%)
EPI		
Amount	(0.4)	($0.01)
Percentage	(1.28%)	(0.66%)
Halobutyl		
Amount	(1)	($0.02)
Percentage	(1.34%)	(0.61%)
NBL		
Amount	(1)	($0.02)
Percentage	(0.69%)	(0.28%)
NBR		
Amount	(3)	($0.07)
Percentage	(1.17%)	(0.48%)
Neoprene		
Amount	(2)	($0.06)
Percentage	(1.51%)	(0.89%)
SBL		
Amount	(8)	($0.18)
Percentage	(0.80%)	(0.35%)
SBR		
Amount	(22)	($0.53)
Percentage	(1.58%)	(0.77%)
BR		
Amount	(48)	($0.11)
Percentage	(4.23%)	(2.12%)

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] Hypalon is omitted from the analysis.

The loss in employment is relatively small in terms of the number of eliminated jobs. The magnitude of predicted job losses directly results from the relatively small estimated decrease in production anticipated and the relatively low labor intensity in these synthetic rubber industries.

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 $1.36 million (1989$) for all of the Group I industries collectively is expected to result from this proposed regulation. The changes in energy inputs for individual Group I industries are reported in Table 6-1. As production decreases, the amount of energy input utilized by each affected Group I industry also declines. The estimated changes in energy use do not consider the increased energy use associated with the operation and maintenance of emission control equipment. Insufficient data were available to consider such changes in energy costs.

6.4 FOREIGN TRADE

The implementation of the NESHAP will increase the costs of production for domestic Group I elastomer producers relative to foreign elastomer producers, all other factors being equal. This change in the relative price of imports will cause domestic imports of Group I synthetic rubbers to increase and domestic exports of Group I rubbers to decrease. The overall balance of trade for Group I elastomers is positive in the baseline (exports exceed imports). The NESHAP is likely to cause the balance of trade to become less positive. The range of estimated net export decreases ranges from 0.03 million kilograms annually for EPI to 6.8 million kilograms for BR annually. The predicted changes in the trade balance for each individual Group I industry are reported in Table 6-2.

TABLE 6-2. FOREIGN TRADE (NET EXPORTS) IMPACTS OF POLYMERS AND RESINS GROUP I NESHAP

	Estimated Impacts[1,4]		
Group I Industry	Amount[2]	Percentage	Dollar Value of Net Export Change[3]
Butyl	(1.41)	(27.05%)	($0.47)
EPDM	(1.19)	(1.59%)	($1.18)
EPI	(0.03)	(2.50%)	($0.06)
Halobutyl	(0.56)	(7.43%)	($0.18)
NBL	(0.05)	(34.38%)	($0.12)
NBR	(0.20)	(58.34%)	($0.42)
Neoprene	(0.69)	(2.00%)	($0.23)
SBL	(0.79)	(2.79%)	($0.85)
SBR	(2.46)	(2.35%)	($2.37)
BR	(6.80)	(9.23%)	($5.75)

NOTES:
[1] Brackets indicate reductions or negative values.
[2] Millions of kilograms.
[3] Millions of dollars ($1989).
[4] Hypalon is omitted from the analysis.

6.5 REGIONAL IMPACTS

No significant regional impacts are expected from implementation of the proposed NESHAP. No facility closures are predicted to occur as a result of the regulations. In general, market impacts are not significant and will not affect any particular region of the country disproportionately.

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 Group I industries. The limitations described in Section 5.4 of this report are also applicable to the secondary economic impacts presented 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 markets that use Group I synthetic rubbers 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 Polymers and Resins Group I industries.

6.7 SUMMARY

The estimated secondary economic impacts are relatively small. Approximately 100 job losses may occur nationwide. Energy input reductions are estimated to be $1.36 million annually (1989$). A decrease in net exports of 14.18 million kilograms annually for all Group I industries 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 typically 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 Group I NESHAP, this analysis will focus on the remaining two criteria: the potential for closure, and a comparison of the compliance costs as a percentage of sales. EPA's most recent guidance on implementing the Regulatory Flexibility Act provides that *any* impact on small businesses is considered to be significant, and 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 I NESHAP is warranted.

7.3 SMALL BUSINESS CATEGORIZATION

Consistent with U.S. Small Business Administration (SBA) size standards, an elastomer producing firm is classified as a small business if it employs less than 1,000 workers. 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 I firms were small businesses was obtained from national directories of corporations. Based upon the SBA size criterion and the employee data which were presented in Chapter 2.0 of this report, the firms affected by the Group I NESHAP that employ less than 1,000 employees include: American Synthetic Rubber Corporation, Ameripol Synpol, DSM Copolymer, Hampshire Chemical, and Zeon Chemical. Of these 5 firms, American Synthetic Rubber Corporation and Ameripol Synpol are affiliated with larger business entities; there are, therefore, 3 affected small firms.

7.4 SMALL BUSINESS IMPACTS

Since the results of the partial equilibrium analysis lead to the conclusion that none of the affected Group I facilities are at risk of closure, this criterion for adverse small business effects is not met.

The remaining criterion for determining the significance of small business impacts is to analyze the total annual compliance costs as a percentage of sales for small firms. Sales and annualized compliance cost data for the three small businesses are shown in Table 7-1. In 1991, sales for these firms ranged from $94 million (1989 dollars) for DSM Copolymer to $195 million (1989 dollars) for Hampshire Chemical. Total compliance cost estimates for these firms based on 1991 production range from $82,577 for Hampshire Chemical to $799,835 for DSM Copolymer. Expressed as percentages of total sales, costs range from 0.04 percent for Hampshire Chemical to 0.85 percent for DSM Copolymer. Because the ratios in Table 7-1 are low, the conclusion is drawn that a significant number of small businesses are not adversely affected by the proposed regulations.

TABLE 7-1. COMPLIANCE COSTS AS A PERCENTAGE OF SALES AT SMALL GROUP I FIRMS

Firm	1991 Sales (Million 1989 $)[1]	Compliance Costs (Million 1989 $)	Cost-to-Sales Ratio
DSM Copolymer	$ 94	$0.80	0.85%
Hampshire Chemical	$195	$0.08	0.04%
Zeon Chemical	$98	$0.30	0.31%

NOTE: [1] Economic Indicators

REFERENCES

1. U.S. Congress, Council of Economic Advisors. Economic Indicators: September 1993. Prepared for the Joint Economic Committee. Washington, DC. September 1993.

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 models. The analysis of the price elasticity of demand will presume the supply elasticity is 1.49 as hypothesized in the partial equilibrium model. Alternatively, the sensitivity analysis of supply elasticities will assume that the demand elasticity estimates postulated in the model and listed under the *Elasticity Measure* column in Table A-1 are accurate for each of the Group I elastomers.

The results presented in this appendix are based upon price elasticities of demand estimates for each Group I industry 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 I elastomer.

TABLE A-1. PRICE ELASTICITY OF DEMAND ESTIMATES

Group I Industry	Elasticity Measure	High Estimate	Low Estimate
Butyl	-1.17	-1.72	-0.62
EPDM	-1.23	-1.90	-0.56
EPI	-1.17	-1.72	-0.62
Halobutyl	1.17	-1.72	-0.62
NBL	-2.78	-1.87	-3.69
NBR	-2.78	-1.87	-3.69
Neoprene	-1.17	-1.72	-0.62
SBL	-0.99	-1.17	-0.81
SBR	-3.58	-4.44	-2.72
BR	-2.04	-2.37	-1.71

The results of the sensitivity analysis results 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.

The results of the low-end demand elasticity scenario differ very little from the reported results presented in Chapter 5 of this report. The signs of the changes in price and quantity are unchanged, and the relative size of the changes are not significantly altered. Revenue changes become slightly positive for some Group I industries with inelastic price elasticity of demand measures. The results of this analysis tend to present relatively more favorable results for the Group I industries with lower output and revenue declines and larger price increases. In general, the scenario for the high-end elasticity results in primary market impacts that do not differ significantly from previously reported results for price increases and quantity decreases for most of the Group I industries. However, the results are less favorable for Group I industries with lower price increases and greater output and revenue decreases.

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

Group I Industry	Market Price Change (%)	Domestic Market Output Change (%)	Change in the Value of Shipments (%)
Butyl	3.14	(4.01)	(1.00)
EPDM	1.15	(0.79)	0.35
EPI	1.03	(0.96)	(0.06)
Halobutyl	0.86	(1.11)	(0.26)
NBL	0.23	(0.62)	(0.39)
NBR	0.39	(1.05)	(0.66)
Neoprene	1.40	(1.08)	0.31
SBL	0.69	(0.72)	(0.04)
SBR	0.49	(1.46)	(0.98)
BR	2.10	(4.23)	(2.22)

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 I Industry	Market Price Change (%)	Domestic Market Quantity Change (%)	Change in the Value of Shipments (%)
Butyl	2.07	(5.57)	(3.61)
EPDM	0.70	(1.46)	(0.77)
EPI	0.68	(1.49)	(0.82)
Halobutyl	0.56	(1.54)	(0.98)
NBL	0.15	(0.74)	(0.59)
NBR	0.26	(1.25)	(1.00)
Neoprene	0.93	(1.79)	(.88)
SBL	0.60	(0.86)	(0.27)
SBR	0.35	(1.67)	(1.33)
BR	1.74	(4.75)	(3.09)

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

The results of the sensitivity analyses under the low-end and high-end price elasticity of supply scenarios are reported in Table A-4 and Table A-5, respectively. The high estimate used in this analysis was 2.49, and the low-end estimate used in this analysis was 0.49. 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 I industries than those previously reported in Chapter 5, with smaller output and revenue decreases. The price increases decline, however. In contrast, the results under the high-end elasticity scenario are generally less favorable for the affected industries.

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

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

Group I Industry	Market Price Change (%)	Domestic Market Quantity Change (%)	Change in the Value of Shipments (%)
Butyl	1.34	(2.24)	(0.94)
EPDM	0.45	(0.60)	(0.15)
EPI	0.43	(0.61)	(0.18)
Halobutyl	0.36	(0.61)	(0.25)
NBL	0.08	(0.28)	(0.20)
NBR	0.13	(0.47)	(0.34)
Neoprene	0.59	(0.76)	(0.17)
SBL	0.35	(0.40)	(0.05)
SBR	0.17	(0.64)	(0.48)
BR	0.88	(2.02)	(1.16)

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

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

Group I Industry	Market Price Change (%)	Domestic Market Quantity Change (%)	Change in the Value of Shipments (%)
Butyl	2.99	(6.90)	(4.12)
EPDM	1.06	(1.53)	(0.49)
EPI	0.99	(1.70)	(0.72)
Halobutyl	0.82	(1.92)	(1.11)
NBL	0.25	(0.99)	(0.75)
NBR	0.42	(1.68)	(1.27)
Neoprene	1.35	(1.93)	(0.60)
SBL	0.76	(1.03)	(0.28)
SBR	0.56	(2.24)	(1.69)
BR	2.46	(6.08)	(3.78)

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