Economic Impact Analysis of the Fabric and Textiles Printing, Coating, and Dyeing NESHAP: Final Rule

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Economic Impact Analysis of the Fabric and Textile Printing, Coating, and Dyeing NEHSAP: Final Rule

Final Report

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Standards and Strategies Division
Innovative Strategies and Economics Group
Research Triangle Park, North Carolina.

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EXECUTIVE SUMMARY

The Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS) has developed a National Emission Standard for Hazardous Air Pollutants (NESHAP) under Section 112 of the Clean Air Act (CAA) Amendments of 1990 to limit air emissions from the production of coated, printed, dyed, slashed, or finished fabrics. This document analyzes the economic impacts of the NESHAP on the fabric coating and finishing industries and their customers.

Coated fabric products fall under the North American Industry Classification System (NAICS) 313320, Fabric Coating Mills. Finished fabrics are categorized under NAICS 313311, Broadwoven Fabric Finishing Mills; NAICS 313312, Textile and Fabric Fishing (Except Broadwoven Fabric) Mills; and part of NAICS 313210, Broadwoven Fabric Mills. All the affected NAICS codes are part of the textile industry, which has experienced difficult market conditions associated with increased international competition over the past decade. This has resulted in plant closures, restructuring of ownership, increasing automation, and some company bankruptcies. This recent industry experience is reflected in EPA's modeling of impacts in the finishing sector.

EPA has determined that textile coating and finishing operations are a source of hazardous air pollutants (HAPs). The principal source of HAPs is the use of solvents in the production process. Emissions from the production of coated and finished fabrics come from various stages of the industrial process. The preparation of coating/finishing materials in mills, mixers, and tanks prior to application; the coating/finishing application area; the flash-off area; and the drying ovens are all sources of HAP emissions. These processes are described in detail in Section 2.1. EPA combined information from a facility-specific database with information from publicly available sources to profile the industry.

EPA used detailed facility-specific operations data provided by industry to assess baseline emissions and estimate the costs of complying with the NESHAP (See Section 3). For the coating and printing subcategory, compliance activities include installing and operating control equipment as well as monitoring, recordkeeping, and reporting (MRR) activities. EPA developed compliance cost estimates for a variety of model plants. Most facilities in the coating subcategory are expected to incur some compliance costs above MRR costs. For the finishing, dyeing, and slashing subcategory, EPA identified 7 facilities that would be required to reformulate their finishing chemicals to reduce formaldehyde emissions. All other facilities in the finishing subcategory are estimated to incur only MRR costs. Estimated national costs of the regulation are shown in Table ES-1.

Table ES-1. Summary of Textile Coating, Printing, Slashing, Dyeing, and Finishing NESHAP

Nationwide Cost Component	Nationwide Total Capital Investment ($\$10^6$)	Nationwide Total Annual Cost ($\$10^6$)
Coating and printing subcategory control costs	17.6	5.6
Dyeing and finishing subcategory reformulation costs		7.5
Source category MRR costs	1.2	1.4
Nationwide total compliance costs	18.8	14.5

To analyze the impacts of the NESHAP, EPA constructed a model of national markets for finished and coated fabrics. EPA's analysis, reported in Section 4, projects that market impacts of the NESHAP will be very small. Production of coated fabrics is projected to decline by less than one-tenth of a percent, as is production of finished fabrics. EPA's facility database contained identifying information for only a subset of the facilities, so EPA collected information on companies owning fabric coating and finishing facilities from publicly available financial databases. Using these data, EPA compared the minimum, median, mean, and maximum costs of compliance for its model plants with company sales revenues. EPA's cost-to-sales analyses indicate that, based on median compliance costs, the majority of companies would find complying with the NESHAP affordable.

EPA paid particular attention to assessing impacts to small businesses in the industry. Both the fabric coating and finishing industries have a large share of small businesses. For most of the NAICS codes affected by the NESHAP, small businesses are defined as those with 1,000 or fewer employees. Of 248 companies identified in publicly available financial databases as owning facilities in the applicable NAICS codes, 181 are classified as possibly small (this total includes companies without employment data). Thus, EPA was aware that there was the potential to adversely impact small businesses. In the finishing subcategory, only 7 facilities, owned by 5 companies, incur significant costs. Of the 5 companies, only one is identified, and it is not a small business. Thus, in the finishing subcategory, only at most four small businesses could incur substantial costs. In the coating subcategory, costs are estimated based on model plants, and EPA does not generally have sufficient data to estimate the costs for individual facilities. To assess potential impacts on small businesses owning fabric coating facilities, therefore, EPA collected additional process and control data for small businesses that could potentially incur costs. EPA estimated facility-specific compliance costs for 18 small businesses. Of these, only three are projected to incur costs exceeding 1 percent of their baseline sales. Only one of these is projected to incur costs exceeding three percent of baseline sales (3.2 percent). EPA therefore does not believe that the rule will impose significant impacts on a substantial number of small businesses.

SECTION 1

INTRODUCTION

The Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS) has developed a National Emission Standard for Hazardous Air Pollutants (NESHAP) under Section 112 of the Clean Air Act (CAA) Amendments of 1990 to limit air emissions from the production of coated, printed, dyed, slashed, or finished fabrics. This document analyzes the economic impacts of the NESHAP on the fabric coating and finishing industries and their customers.

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The textile finishing industry is mostly engaged in bleaching, dyeing, printing, and finishing (i.e., preshrinking, calendering, and napping) fabrics, yarn, or raw stock. Fabrics are finished to enhance their performance attributes (e.g., to impart permanent-press characteristics). Most companies do at least some commission work, that is, dyeing and finishing fabrics that are owned by other companies. Finished fabrics serve three markets: apparel, home furnishings, and industrial. All the affected NAICS codes are part of the textile industry, which has experienced difficult market conditions associated with increased international competition over the past decade. This has resulted in plant closures, restructuring of ownership, increasing automation, and some company bankruptcies. To reflect this recent industry experience, EPA has assumed that textile finishers will be unable to increase the price of their products in response to the rule. Foreign producers are assumed to increase their output to compensate for any reductions in domestic output, so that market price and quantity in the textile finishing sector remain unchanged due to the rule.

EPA has determined that textile coating and finishing operations are a source of hazardous air pollutants (HAPs). The principal source of HAPs is the use of solvents in the production process. Emissions from the production of coated and finished fabrics come from various stages of the industrial process. The preparation of coating/finishing materials in mills, mixers, and tanks prior to application; the coating/finishing application area; the flash-off area; and the drying ovens are all sources of HAP emissions. These processes are described in detail in Section 2.1. EPA combined information from a facility-specific database with information from publicly available sources to profile the industry.

EPA used detailed facility-specific operations data provided by industry to assess baseline emissions and estimate the costs of complying with the NESHAP (See Section 3). For the coating and printing subcategory, compliance activities include installing and operating control equipment as well as monitoring, recordkeeping, and reporting (MRR) activities. EPA developed compliance cost estimates for a variety of model plants. Most facilities in the coating subcategory are expected to incur some compliance costs above MRR costs. For the finishing, dyeing, and slashing subcategory, EPA identified seven facilities that would be required to reformulate their finishing chemicals to reduce formaldehyde emissions. All other facilities in the finishing subcategory are estimated to incur only MRR costs.

To analyze the impacts of the NESHAP, EPA constructed a model of national markets for finished and coated fabrics. EPA's analytical approach and results are described in Section 4 and Appendix A.

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SECTION 2

INDUSTRY PROFILE

This industry profile provides a basic understanding of the fabric coating, printing, slashing, dyeing, and finishing operations to support the economic impact analysis (EIA) of the NESHAP. Coated fabric products fall under the North American Industry Classification System (NAICS) 313320 Fabric Coating Mills. Finished fabrics are categorized under NAICS 313311 Broadwoven Fabric Finishing Mills; NAICS 313312, Textile and Fabric Finishing (Except Broadwoven Fabric) Mills; and part of NAICS 313210, Broadwoven Fabric Mills. Table 2-1 lists the textile mill products produced by affected entities along with the respective NAICS codes of the industries to which those entities belong.

The fabric coatings industry produces a wide variety of products, all of which are created by coating a textile substrate with various polymers. The final product takes on characteristics of both the substrate and the coating. Products made by the industry include air bags, clothing, wall coverings, upholstery, tarpaulins, tents, air inflated structures, and pond liners. The almost infinite variety of combinations of coating and fabric materials allows for the production of highly technical products with specialized performance characteristics. Consequently, coated fabrics can be found serving many different functions in the manufacturing, road building, apparel, aircraft, automotive, boating, transportation, outdoor equipment, mining, and other industries. Despite the wide variety of products, they are all created using similar processes. A coating is dipped, rolled, laminated, or spread onto a fabric substrate.

The textile finishing industry is mostly engaged in bleaching, dyeing, printing, and finishing (i.e., preshrinking, calendering, and napping) fabrics, yarn, or raw stock. Fabrics are finished to enhance their performance attributes (e.g., to impart permanent-press characteristics). Most companies do at least some commission work, that is, dyeing and finishing fabrics that are owned by other companies. Finished fabrics serve three markets: apparel, home furnishings, and industrials. Apparel and home furnishings account for 75 to 80 percent of broadwoven fabric production in the United States (Marlow-Ferguson, 2001).

Table 2-1. Types of Primary Products in Coated and Finished Fabrics Industries (NAICS 313320, 313311, 313312, and 313210)

Industry/Primary Product	NAICS Code
Fabric Coating Mills (NAICS 313320)	
Vinyl-coated fabrics, including expanded vinyl coated	3133201
Rubber-coated fabrics	3133203
Other coated or laminated fabrics and coated yarns, not rubberized	3133205
Broadwoven Fabric Finishing Mills (NAICS 313311)	
Finished cotton broadwoven fabrics (not finished in weaving mills)	3133111
Job or commission finishing of cotton broadwoven fabrics	3133113
Finished manmade fiber and silk broadwoven fabrics (not finished in weaving mills)	3133115
Job or commission finishing of manmade fiber and silk broadwoven fabrics	3133117
Finished broadwoven wool fabrics and felts (finished in weaving mills)	3133119
Textile and Fabric Finishing (Except Broadwoven Fabric) Mills (NAICS 313312)	
Finished fabrics (except broadwoven) and other finished textiles	3133120
Broadwoven Fabric Mills (NAICS 313210)	
Finished cotton broadwoven fabrics (finished in weaving mills)	3132109
Finished manmade fiber and silk broadwoven fabrics (finished in weaving mills)	313210P
Finished broadwoven wool fabrics and felts (finished in weaving mills)	313210U

Sources: U.S. Census Bureau. 1999a. Broadwoven Fabric Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3132a.pdf>.
U.S. Census Bureau. 1999b. Broadwoven Fabric Finishing Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133a.pdf>.
U.S. Census Bureau. 1999c. Textile and Fabric Finishing (Except Broadwoven Fabric) Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133b.pdf>.
U.S. Census Bureau. 1999d. Fabric Coating Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133c.pdf>.

EPA has determined that textile coating and finishing operations are a source of hazardous air pollutants (HAPs). The principal source of HAPs is the use of solvents in the production process. Emissions from the production of coated and finished fabrics come from various stages of the industrial process. The preparation of coating/finishing materials in mills, mixers, and tanks prior to application; the coating/finishing application area; the flash-off area; and the drying ovens are all sources of HAP emissions. These processes are described in detail in Section 2.1. Emissions are dealt with by using a capture and a control device. Given the similarity among sources, it is not surprising that similar abatement technologies are used across the industry. Capture devices are typically covers, vents, hoods, and partial or total enclosures (EPA, 1988). The most common control devices are incinerators and absorbers.

This profile presents background information on these topics organized within a conventional economic framework.

- Section 2.1 includes a description of the production process and its costs.
- Section 2.2 is an examination of the demand side of the industry, which includes the characteristics, uses, and consumers of coated/finished fabric products and substitution possibilities in consumption.
- Section 2.3 discusses the industry's organization and provides information on both market structure and companies that own potentially affected plants (i.e., size and location data and their financial characteristics). Special attention is given to data on small businesses as required by the Small Business Regulatory Enforcement and Fairness Act (SBREFA) and the Regulatory Flexibility Act (RFA).
- Section 2.4 presents the market data to be used in the EIA. This section provides data on production, consumption, exports and imports, and prices in industries affected by this NESHAP.

2.1 The Supply Side

This section describes the supply side of the textile coating and finishing industry. Figure 2-1 presents basic textile processes (i.e., dry and wet processing) related to fabric printing, coating, dyeing, and finishing. The first part of this section illustrates the coating process and describes materials used in the production process and production techniques, followed by a brief description of the finishing production process. A discussion of

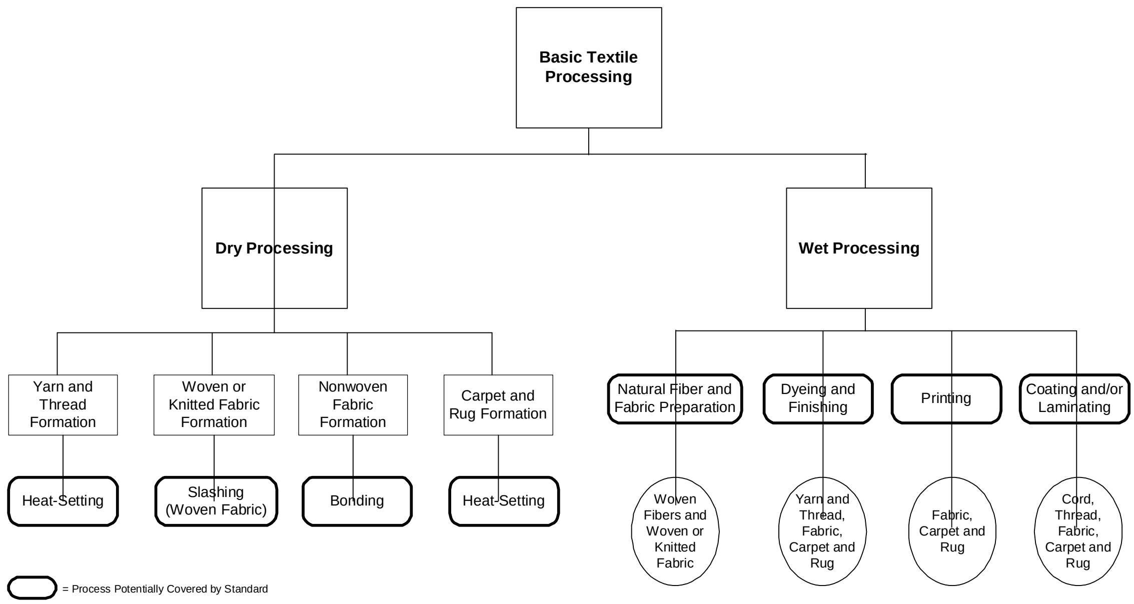


Figure 2-1. Fabric Printing, Coating, and Dyeing Source Category

production costs gives a detailed summary of the costs suppliers face in the production of coated and finished fabric products.

2.1.1 Coating Production Process

A similar production process is used to create a wide array of different products in the fabric coatings industry. All products are composed of a fabric substrate to which a polymer coating is applied, giving the product characteristics of the coating and the fabric. The fabric gives the product strength, structure, and flexibility. The coating significantly enhances the fabric's performance capabilities and provides qualities such as water repellency, flame retardence, chemical resistance, increased strength, and abrasion resistance. Coatings are composed of the polymer base, solvents, pigments, plasticizers, lubricants, and fillers. These ingredients are prepared in mills and mixers to ready the material for application to the fabric. The coating is applied using a variety of techniques that dip, roll, or spread the coating onto the fabric material. The process must ensure that the fabric is not damaged during coating application. After application, the product passes through a flash-off area on its way to the drying and curing ovens. These ovens mark the final stage of the production process, where the coating is fused to the substrate. A diagram of the production process is shown in Figure 2-2.

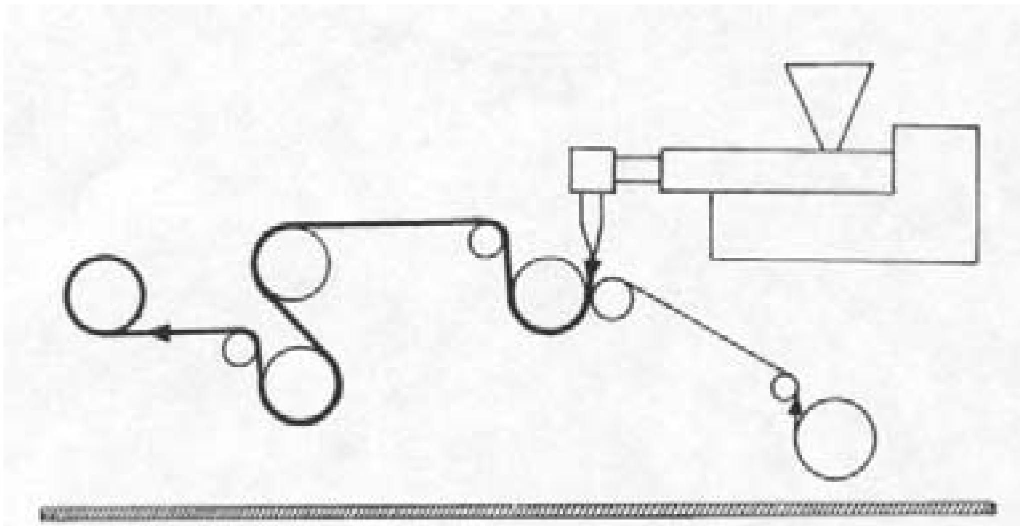


Figure 2-2. Extrusion Coating Plant

Source: Wypych, J. 1988. *Polymer Modified Textile Materials.* New York: John Wiley & Sons.

2.1.1.1 Substrates

The substrate used depends on the type of product desired. Characteristics such as tear strength, tensile strength, dimensional stability, and flexibility are heavily influenced by the choice of the textile material and the way in which it is constructed. The strength and weight of a fabric depend on the construction method, the size and weight of the yarn, and the number of yarns per unit area in the fabric. The most common fabric construction types are weaves, knits, and nonwoven fabrics. Woven fabrics are very strong and are resistant to elongation. Knitted substrates allow the fabric to be stretched and contoured. Stretching allows for tear resistance, but the coating must be able to stretch and flex along with the fabric. Nonwoven fabrics are less expensive to construct but are not strong unless they are coated. Unlike knits and weaves, a coating must be used to impart stability to a nonwoven fabric.

Cotton, nylon, polyester, polypropylene, rayon, glass, and blends are the most common types of textile materials. Among these, polyester, cotton, and nylon accounted for over 90 percent of coated fabrics sold in 1998 (Industry News, 1999). Nylon is the strongest material used in coated fabrics. Its performance qualities include good abrasion resistance, high tensile strength, wet strength, excellent flexibility, and elasticity, and it can be heat set to reduce shrinkage. Although sunlight degrades its performance characteristics, the coating can eliminate this problem.

Polyester is not unlike nylon and is used in many similar applications. It is the most commonly used substrate fiber (Industry News, 1999). Although polyester is more resistant to environmental degradation than nylon, the application of coatings is more problematic. The fibers have a very smooth surface that creates bonding difficulties. Polypropylene is very inexpensive and has the highest weight-to-strength ratio among common fibers. Like polyester, it is difficult to apply a durable coating to polypropylene. It is also susceptible to heat damage.

Cotton absorbs and transmits moisture very easily and is commonly used in apparel products. It can act as a barrier under intense heat and is stronger when wet. Rayon is a synthetic form of cotton; it is not as strong as cotton and tends to shrink. Mechanical adhesion to rayon is difficult, but chemical adhesion and dyes are easily imparted to the fabric. Glass is used in conveyor belts and other applications where rigid reinforcement is needed. It resists high temperatures, is chemically inert, and has high tensile strength, but it breaks easily when bent. High-strength fibers such as kevlar and other carbon fibers are used in the industry for specialized applications.

2.1.1.2 Coatings

The most common coating materials used in the industry are vinyl (PVC), polyurethane, and rubber compounds. Other compounds, such as acrylic and teflon, are also used to produce coated fabrics. PVC is often the least expensive coating material, but it does not always provide the desired product performance qualities. There is no unique solution to polymer choice in coatings because different materials can be used to achieve similar results in the end product. The manufacturer’s choice of polymer is affected by polymer properties, polymer availability, cost analysis, coating equipment to be used, tradition, and environmental protection (Wypych, 1988).

Prior to application, base polymers are mixed in tanks with plasticizers and solvents to adjust viscosity. The viscosity of the coating must permit flow around the fiber surface (Kroschwitz, 1986). Pigments, lubricants, stabilizers, and fillers are also added to the mixture to form the coating material. From the mixing tanks, the coating is transported to the line of production, where it is applied using various techniques discussed later in this report.

PVC is the most commonly used polymer. It is inexpensive and resistant to combustion, chemicals, aging, and abrasion, and it can be applied to the substrate using a variety of techniques. With the use of plasticizers, PVC can be processed into a soft, manageable compound that can be easily applied to a fabric. PVC is used to produce coated products such as tarpaulins, tents, roofing materials, greenhouses, boat covers, boats, conveyor belts, pool covers, rainwear, luggage, automotive upholstery, and a variety of chemical protective clothing products [i.e., vapor protective or liquid-splash protective suits] (Wypych, 1988).

Polyurethane is another common coating type that can be used for a wide variety of products such as tents, life vests, evacuation slides, flexible fuel storage tanks, and apparel items (Howe-Grant, 1993). Inflatable boats, rainwear, luggage, automotive upholstery, water storage bags, food conveyor belts, and fuel hoses are also made with polyurethane coatings (Wypych, 1988). They provide ultraviolet protection and toughness and can impart a leather-like feel to the fabric. Like PVC, polyurethanes can create a clear protective finish to decorative products (such as wall coverings). Polyurethane coatings provide more protection from abrasion than PVC but are less elastic.

Rubber or elastomer coatings make up another category of commonly used coatings in the industry. There are an extremely large number of variations of available elastomers, including natural rubber, silicones, acrylics, styrene-butadiene (SBR), polyisoprene, and many more. These different materials can be used to create products that are oil, water, and flame resistant. Rubber or elastomer coatings are used in both latex and solid forms. Rubber-coated products are used for rainwear, boats, lifeboats, gymnasium mats, aprons, truck covers, containers, garbage chutes, neoprene wetsuits, roofing materials, protective garments, inflated structures, balloons, and fumigation covers (Wypych, 1988; Howe-Grant, 1993). Solvents are often used with rubber coating processes and add high levels of HAP emissions to the production process.

Acrylic and teflon are also used extensively as coating materials. Acrylic resins are the most common material for a class of products known as geotextiles. These fabric products are used in earth structures. Drainage projects, asphalt construction, erosion control, mining, road building, and earth stabilization projects all use geotextiles (Wypych, 1988). Teflon is used to coat glass fabrics in industrial applications such as warehouses, sports halls, exhibition tents, stadiums, swimming pools, gaskets, conveyor belts, public meeting facilities, and other large structures (Wypych, 1988).

The list of products presented above illustrates the wide variety of uses for coated fabrics. It is important to note that the same products may be produced with different materials. As stated earlier, the choice of the coating material depends on a variety of factors, including end use, cost, traditional local techniques, environmental concerns, and the availability of materials and equipment.

2.1.1.3 Coating Application Processes

There are various ways to apply coating to the fabric substrate. The method chosen depends on the properties of the substrate and the coating material. In all application types, the fabric is placed under tension and is directed through a system of rollers. Rollers are combined with various types of equipment used to apply the coating material. The most commonly used techniques are reverse-roll coating, calendering, knife-over-roll coating, transfer coating, impregnation, direct-gravure coating, lamination, rotary-screen, and extrusion coating. The coating is usually heated, and care must be taken to ensure that the fabric is not damaged by high temperatures. The coating application process is a source of HAP emissions, which come primarily from using solvents in coating materials.

In knife-over-roll coatings, the fabric passes under a blade that spreads the coating onto the fabric. The coating material is placed in front of the knife, and the distance between the knife and the fabric regulates the thickness of the coating (see Figure 2-3). This method is most commonly used in the production of polyurethane-coated fabrics (Howe-Grant, 1993). This process often requires the heavy use of solvents, which creates a larger amount of HAP emissions. The technique is usually used with slow application rates and is most common with thin coatings.

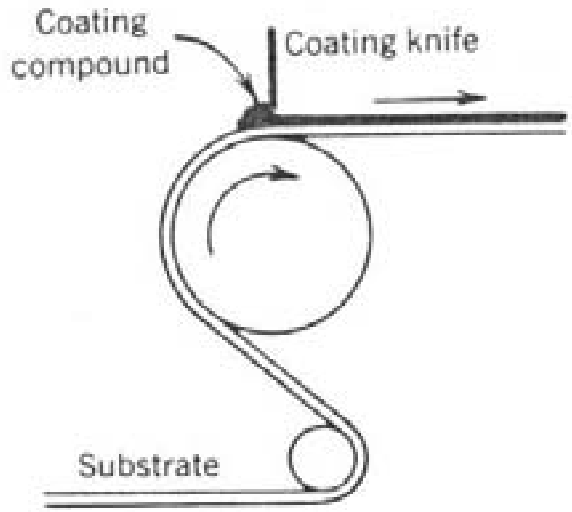


Figure 2-3. Knife-Over-Roll Coating

Source: Kroschwitz, J.I. ed. 1986. *Encyclopedia of Polymer Science and Engineering. Volume 6: Emulsion Polymerization to Fibers, Manufacture*. New York: John Wiley & Sons.

The most expensive coating technique is reverse-roll coating, which uses three precisely ground steel rollers to apply a coating to the fabric (see Figure 2-4). The rolls must have precisely regulated drive speeds to obtain the desired coating effect. Reverse-roll coating is versatile and can be used with the widest variety of coating viscosities and production speeds. The distance between the transfer roll and the backing roll determines the thickness of the coating. This technique commonly makes use of solvents.

Reverse-roll and knife-over-roll techniques often result in heavy penetration of the coating into the fabric. A method known as rotary screen coating is often used to avoid this result. In this technique, the coating material is placed inside a screen roller, and the fabric material passes underneath. The coating passes through the screen and onto the substrate. The size of the holes in the rotary screen regulate coating thickness (see Figure 2-5).

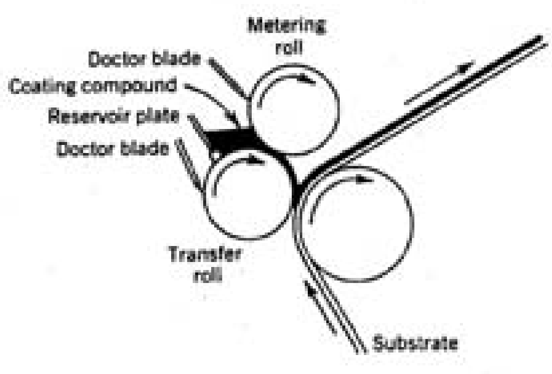


Figure 2-4. Reverse-Roll Coating

Source: Kroschwitz, J.I. ed. 1986. *Encyclopedia of Polymer Science and Engineering. Volume 6: Emulsion Polymerization to Fibers, Manufacture*. New York: John Wiley & Sons.

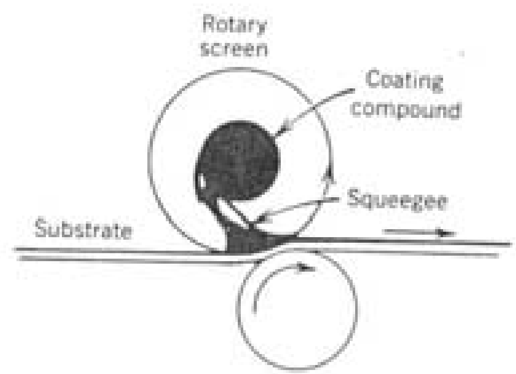


Figure 2-5. Rotary Screen Coating

Source: Kroschwitz, J.I. ed. 1986. *Encyclopedia of Polymer Science and Engineering. Volume 6: Emulsion Polymerization to Fibers, Manufacture*. New York: John Wiley & Sons.

Other less common coating techniques include transfer coating, extrusion and lamination coating, direct gravure coating, and impregnation coating (see Figures 2-6 through 2-10). The transfer technique applies a coating to release paper using a reverse-roll or knife-over-roll technique. The paper is then pressed against the substrate, which subsequently peels the coating from the paper. Decorative effects are obtained by embossing designs on the release paper, so this process is commonly used for decorative products. Extrusion and lamination coating processes apply separate films to the fabrics at high speeds and the two are fused together using a melting or adhesive process. The thinnest coatings (as thin as .003 mm) are applied using a direct gravure technique (Kroschwitz, 1986). A roller applies an extremely low viscosity compound, which passes by a blade that regulates the amount of coating applied to the fabric. Impregnation coating uses a dipping technique to apply material to the substrate. The fabric passes through rollers and is submerged in the coating material before surfacing and passing through another set of rollers.

The choice of coating technique controls coating thickness, which in turn influences water absorptivity, water permeability, weight, dimensional stability, tensile strength, tear strength, transparency, and elasticity. Different techniques can achieve similar results, and

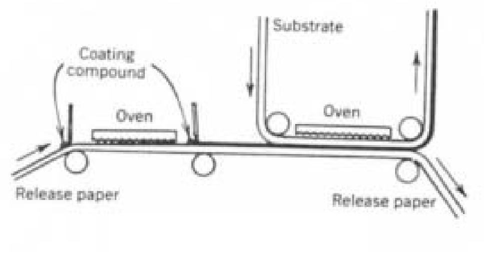


Figure 2-6. Transfer Coating

Source: Kroschwitz, J.I. ed. 1986. *Encyclopedia of Polymer Science and Engineering. Volume 6: Emulsion Polymerization to Fibers, Manufacture*. New York: John Wiley & Sons.

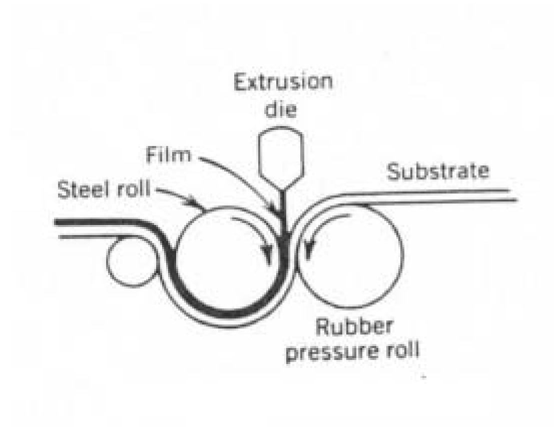


Figure 2-7. Extrusion Coating

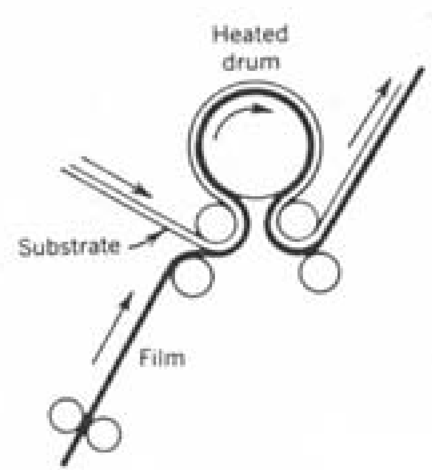
Source: Kroschwitz, J.I. ed. 1986. *Encyclopedia of Polymer Science and Engineering. Volume 6: Emulsion Polymerization to Fibers, Manufacture*. New York: John Wiley & Sons.

the choice is a function of cost, equipment availability, traditional preference, and the desired product characteristics.

2.1.2 Finishing Production Process

Fabric finishing improves the appearance, texture, and/or performance of fabrics. In general, finishing can be accomplished through the following three steps (Marlow-Ferguson, 2001):

- Fabric preparation: bleaching and preparing fabrics with chemical agents (hydrogen peroxide). The purpose of bleaching is to decolorize naturally present pigments into whitened fabric without damaging the fabric (EPA, 1998);
- Fabric coloration: dyeing and printing fabrics performed by various dyeing methods and printing machines, respectively. Main types of dye methods used in the industry include stock dyeing, package dyeing, skein dyeing, beck dyeing, jet dyeing, beam dyeing, jig dyeing, paddle dyeing, rotary dyeing, and continuous dyeing. As to fabric printing, rotary screen printing, flat-bed screen printing, engraved roller printing, and heat transfer printing are the most commonly used techniques (EPA, 1998); and



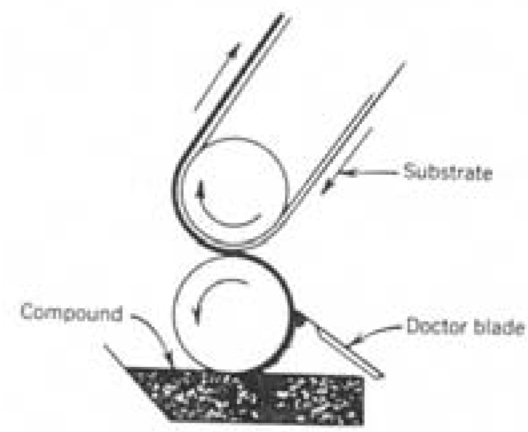


Figure 2-8. Lamination Coating

Source: Kroschwitz, J.I. ed. 1986. *Encyclopedia of Polymer Science and Engineering. Volume 6: Emulsion Polymerization to Fibers, Manufacture*. New York: John Wiley & Sons.

Figure 2-9. Gravure Print Coating

Source: Kroschwitz, J.I. ed. 1986. *Encyclopedia of Polymer Science and Engineering. Volume 6: Emulsion Polymerization to Fibers, Manufacture*. New York: John Wiley & Sons.

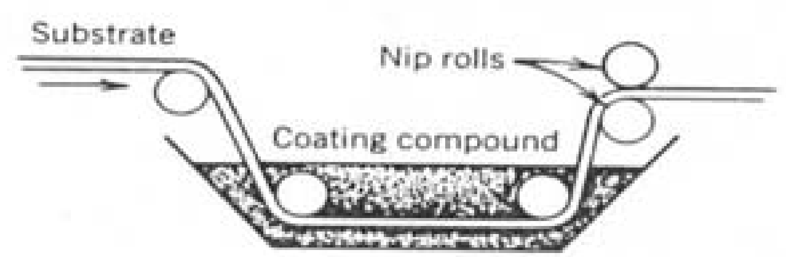


Figure 2-10. Impregnation Coating

Source: Kroschwitz, J.I. ed. 1986. *Encyclopedia of Polymer Science and Engineering. Volume 6: Emulsion Polymerization to Fibers, Manufacture*. New York: John Wiley & Sons.

- Fabric finishing: finishing through either dry (mechanical) finishing or wet (chemical) finishing. Dry finishing includes sueding, sanding, shearing, calendering, embossing, and napping. Wet finishing consists of preshrinking/sanforizing, mercerization, or heat-setting. During finishing processes, chemical finishes are applied for wrinkle resistance, water repellency, flame retardence, mildew proofing, and wash-and wear characteristics (Marlow-Ferguson, 2001).

2.1.3 Costs of Production

The three primary costs of production for the fabric coatings and finishings industry are capital expenditures, labor expenses, and cost of materials.

- As shown in Tables 2-2a and 2-2b, capital expenditures totaled $814 million in 1997 for the coating and finishing industry. During the same year, this industry spent more than $3 billion and $10 billion on its labor and materials for production, respectively (U.S. Census Bureau, 1999a, b, c, d).

- Table 2-2a shows the fabric coating industry spent $74 million on capital, $505 million on labor, and $1.3 billion (69 percent of total production costs) on materials in 1997 (U.S. Census Bureau, 1999a, b, c, d).

  – For capital expenditures, machinery and equipment accounted for 84 percent of the costs, while buildings and other structures made up the remaining 16 percent.

  – About 76 percent of labor costs were spent on annual payroll, and the remainder went toward fringe benefits.

  – Approximately 92 percent of materials costs were for materials, parts, containers, and other such materials. The remaining 8 percent was made up by resales, fuels purchased, electricity, and contract work.

- As Table 2-2b presents, the finishing industry allocated $740 million for capital purchases, $3 billion for labor, and $9.7 billion for materials (about 71 percent of total production costs) in 1997 (U.S. Census Bureau, 1999a, b, c, d).

  – Seventeen percent of the capital costs were spent on buildings and other structures, while 8 percent were for machinery and equipment purchases.

  – As to labor expenditures, annual payroll accounted for 85 percent of the costs, while fringe benefits made up the remaining 15 percent.

Table 2-2a. Production Costs for Fabric Coating Mills (NAICS 313320)

	Total Cost of Production, 1997 ($\$10^6$)	Percentage of Total Cost of Production
Total cost of production	1,881	100.0%
Total capital expenditures	74	4.0%
Buildings and other structures	12	0.7%
Machinery and equipment	62	3.3%
Total labor expenditures	505	26.9%
Annual payroll	383	20.4%
Fringe benefits	122	6.5%
Total cost of materials	1,301	69.2%
Materials, parts, containers, etc.	1,203	63.9%
Resales	38	2.0%
Fuels	20	1.1%
Purchased electricity	23	1.2%
Contract work	18	0.9%

Source: U.S. Census Bureau. 1999d. Fabric Coating Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133c.pdf>.

Table 2-2b. Production Costs for Fabric and Textile Finishing Mills (NAICS 313311, 313312, 3132109, 313210P, 313210U)

	Total Cost of Production, 1997 ($\$10^6$)	Percentage of Total Cost of Production
Total cost of production	13,683	100.0%
Total capital expenditures	740	5.4%
Buildings and other structures[a]	128	0.9%
Machinery and equipment[a]	60	3.4%
Total labor expenditures	3,251	23.8%
Annual payroll	2,788	20.4%
Fringe benefits[a]	463	3.4%
Total cost of materials	9,692	70.8%
Materials, parts, containers, etc.[a]	6,739	49.3%
Resales[a]	129	0.9%
Fuels[a]	286	2.1%
Purchased electricity[a]	222	1.6%
Contract work[a]	244	1.8%

[a] Values are reported for NAICS 313311 and 313312 only.

Sources: U.S. Census Bureau. 1999a. Broadwoven Fabric Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3132a.pdf>.
U.S. Census Bureau. 1999b. Broadwoven fabric Finishing Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133a.pdf>.
U.S. Census Bureau. 1999c. Textile and Fabric Finishing (Except Broadwoven Fabric) Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133b.pdf>.

– Approximately 70 percent of materials costs were for materials, parts, containers, and other such materials. The remaining 30 percent was made up by resales, fuels purchased, electricity, and contract work.

2.2 The Demand Side

This section gives a detailed illustration of the demand side of the fabric coatings industry as well as the finishing industry. It starts by describing coated and finished fabric products and then discusses the uses and consumers of coated/finished fabrics and possible substitutes.

2.2.1 Product Characteristics

The characteristics of coated and finished fabrics are a function of the type of fabric used and the coating/finishing that is applied to it. The fabric provides the foundation for the product's strength and flexibility characteristics. Coating and finishing improve fabric appearance, wrinkle resistance, durability, abrasion resistance, water repellency, flame retardence, oil resistance, chemical resistance, strength, and/or flexibility.

Table 2-3 lists the wide variety of product characteristics demanded by consumers of coated and finished fabrics. The techniques used to achieve these product characteristics are variable, and different materials and manufacturing techniques can be used to obtain the same characteristics in the final product. Both coated and finished fabric products are produced to meet specialized requirements determined by the end use. For example, the product may be relatively simple and inexpensive or highly technical and expensive, depending on how it will be used.

2.2.2 Uses and Consumers

The fabric coating and finishing industry produces products for a wide variety of uses and consumers. Coated and finished fabrics can be used for indoor and outdoor apparel, home furnishings (i.e., bedding products, curtains, and upholstery fabrics), luggage, tarpaulins, equipment covers, wall coverings, automotive uses, tents, air-inflated structures, books, hoses, belts and gaskets, leather imitations, and a variety of industrial uses.

As Table 2-4 indicates, there are a wide variety of products in the coatings industry. It is also important to note that many products are produced with a variety of techniques. For instance, food containers are produced with rubber, polyurethane, and PVC coatings.

Table 2-3. Variables Essential for Product Development Derived from Applications of Coated and Finished Materials

Tensile Strength	Food Contact
Elasticity	Effect of chemicals
Abrasion resistance	Microbiological protection
Tear resistance	Biological corrosion
Dimensional stability	Aging properties
Interlayer adhesion	Service duration
Surface roughness	Weight
Compatibility	Odor
Joints formation and properties	Effect of temperature
Burning behavior	Thermal properties
Water permeability	Antistatic properties
Solvent vapor permeability	Air tightness
Light transparency	Sunlight reflection
Product appeal	Colorfastness
	Cleaning frequency

Source: Wypych, J. 1988. *Polymer Modified Textile Materials*. New York: John Wiley & Sons.

Similarly, clothing products are made with all three types of coatings. Although various coatings can provide the same function, many specialized products are only made with specific coating materials, such as arctic fuel drums and fabrics used to control erosion (Wypych, 1988).

The wide variety of uses and applications for both coated and finished fabrics translates into an equally wide variety of industries and consumers that use them. Automotive, apparel, furniture, home furnishing, wallcovering, book, tent, road building, and many other industries all make extensive use of coated and finished fabrics. Table 2-5 presents the markets that demand coated fabrics. In a 1993 report on the industry, the U.S. International Trade Commission (USITC) gives another account of industries that use coated and finished fabrics. These industries and the factors that influence their demand are shown in Table 2-6. These industries range from the military and aerospace industries to apparel and home furnishings. The automotive sector is the largest consumer of coated and finished

Table 2-4. Coated Fabric Products and the Materials Used to Make Them

Coated Fabric Product	Produced with PVC Coated Materials	Produced with Polyurethane Coated Materials	Produced with Rubber Coated Materials	Produced with Acrylic Coated Materials	Produced with Teflon Coated Materials
Air inflated structures			✓		
Aprons			✓		
Arctic fuel drums		✓			
Asphalt construction				✓	
Automotive upholstery	✓	✓			
Awnings	✓				
Boat covers	✓		✓		
Boats	✓		✓		
Chimney covers	✓				
Clothing	✓	✓	✓		
Collapsible containers	✓	✓	✓		
Collapsible fuel tanks		✓			
Conveyor belts	✓	✓			✓
Devices to reduce escape of vapors			✓		
Earth stabilization				✓	
Erosion control				✓	
Factory curtains			✓		
Flexible space dividers	✓				
Food containers	✓	✓	✓		
Footwear	✓	✓	✓		
Fuel hoses		✓	✓		
Garbage chutes			✓		
Gaskets					✓
Greenhouses					
Gymnasium mats			✓		
Home furnishings	✓	✓			
Inflatable boats		✓	✓		
Large buildings and structures					✓
Life jackets		✓			
Luggage	✓	✓			
Membranes			✓		
Mining				✓	
Oil ring shelters			✓		

(continued)

Table 2-4. Coated Fabric Products and the Materials Used to Make Them (continued)

Coated Fabric Product	Produced with PVC Coated Materials	Produced with Polyurethane Coated Materials	Produced with Rubber Coated Materials	Produced with Acrylic Coated Materials	Produced with Teflon Coated Materials
Pool covers	✓				
Pool liners	✓				
Rainwear	✓	✓	✓		
Road building				✓	
Roof sealants		✓			
Silos	✓				
Sliding roofs	✓				
Sportswear	✓	✓	✓		
Storage bags	✓	✓			
Swimming pools				✓	
Tarpaulins	✓	✓	✓		
Tents	✓	✓			✓
Truck covers	✓		✓		
Ventilation ducts	✓				
Ventilation tubing			✓		
Warehouses					✓

Source: Wypych, J. 1988. *Polymer Modified Textile Materials.* New York: John Wiley & Sons.

fabrics, (USITC, 1993). For each industry, specific factors influence their demand for products. However, in general, demand closely follows changes in general economic activity (USITC, 1993).

2.2.3 Substitutes

The presence of substitutes is important because they are a critical determinant of demand elasticity. Demand will be far more elastic for goods that have readily available substitutes with comparable price and performance qualities. The principal substitutes for coated fabrics are uncoated fabrics and leather, rubber, or plastic products that do not have a fabric substrate. For example, uncoated canvas fabric is sometimes used for tents. Also, plastic sheets can be used as tarpaulins or rain ponchos. Imitation leather products are typically made with polyurethane-coated fabrics. Consequently, authentic leather products

Table 2-5. Coated Fabric Demand by Product Market

Market	Percent of Demand
Motor vehicles	26%
Furniture	19%
Industrial	10%
Wallcoverings	9%
Protective clothing	9%
Books	6%
Awnings	5%
Nonauto transportation	5%
Tents and other	11%

Source: Freedonia Group. 1999. *Coated Fabrics in the United States to 2003—Introduction, Executive Summary, Market Environment, Coated Shipments, Demand and Markets*. Available at <http://www.profound.com/htbin/titles_do>.

are substitutes for the imitations. Coated fabrics tend to perform better than fabrics that are not coated; they can be stronger or more waterproof or exhibit other qualitites presented earlier in this section that cannot be achieved from an uncoated fabric product. Similarly, materials that lack a fabric substrate are not as stable and resilient as a coated fabric product. Consequently, there are not many substitutes for coated fabrics that exhibit comparable performance characteristics. However, coated fabrics can be substituted for one another, because various types of fabrics and coatings can be combined to perform similar tasks. Likewise, various finished fabrics can be substitutes for one or another. However, there are no apparent substitutes for finished fabrics as a whole.

2.3 Industry Organization

This section provides information to describe firms' behavior within the market for both fabric coated and finished products. Data for location of coating and finishing facilities are provided, along with a description of market structure in terms of key estimates of industry construction.

Table 2-6. Coated Fabrics: Principal U.S. Industries and Factors Affecting Demand

Industry	Demand Factors
Aerospace	Space programs and developmental projects; military spending on aircraft; replacement of aircraft or parts by commercial airlines
Apparel and footwear	Styles and fashion; improved characteristics (i.e., breathability and moisture absorbency)
Automotive	New products, (i.e., air bags); interior style change (i.e., cloth seats); substitibility for other materials (i.e., plastics)
Chemicals and oil	Environmental awareness; new EPA regulations; change in storage and shipping capacity
Construction and building	Expansion of infrastructures; housing starts; repairing of existing civil engineering projects
Home furnishings	Awareness of home energy conservation; home decorating; popularity of leisure and casual furniture
Luggage	Economic conditions affecting the travel industry; styles and fashion
Marine and boating	Popularity of water-related activities; favorable climatic conditions
Medical and health	Public and institutional awareness of confinement of contagious diseases; disposable versus reusable products; new medical discoveries and applications
Military	Shortage of required equipment; international armed conflict; change in number of active-duty and reserve forces
Recreation and sports	New sports facilities; promotion of physical fitness and individual conditioning; more individual leisure and recreational time

Source: U.S. International Trade Commission (USITC). 1993. *Industry and Trade Summary: Coated Fabrics*. Washington, DC: U.S. International Trade Commission.

2.3.1 Market Structure

Market structure is of interest because it determines the behavior of producers and consumers in the industry. In perfectly competitive industries, neither consumers nor producers can affect the prices of goods. In addition, producers are unable to affect the price of inputs purchased for use in their products. This condition most likely holds if the industry has a large number of buyers and sellers, the products sold and inputs used in production are homogeneous, and there is free entry and exit for firms in the industry. Entry and exit of firms are unrestricted for most industries, except in cases where one firm holds a patent on a product, where the government regulates who is able to produce output (like in the utility industries), where one firm owns the entire stock of a critical input (as in the diamond industry), or where a single firm is able to supply the entire market. In industries that are not perfectly competitive, producer and/or consumer behavior can affect price considerations.

Concentration ratios (CRs) and Herfindahl-Hirschmann indices (HHIs) can provide some insight into the competitiveness of an industry. The U.S. Department of Commerce reports these ratios and indices for the six-digit NAICS code level for 1997, which is the most recent year available. CRs are typically measured in two ways: the CR4 gives the percentage of sales for the top four companies in an industry, and the CR8 is the percentage of sales for the top eight companies in an industry. Table 2-7 shows the measure of market concentration for fabric coatings and finishing companies in 1997.

Table 2-7. Measure of Market Concentration for Fabric Coatings and Finishings Companies: 1997

NAICS	Number of Companies	Value of Shipments (10^3)	CR4	CR8	HHI
313210	734	18,269	23.8	35.4	252.1
313311	1255	9,295	28.0	38.4	274.8
313312	346	4,403	29.7	41.6	323.9
313320	246	2,133	14.8	26.2	160.2

Source: U.S. Census Bureau. 1997. *Concentration Ratios in Manufacturing, EC97M31S-CR*. Available at <http://www.census.gov/prod/ec97/m31s-cr.pdf>.

The criteria for evaluating the HHIs are based on the 1992 Department of Justice's Horizontal Merger Guidelines. According to these criteria, industries with HHIs below 1,000 are considered unconcentrated (i.e., more competitive), those with HHIs between 1,000 and 1,800 are considered moderately concentrated (i.e., moderately competitive), and those with HHIs above 1,800 are considered highly concentrated (i.e., less competitive). In general, firms in less concentrated industries are more likely to be price takers, while those in more concentrated industries have more ability to influence market prices. Based on these criteria, the fabric coating and finishing industry is considered unconcentrated.

2.3.2 Manufacturing Facilities

EPA has identified 61 facilities that are major sources and produce coated fabrics. Out of 61 facilities, 52 are identified by ownership, and are owned by 44 ultimate parent companies. According to publicly available business directories, there are 84 facilities, owned by 71 parent companies, that are engaged in fabric coating. Because EPA does not have data to identify the companies owning nine of the major sources, these 71 coating companies are the focus for Section 2.3.4. Several of the facilities and companies described are not major sources and will not incur costs.

Table 2-8 shows the location (by state) of the 84 facilities. Most production for the industry is concentrated in the eastern part of the country. Both Massachusetts and Ohio have the greatest number of manufacturing facilities (10). South Carolina is second (7), followed by Connecticut (6), North Carolina (6), and Tennessee (5). There are 19 states without any facilities that produce coated fabrics. These are mostly concentrated in the western United States, but Florida, Maine, Oklahoma, Pennsylvania, Vermont, and West Virginia are also without any facilities.

Besides coating facilities, EPA has identified 74 facilities that are major sources engaged in finishing fabrics. Of the 74 facilities, 22 are identified by ownership and owned by 6 ultimate parent companies. However, according to the 1997 Census of Manufactures, there were approximately 1,784 facilities engaged in finishing fabrics in the U.S. (see Table 2-9). Out of 1,784 facilities, 203 are listed in Ward's Business Directory, owned and operated by 177 parent companies, and categorized under NAICS 313311 Broadwoven Fabric Finishing Mills, NAICS 313312 Textile and Fabric Finishing (Except Broadwoven Fabric) Mills, and part of NAICS 313210, Broadwoven Fabric Mills. The vast majority of these facilities are not major sources and will not incur costs due to the rule. The majority of these are located in the eastern United States, particularly in New York (354), North Carolina (211), New Jersey (128), and South Carolina (98). However, California has the second greatest number of finishing facilities (224).

2.3.3 Facility Employment and Economies of Size

This section presents employment data based on the statistics from the Census Bureau because of the lack of facility-specific data. As shown in Table 2-10, only six coating facilities (2 percent of the total coating facilities) employ more than 250 workers, and 250 finishing facilities employ more than 250 workers (about 10 percent of the total finishing

Table 2-8. Textile Coating Facility Locations

State	Number of Facilities	State	Number of Facilities
Arizona	2	Mississippi	1
Arkansas	3	Missouri	2
California	3	Nebraska	1
Colorado	2	New Hampshire	1
Connecticut	6	New Jersey	4
Delaware	1	New York	1
Georgia	1	North Carolina	6
Idaho	1	Ohio	10
Illinois	2	Rhode Island	2
Indiana	2	South Carolina	7
Kansas	1	Tennessee	5
Kentucky	1	Texas	2
Maryland	1	Virginia	1
Massachusetts	10	Washington	1
Michigan	2	Wisconsin	1
Minnesota	1	Total	84

facilities). The smallest employment size category, with between one and nine workers, has the largest number of operating facilities for both coating (102) and finishing (1,351). These represent about 40 percent of the 258 facilities that make up the 313320 NAICS category and 51 percent of the 2,629 facilities in NAICS codes 313311, 313312, and 313210. The next largest employment size category has between 10 and 49 workers. There are 90 coating facilities in this grouping (approximately 35 percent of the total coaters) and 587 finishing facilities (22 percent of the total finishers). It should be noted that these figures are for the facility level, not the company level. Company-specific employment data are presented in Section 2.3.4.

Different types of production may be most efficiently performed in certain sizes of facilities. Economies of size refer to production processes that are more efficiently performed, the larger the size of the facility. Table 2-9 provides information on the efficiency of plant size for those facilities in NAICS 313320, 313311, 313312, and 313210 in

Table 2-9. Textile Finishing Facility Locations, by State

NAICS Code	313311	313312	3132109	313210P	313210U	Total
Total Establishments	1,337	383	14	38	12	1,784
California	173	51				224
Georgia	52	26	5[a]	2[a]		85
Massachusetts				1[a]		1
Michigan	11					11
New Hampshire					1[a]	1
New Jersey	90	38				128
New York	284	70				354
North Carolina	114	75	5[a]	18[a]		211
Ohio	22					22
Pennsylvania	39	27				66
Rhode Island	21	8				29
South Carolina	75	17		6[a]		98
Tennessee	24	10				34
Texas	36	5				41
Virginia				5[a]		5

[a] The number of facilities in a state = Total establishments in the United States x (Value of shipments in a state / Value of shipments in the United States)

Sources: U.S. Census Bureau. 1999a. Broadwoven Fabric Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3132a.pdf>.
U.S. Census Bureau. 1999b. Broadwoven Fabric Finishing Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133a.pdf>.
U.S. Census Bureau. 1999c. Textile and Fabric Finishing (Except Broadwoven Fabric) Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133b.pdf>.

Table 2-10. Facility-Level Employment and Size Economy for Fabric Coating and Finishing Industry, 1997

	Number of Employees				
NAICS Code/Industry	**1 to 9**	**10 to 49**	**50 to 249**	**250 to 999**	**1,000 or more**
Coating Industry					
313320 Fabric Coating Mills					
Number of facilities	102	90	60	6	NA
Value added by manufacturer ($\$10^6$)	23	172	542	138	NA
Number of production worker hours (10^6)	0.5	3.1	10.1	3.1	NA
Value added/production worker hour ($)	49.91	55.72	53.60	44.71	NA
Finishing Industry					
Number of facilities	1,351	587	441	224	26
Value added by manufacturer ($\$10^6$)	354	1,062	3,879	5,522	NA
Number of production worker hours (10^6)	8.1	19.5	93.6	175.2	NA
Value added/production worker hour ($)	43.96	54.44	41.44	31.52	NA
313311 Broadwoven Fabric Finishing Mills					
Number of facilities	813	310	172	36	6
Value added by manufacturer ($\$10^6$)	272	619	1,506	1,236	409
Number of production worker hours (10^6)	5.0	9.5	33.7	25.7	11.8
Value added/production worker hour ($)	53.90	65.39	44.63	48.17	34.60
313312 Textile & Fabric Finishing Mills					
Number of facilities	120	128	100	34	1
Value added by manufacturer ($\$10^6$)	21	268	624	459[a]	NA
Number of production worker hours (10^6)	0.7	5.0	18.9	16.5[a]	NA
Value added/production worker hour ($)	31.13	53.69	33.05	27.82[a]	NA
313210 Broadwoven Fabric Mills [b]					
Number of facilities	418	149	169	154	19
Value added by manufacturer ($\$10^6$)	61	175	1,749	3,827	NA
Number of production worker hours (10^6)	2.3	5.1	41.0	133.0	NA
Value added/production worker hour ($)	26.21	34.69	42.68	28.77	NA

[a] Data for employment size 500 to 999 were withheld to avoid disclosing data of individual companies.

[b] Including all the 909 establishments categorized in NAICS Code 313210 instead of the facilities (categorized in NAICS 3132109, 313210P, and 313210U) engaged only in fabric finishing .

NA = Not available

Sources: U.S. Census Bureau. 1999a. Broadwoven Fabric Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3132a.pdf>.
U.S. Census Bureau. 1999b. Broadwoven Fabric Finishing Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133a.pdf>.
U.S. Census Bureau. 1999c. Textile and Fabric Finishing (Except Broadwoven Fabric) Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133b.pdf>.
U.S. Census Bureau. 1999d. Fabric Coating Mills. 1997 Economic Census: Manufacturing—Industry Series. <http://www.census.gov/prod/ec97/97m3133c.pdf>.

1997. Using the value added per production worker hour as a measure of plant efficiency, the fabric coating and finishing industry shows no apparent size economies. For most of the NAICS codes, relatively small facilities (10 to 49 workers) appear to be the most efficient, because they demonstrate the highest value added per worker hour.

2.3.4 Companies

Potentially directly affected companies include entities that own manufacturing plants that perform fabric coating or printing operations or fabric slashing, dyeing, or finishing operations. The chain of ownership may be as simple as one plant owned by one company or as complex as multiple plants owned by subsidiary companies. Based on survey and secondary source data, EPA identified 71 ultimate parent companies that may own and operate the 61 directly affected fabric coatings facilities. For the economic analysis, EPA obtained company sales and employment data from survey data or from one of the following secondary sources:

- Dun & Bradstreet Market Identifiers (Lycos Companies Online, 2001),
- Hoover’s Company Profiles (Hoover’s Online, 2001), and
- ReferenceUSA Business Database Version 4.1 (ReferenceUSA, 2001).

Out of the 71 companies, sales and employment data were available for 68 and 69 companies, respectively, which are shown in Table 2-11. As for the fabric finishing facilities, the sales and employment data are not discussed here because most of the company identities are unavailable to EPA.

2.3.4.1 Small Business Identification

The Regulatory Flexibility Act (RFA) of 1980, as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996, requires EPA to give special consideration to small entities affected by federal regulation. Companies operating fabric coatings manufacturing plants can be grouped into small and large categories using Small Business Administration (SBA) general industry size standard definitions. The SBA defines small businesses in terms of the sales or employment of the owning entity, and these thresholds vary by the industry classification (NAICS code). Businesses within the NAICS 313210, 313311, and 313320 industry categories that have 1,000 or fewer employees are considered small by the SBA, and for NAICS 313312 those with 500 and fewer employees

Table 2-11. Parent Companies

Parent Company Name	Sales ($\$10^6$)	Employment Number	Year	Source
Alpha Associates Inc.	35	105	2000	InfoTrac
Amerbelle Corporation	26	300	2000	Dun & Bradstreet
American Industrial Partners Capital Fund II LP	247	2,650	2001	Dun & Bradstreet
American Roller Company				
ATHOL Corporation	47	230	2000	Dun & Bradstreet
Avery Dennison Corporation	3,700	17,400	2001	Dun & Bradstreet
Avon Tape Inc.	2	35	2001	ReferenceUSA
Avondale Inc./Avondale Mills	880	7,300	2001	Dun & Bradstreet
Bando Mfg. of America, Inc.	14	153	2000	Dun & Bradstreet
Bradford Industries, Inc.	53	177	2000	Dun & Bradstreet
Brownell & Company, Inc.	8	35	2001	ReferenceUSA
Carolina Rubber Rolls	35	75	2001	ReferenceUSA
Coats PLC	2,383	49,946	2000	Hoover's Online
Cooper Tire & Rubber Company, Inc.	2,100	21,586	2001	Dun & Bradstreet
Cortland Line Company, Inc.	15	110	2001	Dun & Bradstreet
Cytec Industries, Inc.	1,493	4,800	2000	Hoover's Online
Dana Corporation	12,460	79,300	2000	Hoover's Online
Delatex Processing Corporation	1	8	2000	InfoUSA
Dimension Polyant Sailcloth, Inc.	8	35	2000	InfoUSA
Duraco, Inc.	28	151	2000	Dun & Bradstreet
Duro Industries, Inc.	199	800	2000	Dun & Bradstreet
Eddington Thread Mfg. Company	5	100	2000	Dun & Bradstreet
Excello Fabric Finishers, Inc.	4	15	2000	InfoUSA
Fil-Tec, Inc.	14	83	2000	Dun & Bradstreet
GenCorporation, Inc.	1,047	7,895	2000	Hoover's Online
General Clothing Company, Inc.	8	35	2001	ReferenceUSA
Globe Rubber Works, Inc.	35	75	2001	ReferenceUSA
Goodrich Corporation	4,364	22,136	2000	Hoover's Online
Goodyear Tire & Rubber Company	14,417	105,128	2000	Hoover's Online
Groupe Zodiac	1,154	9,615	2000	Hoover's Online
Guardian Mfg. Company	8	35	2001	ReferenceUSA
H.C. Chandler & Son, Inc.				

(continued)

Table 2-11. Parent Companies (Continued)

Parent Company Name	Sales ($\$10^6$)	Employment Number	Year	Source
Haartz Coporation	100	350	2000	Dun & Bradstreet
Habasit	213	1,850	2000	InfoTrac
Hallwood Group, Inc.	115	807	2000	InfoTrac
Hbd Ind., Inc.	100	1,350	2000	InfoTrac
Hexcel Corporation.	1,056	6,072	2000	Hoover's Online
Holliston Mills, Inc.	21	184	2000	Dun & Bradstreet
Hub Fabric Leather Company, Inc.	5	35	2000	Dun & Bradstreet
Imco, Inc.	15	175	2001	ReferenceUSA
Invensys PLC	14,380	121,683	2000	Hoover's Online
J. Charles Saunders Company, Inc.	15	75	2001	ReferenceUSA
Koch Enterprises, Inc.	284	3,500	2001	Dun & Bradstreet
Lord Corporation		3,000	2001	Dun & Bradstreet
Mark IV Industries, Inc.	500	17,000	2001	Dun & Bradstreet
Meridian Industries, Inc.	270	1,200	2000	Dun & Bradstreet
Norcross Safety Products LLC	250	2,600	2001	Dun & Bradstreet
Ouimet Corporation	15	65	2000	InfoUSA
Par Products	2	15	2001	ReferenceUSA
Parker Hannifin Corporation	5,300	42,728		Dun & Bradstreet
Penn Racquet Sports	75	390	2000	InfoUSA
Phoenix Medical Techs., Inc.	13	300		Dun & Bradstreet
Plymouth Rubber Company, Inc.	74	480	2000	Hoover's Online
Polycraft	4	15	2001	ReferenceUSA
Rapid Die & Molding Company, Inc.	4	8	2000	InfoUSA
RBX Corporation	263	2,300	2001	Dun & Bradstreet
Reeves Brothers, Inc.	300	3,000	2000	InfoUSA
Robin Ind., Inc.	15	75	2001	ReferenceUSA
Ruddick Corporation	2,683	20,000	2000	Hoover's Online
Schneller, Inc.	28	200	2000	Dun & Bradstreet
Seaman Corporation	22	290	2000	Dun & Bradstreet
Star-Glo Ind., Inc.	14	180	2001	Dun & Bradstreet
Takata, Inc.	375	6,000	2000	InfoTrac

(continued)

Table 2-11. Parent Companies (Continued)

Parent Company Name	Sales ($\$10^6$)	Employment Number	Year	Source
Tennessee Mat Company	13	175	2001	Dun & Bradstreet
Textile Tapes Coporation	2	35	2001	ReferenceUSA
Canadian General Tower, Ltd.	300	1,100	2001	Dun & Bradstreet
Tomkins PLC	5,908	52,755	2001	Hoover's Online
Toray Industries, Inc.	8,513	35,686	2001	Hoover's Online
Uniroyal Technology Corporation	201	1,233	2001/2000	Dun & Bradstreet/ Hoover's Online
Uretek, Inc.	13	70	2000	Dun & Bradstreet
Warco Holdings, Inc.	35	450	2001	Dun & Bradstreet

Sources: Lycos Companies Online. 2001. Dun & Bradstreet Market Identifiers.
Hoover's Online. 2001. *Companies and Industry*. Available at <http://www.hoovers.com/companyindustry/0,1334,8,00.html>.
InfoUSA.
ReferenceUSA. 2001. ReferenceUSA Business Database Version 4.1.

are considered small (U.S. SBA, 2001). However, only the small businesses in NAICS 313320 are investigated further in this section due to the lack of information on companies owning of finishing facilities.

As mentioned above, EPA identified 71 parent companies that may own and operate the directly affected fabric coating facilities. Forty-one percent of the companies identified by EPA as owners of affected facilities employ more than 1,000 workers. Using the SBA definition of a small business, 59 percent of the companies identified fall in the small business category, including companies without employment data. Table 2-12 shows the large number of small businesses in this industry that employ a small number of workers. The employment size category with 0 to 49 employees and 100 to 249 employees per company had the largest number of companies with 12 (29 percent of the total).

Table 2-13 shows a frequency distribution of small companies in the industry by sales. As with employment data, sales data were not available for 2 of the 42 identified companies. Companies with less than $10 million in annual sales made up 31 percent of the identified firms. Fifty percent of the companies had sales from $10 to $49 million. Fourteen

Table 2-12. Employment Size Distribution of Small Companies

Employment Range	Number of Companies	Percent
0 to 49	12	29%
50 to 99	7	17%
100 to 249	12	29%
250 to 499	7	17%
500 to 999	2	5%
NA	2	5%
Total Companies	42	100%

Sources: Hoover's Online. 2001. *Companies and Industry*. Available at <http://www.hoovers.com/companyindustry/0,1334,8,00.html>.
Lycos Companies Online. 2001. Dun & Bradstreet. Market Identifiers.
Hoover's Online. 2001. *Companies and Industry*. Available at <http://www.hoovers.com/companyindustry/0,1334,8,00.html>.
ReferenceUSA. 2001. ReferenceUSA Business Database Version 4.1.

percent of companies had $50 million or more in sales. Once again, the number of small companies is most likely an underestimate, because it does not include the companies for which data are not available (these companies are most likely small).

The large number of small firms in the industry is in part the result of significant structural change in recent years. The fabric coatings industry has seen the entry of many small, highly specialized firms. Between 1987 and 1992, the industry realized a net gain of almost 30 firms (USITC, 1993). Most of these new firms are believed to be very small manufacturers of high performance textiles with special properties for specific end-use applications. The trend towards specialization has occurred because these products often have very specific capital equipment requirements for their production (USITC, 1993).

2.4 Markets

This section examines market volumes and prices only for the fabric coating industry. Market information for finishing industry is not discussed in detail because fabric finishers are categorized as part of several NAICS codes, all data from the Census Bureau have been aggregated at the industry level based on NAICS codes, and detailed market data are not available from the Freedonia Group. The rest of this section starts by examining trends in product shipments for the fabric coating industry. This discussion is followed by a presentation of market price data. Next is a brief analysis of the industry's future outlook. Finally, foreign trade issues are examined, along with export and import data.

Table 2-13. Sales Size Distribution of Small Companies

Sales Range ($\$10^6$)	Number of Companies	Percent of Total
0 to 4	7	17%
5 to 9	6	14%
10 to 24	13	31%
25 to 49	8	19%
50 to 99	3	7%
100 to 499	3	7%
NA	2	5%
Total	42	100%

Sources: Hoover's Online. 2001. *Companies and Industry*. Available at <http://www.hoovers.com/companyindustry/0,1334,8,00.html>.
Lycos Companies Online. 2001. Dun & Bradstreet. Market Identifiers.
Hoover's Online. 2001. *Companies and Industry*. Available at <http://www.hoovers.com/companyindustry/0,1334,8,00.html>.
ReferenceUSA. 2001. ReferenceUSA Business Database Version 4.1.

2.4.1 Value of Shipments

Table 2-14 shows the trends in employment and shipments for the industry from 1985 through 1998. It is clear from these data that, although shipments have expanded over this time, employment has not increased significantly. For NAICS 313320 (SIC 2295), value of shipments increased approximately 55 percent from 1985 to 1996 (U.S. Census Bureau, 2000a). Conversely, employment increased at only 1 percent over the same period. Thus, increased production can be explained by increased productivity per worker or higher capital to labor ratios rather than by the addition of more workers. The decline in the average number of production workers in the industry is the result of an increased emphasis on capital investments and the greater efficiency of machinery (USITC, 1993).

The value of shipments by product type has been fairly stable over the past decade. Table 2-15 presents data from a Freedonia Group report from August 1999. It shows that the proportion of total shipments that accounted for nonrubber-coated fabrics was 71 percent in 1989, 71 percent in 1993, and 72 percent in 1998. The report predicts that these numbers will jump to 74 percent and 76 percent, respectively, in 2003 and 2008. Rubber-coated

Table 2-14. General Trends: 1985–1998

Year[a]	Value of Shipments ($\$10^6$)	Employment	Value of Shipments/Employee ($\$10^6$)	New Capital Expenditures[b] ($\$10^6$)
SIC 2295				
1985	$1,228.2	10,400	$0.1181	$33.9
1986	$1,172.0	9,700	$0.1208	$37.4
1987	$1,433.7	10,300	$0.1392	$63.4
1988	$1,509.4	10,300	$0.1465	$38.7
1989	$1,542.7	9,400	$0.1641	$59.8
1990	$1,361.8	8,900	$0.1530	$52.9
1991	$1,298.4	8,000	$0.1623	$54.5
1992	$1,528.1	9,200	$0.1661	$47.1
1993	$1,773.3	9,900	$0.1791	$55.8
1994	$1,804.3	10,800	$0.1671	$75.2
1995	$1,827.9	11,100	$0.1647	$74.8
1996	$1,906.1	10,500	$0.1815	$89.8
NAICS 313320[c]				
1997	$2,256.7	11,592	$0.1947	$74.39
1998	$2,304.2	11,441	$0.2014	$47.686

[a] Data from 1993–1996 were taken from U.S. census Annual Surveys of Manufactures for those years. Data from 1985–1992 were taken from 1992 U.S. census data. Data from 1997–1998 were taken from U.S. Census Annual Survey of Manufactures for NAICS 313320 for 1997–1998.

[b] The 1997–1998 survey of manufactures refers to capital expenditures as "total capital expenditures," rather than "new capital expenditures," which was the term used for data from previous years.

[c] Data for 1997–1998 are for NAICS code 313320, which includes "rubber coated fabrics." These products were not previously classified under the SIC code 2295. In 1998, "rubber coated fabrics" accounted for 9.5 percent of the value of product shipments for coated fabrics included in the NAICS 313320 product class.

Source: U.S. Census Bureau. 2000a. *Annual Survey of Manufactures—Industry Statistics*. <http://www.census.gov/prod/2000pubs/M98-as1.pdf>.

Table 2-15. Coated Fabrics Shipments by Type: 1989–2008 ($\$10^6$)

Product	1989	1993	1998	2003	2008
United States GDP ($\$10^9$)	5,439	6,558	8,511	1,075	13,550
$ Fabric/million $ GDP	374	342	331	319	304
Nonrubber-coated fabrics	1,459	1,585	2,052	2,555	3,150
Rubber-coated fabrics	351	431	484	550	630
Fabric-backed wallcoverings	226	226	285	310	340
Total coated fabric shipments	2,036	2,242	2,821	3,415	4,120

Source: Freedonia Group. 1999. *Coated Fabrics in the United States to 2003—Introduction, Executive Summary, Market Environment, Coated Shipments, Demand and Markets*. Available at <http://www.profound.com/htbin/titles_do>.

fabrics made up 17 percent of total shipments in 1989, 19 percent in 1993, and 17 percent in 1998 and are predicted to be 16 percent in 2003 and 15 percent in 2008. Finally, fabric-backed wallcoverings accounted for 11 percent of total shipments in 1989. The proportion is predicted to be 9 percent in 2003 and 8 percent in 2008 (Freedonia, 1999).

2.4.2 Market Prices

Price data for the fabric coatings industry are presented in Table 2-16. The table shows that prices in dollars per square yard of coated fabric were $4.72 in 1998, according to a Freedonia Group report from August 1999. Prices for coated fabrics fell roughly 10 percent between 1989 and 1998. The report predicts a similar decline through 2008. Because of the wide range and variability of coated fabric products, the price per yard also varies widely, and specialized, highly technical products are more costly. Disaggregated price data were not available.

2.4.3 Future Outlook

Shipments of coated fabrics are forecasted to increase 3.9 percent annually until 2003 (Freedonia Group, 1999). This represents a decline in growth from the mid-1990s, when demand was high due to a rebound from the recession of the early 1990s. The Freedonia Group (1999) forecasts that average prices for coated fabrics will continue to decrease through 2008.

Table 2-16. Coated Fabrics Pricing Trends: 1989–2008 ($\$10^6$)

Year	1989	1993	1998	2003	2008
Coated fabrics demand (million sq. yards)	355	401	525	635	770
$/sq. yard	5.22	5.17	4.72	4.54	4.39
Coated fabrics demand ($\$10^6$)	1,854	2,072	2,480	2,880	3,380

Source: Freedonia Group. 1999. *Coated Fabrics in the United States to 2003—Introduction, Executive Summary, Market Environment, Coated Shipments, Demand and Markets*. Available at <http://www.profound.com/htbin/titles_do>.

Parts of the industry are expected to expand. The increased use of airbags with the addition of side-impact airbags, under-dash airbags, and expanded use of airbags in trucks will create an increase in demand for coated nylon. Industry segments of nonautomotive transport equipment (boat and truck covers), protective clothing, awnings, and canopies are also expected to have increased demand. Table 2-17 shows the demand over time from 1989 through 2008 by market sector. It shows that for all sectors except industrial uses, the growth in demand from 1998 through 2008 is expected to decline from the levels experienced by the industry from 1989 through 1998.

2.4.4 International Trade

When compared to the textile industry in general, the fabric coatings industry has fared relatively well in the face of increased foreign competition. Unlike the broader textile goods industry, the coated fabrics industry had not seen a significant decline in employment during the 1990s (Heil and Peck, 1998). It is clear that trade activity overall has increased because of the industry's increasingly global nature (Smith, 1999). Import and export sales totals rose 30 percent from 1989 to 1998. However, despite the growth of the industry abroad and an increase in imports, exports have also increased. Actually, the trade surplus for coated fabrics in the United States doubled from $170 million in 1993 to $341 million in 1998. This growth came after a 7 percent decline in net exports from 1989 to 1993. The increase in net exports is expected to continue through 2008. Net exports are forecast to be $535 million in 2003 and $740 million in 2008 (Freedonia, 1999). Table 2-18 shows data from the 1999 Freedonia Group report.

Table 2-17. Coated Fabrics Demand (million sq. yards)

Coated Fabrics Demand	1989	1993	1998	2003	2008	Percent Annual Growth 1989–1998	Percent Annual Growth 1998–2008
Coated fabrics demand	355	401	525	635	770	4.4	3.9
Motor vehicles	79	96	137	182	236	6.3	5.6
Furniture	74	79	101	115	135	3.5	2.9
Industrial	46	49	53	61	68	1.6	2.5
Protective clothing	28	34	47	56	65	5.9	3.3
Wall coverings	37	38	45	47	51	2.2	1.3
Book coverings	27	30	32	34	36	1.9	1.2
Awnings and canopies	14	15	27	33	40	7.6	4
Nonautomotive transportation equipment	12	15	25	36	53	8.5	7.6
Commercial tents	11	13	18	21	25	5.6	3.3
Other markets	27	32	40	50	61	4.5	4.3

Source: Freedonia Group. 1999. *Coated Fabrics in the United States to 2003—Introduction, Executive Summary, Market Environment, Coated Shipments, Demand and Markets*. Available at <http://www.profound.com/htbin/titles_do>.

Although U.S. producers have been able to dominate the domestic market for high priced items, imports of lower priced items have increased dramatically. U.S. imports of coated fabrics rose by 33 percent from 1988 to 1992 (USITC, 1993). Imported products are usually lower priced items, such as imitation leather and other consumer goods where small variations in quality are not critical. Canada was the largest supplier of imports from 1988 to 1992, supplying 28 percent of imports by value. Others foreign suppliers were Germany, Taiwan, Italy, and Japan, which collectively supplied 39 percent of the value of imported products (USITC, 1993).

Larger manufacturers supply the greatest proportion of U.S. exports (USITC, 1993). These products tend to be high quality, high priced, industrial-use products with specific applications. U.S. producers have a reputation of producing high quality products with high levels of consistency. The United States is increasingly less competitive in markets for lower priced consumer goods. The largest export markets for U.S.-produced coated fabrics were Canada, Japan, and Europe from 1988 to 1992. However, in developing countries, the

Table 2-18. Coated Fabrics Foreign Trade: 1989–2008 ($\$10^6$)

	1989	1993	1998	2003	2008
Shipments	2,036	2,242	2,821	3,415	4,120
Exports	480	400	677	985	1270
Imports	298	230	336	450	530
Net exports	182	170	341	535	740
Sales	1,854	2,072	2,480	2,880	3,380
Imports as percentage of sales	16.1	11.1	13.5	15.6	15.7
Exports as percentage of shipments	23.6	17.8	24	28.8	30.8

Source: Freedonia Group. 1999. *Coated Fabrics in the United States to 2003—Introduction, Executive Summary, Market Environment, Coated Shipments, Demand and Markets*. Available at <http://www.profound.com/htbin/titles_do>.

market for fabrics that prevent water pollution and contamination is expected to expand considerably (USITC, 1993).

The increase in production of coated fabrics abroad is important when considered within the context of an increasingly strict regulatory environment in the United States. Environmental issues can be expected to have more of an impact on where goods are produced than will the economics of production because compliance costs are becoming a major portion of production costs (Smith, 1999). Unless foreign producers are also facing an increase in regulatory costs, a well-developed foreign industry is likely to become even more competitive with the coated fabrics industry in the United States.

Pressure from foreign producers during the 1990s affected not only coated fabrics, but most sectors of the textile industry. Public comment on the proposed rule noted that increasing imports would make it difficult for domestic manufacturers to pass increased costs along to their customers in the form of higher prices.

SECTION 3

REGULATORY CONTROL COSTS

EPA identified 135 manufacturing plants in the United States that perform fabric coating, dyeing, printing, slashing, or finishing operations, and are major sources subject to the textile coating, printing, slashing, dyeing and finishing NESHAP. Of these 135 facilities, 61 are in the textile coating and printing subcategory, and 74 are in the textile slashing, dyeing, and finishing subcategory. Based on data obtained from industry and supplemented by publicly available information and contacts with potentially affected facilities, EPA estimated costs to comply with the NESHAP.

3.1 National Control Cost Estimates

EPA examined non-confidential data provided by the industry in the Textile Coating and Printing database (ATMI, 1999), and supplemented the data with information drawn from EPA's environmental databases such as the Toxics Release Inventory. EPA used these data to identify major sources in the textile coating, printing, slashing, dyeing, and finishing industry, characterize their current compliance activities, and estimate the incremental compliance activities and costs they would incur as a result of the rule.

3.1.1 Compliance Costs for the Textile Printing and Coating Subcategory

Based on these data, EPA identified 61 textile coating and printing facilities believed to be major sources subject to the rule. EPA developed several model plants for this subcategory, and estimated the incremental costs associated with various types of compliance activities, including installation of compliance capital equipment, operating and maintaining the equipment, and monitoring, recordkeeping, and reporting requirements. The costs for the fabric coating model plants are shown in Table 3-1. Additional details about how these costs were estimated are available in RTI's January 8, 2002, memorandum to EPA, entitled "Fabric Coating, Printing and Dyeing Nationwide Compliance Costs." (York and Peters, 2002).

Table 3-1. Summary of Textile Coating and Printing Subcategory Model and Nationwide Control Costs[a]

Model	Number of Plants[b]	Model Total Capital Investment[c] ($)	Nationwide Total Capital Investment ($)	Model Total Annual Cost[c] ($/yr)	Nationwide Total Annual Cost ($/yr)
New Add-on Control Device[d]					
Model 1, carbon adsorber	2	104,183	208,366	31,068	62,136
Model 1, catalytic oxidizer	1	300,140	300,140	90,888	90,888
Model 2, thermal oxidizer	2	576,551	1,153,102	241,585	483,170
Model 3, carbon adsorber	4	501,693	2,006,772	87,350	349,400
Upgrade of Add-on Control Device					
Model 2, catalytic oxidizer	1	130,967	130,967	36,302	36,302
Model 3, catalytic oxidizer	2	136,036	272,072	47,914	95,828
Model 3, carbon adsorber	3	159,504	478,512	30,492	91,476
Model 4, catalytic oxidizer	2	182,319	364,638	58,646	117,292
Model 4, carbon adsorber	1	218,447	218,447	42,523	42,523
New Coating Room (PTE)					
Small	14	42,720	640,800	19,743	276,402
Medium	13	50,670	658,710	22,186	288,418
Large	29	57,120	1,656,480	23,569	683,501
Total Control Costs for Model Plants Except Methylene Chloride Model Plants			8,089,006		2,617,336
Nationwide Total Control Costs Except Methylene Chloride Control Costs[e]			16,663,352		5,391,712
New Add-on Control System for Methylene Chloride Emissions[f]					
Model 1, carbon adsorber	1	210,568	210,568	62,477	62,477
Model 3, carbon adsorber	1	700,731	700,731	161,218	161,218
Total Methylene Chloride Control Costs			911,299		223,695
Nationwide Total Control Costs with Methylene Chloride Control Costs[g]			17,574,651		5,615,407

Table 3-1 Footnotes

[a] The nationwide costs were calculated using model plants to estimate the costs of bringing each of the 16 MACT database facilities and 20 fabric coating facilities owned by small businesses (3 of which are also in the MACT database) into compliance with the emission limits, extrapolating this to a nationwide cost based on organic HAP emissions for the subcategory, and adding costs for controlling methylene chloride emissions from the 2 major facilities reporting methylene chloride emissions in the TRI database (neither of which is in the MACT database or is owned by a small business). For each of the 33 MACT database and facilities owned by small businesses (8 of which comply with one of the emission limits), the most cost effective add-on control measure (e.g., upgrading capture efficiency by adding PTE to application stations, or if no add-on controls are in place, the installation of a complete system including PTE and add-on control device) was costed to bring the facility into compliance with one of the emission limits. The model plant costs include costs of installing, upgrading, operating and maintaining add-on control systems. MRR costs are presented in Table 2. All costs are in 1997 $.

[b] Number of model plants assigned to the 16 facilities in the MACT database with sufficient information to calculate the facility OCE and HAP emission rate and to the 17 additional facilities in the small business database to estimate the compliance cost of achieving the MACT floor compliance options with add-on controls.

[c] From October 12, 2001 memorandum regarding compliance costs for textile coating model plants. Note that the upgrade costs represent incremental costs above the costs of a baseline unit.

[d] Model plant costs represent the costs of a new add-on control device and auxiliaries, including ductwork, butterfly dampers, fans, motors, and stacks. Coating room costs are presented separately.

[e] Nationwide total control costs for all facilities in the textile coating and printing industry, except plants with methylene chloride emissions are based on factoring the total control costs for model plants except methylene chloride model plants by the ratio of HAP emissions estimated for major HAP emission sources in the coating and printing subcategory (minus methylene chloride emissions) to the HAP emissions reported by plants for which control costs have been estimated (the ratio is 2.06)

[f] Includes cost of add-on control system and coating room.

[g] Nationwide total control costs for all plants in the textile coating and printing industry are the sum of the nationwide total control costs except methylene chloride control costs and the total methylene chloride control costs.

3.1.2 Compliance Costs for the Textile Slashing, Dyeing, and Finishing Subcategory

EPA identified 74 facilities in the textile slashing, dyeing, and finishing subcategory that are believed to be subject to the regulation. For the majority of these facilities, only enhanced monitoring, recordkeeping, and reporting activities will be required. The cost for these MRR activities is estimated to be approximately $11,500 per facility. EPA identified seven plants that will incur compliance costs associated with reformulation of the finish they apply to textiles to reduce formaldehyde emissions. EPA estimates that the cost of reformulation will be approximately $0.04 per pound of fabric finished with non-compliant finishing chemicals. EPA estimated worst-case costs of reformulation by assuming that facilities' total production of finished fabrics was produced using non-compliant finishing. Nationwide, EPA estimates that only approximately 13 percent of formaldehyde-based finishing processes use non-compliant finishes. Discussions with finishing facilities confirm that they have a variety of finishing processes, only a small share of which use non-compliant finishing chemicals. Thus, the assumption that the total production of finished fabrics used non-compliant finishing chemicals results in a substantial over-estimate of costs. However, EPA does not have sufficient data to distinguish, on a facility-specific basis, the share of finishing operations that use non-compliant finishing chemicals. The costs for these plants are shown in Table 3-2. As the table shows, the reformulation costs vary widely, ranging from approximately $28,000 to more than $7.6 million. EPA used these over-estimated costs to assess worst-case company economic impacts.

Table 3-2. Distribution of Maximum Facility Costs for Finishing Reformulation[a]

	Production (10^6 lbs/yr)	Estimated Cost per Facility (10^6 \$/yr)
Minimum	0.43	0.03
Median	98.67	3.96
Mean	81.06	3.25
Maximum	190.00	7.61

a Most facilities in the finishing subcategory will not be required to reformulate their finishing materials, and will incur at most $11,478 for monitoring, recordkeeeping, and reporting.

To estimate the nationwide cost of converting to compliant finishing materials, EPA assumed that 13 percent of the 1.44 billion pounds of fabric per year (i.e., 186 million pounds of fabric per year) reported to be finished at major facilities for HAP emissions in operations with associated formaldehyde emissions would incur the cost of reformulating to low-formaldehyde compliant finishing materials. Applying the 4 cents incremental cost per pound of finished fabric to use a compliant resin versus a formaldehyde resin to the estimated 186 million pounds of fabric currently finished with non-compliant materials yields a nationwide annual cost of $7.5 million per year. The cost of working with chemical suppliers to reformulate the finish is accounted for in the estimate of the MRR costs.

3.1.3 Estimated National Costs of the Rule

Table 3-3 shows EPA's estimate of the national costs of the rule, including total capital costs and total annual costs. Total annual costs include the annualized costs of purchasing and installing the capital equipment plus the annual costs of operating and

Table 3-3. Summary of Textile Coating, Printing, Slashing, Dyeing, and Finishing NESHAP

Nationwide Cost Component	Nationwide Total Capital Investment ($\$10^6$)	Nationwide Total Annual Cost ($\$10^6$)
Coating and printing subcategory control costs	17.6	5.6
Dyeing and finishing subcategory reformulation costs		7.5
Source category MRR costs	1.2	1.4
Nationwide total compliance costs	18.8	14.5

maintaining the equipment and conducting enhanced monitoring, recordkeeping, and reporting activities. National total annualized costs for the rule total approximately $14.5 million, including $5.6 million of control costs for the coating and printing subcategory, $7.5 million in reformulation costs for the finishing subcategory, and $1.4 million in enhanced monitoring, recordkeeping, and reporting costs shared across both subcategories.

SECTION 4

ECONOMIC IMPACT ANALYSIS: METHODS AND RESULTS

The underlying objective of the EIA is to evaluate the effect of the regulation on the welfare of affected stakeholders and society in general. Although the engineering cost analysis presented in Section 3 does represent an estimate of the resources required to comply with the rule under baseline economic conditions, the analysis does not account for the fact that the regulations may cause the economic conditions to change. For instance, producers may elect to discontinue production rather than comply, thereby reducing market supply. Moreover, the control costs may be passed along to other parties through various economic exchanges. The purpose of this section is to develop and apply an analytical structure for measuring and tracking these effects as they are distributed across the stakeholders tied together through economic linkages.

4.1 Markets Affected by the NESHAP

The determination of markets potentially affected by the rule requires identifying the products produced at the affected facilities and linking them to markets where they are exchanged. One important factor that should be considered when considering market definition is the extent to which the affected commodities are substitutable. The NAICS codes help considerably in this task because substitutability is often implicit in the industry definitions. In addition, economic data inputs for these industries are readily available from the 1997 Economic Census of Manufacturing. The Agency identified four broad industries for facilities potentially affected by the rule:

- NAICS 313320 (Fabric Coating Mills)—this industry comprises establishments primarily engaged in coating, laminating, varnishing, waxing, and rubberizing textiles and apparel (U.S. Census Bureau, 1999d).

- NAICS 313311 (Broadwoven Fabric Finishing Mills)—this industry comprises establishments primarily engaged in finishing broadwoven fabrics and establishments of converters who buy broadwoven fabrics as grey goods (undyed, unfinished), have them finished on contract, and sell at wholesale. Finishing operations include bleaching, dyeing, printing (roller, screen, flock, plisse), and other mechanical finishing, such as preshrinking, shrinking, sponging, calendering, mercerizing, and napping (U.S. Census Bureau, 1999b).

- NAICS 313312 (Textile and Fabric Finishing [except Broadwoven Fabric] Mills)—this industry comprises establishments primarily engaged in dyeing, bleaching, printing, and other finishing of textiles, apparel, and fabrics (except broadwoven) and establishments of converters who buy fabrics (except broadwoven) in the grey, have them finished on contract, and sell at wholesale. Finishing operations include bleaching, dyeing, printing (e.g., roller, screen, flock, plisse), stonewashing, and other mechanical finishing, such as preshrinking, shrinking, sponging, calendering, mercerizing and napping; as well as cleaning, scouring, and preparing natural fibers and raw stock (U.S. Census Bureau, 1999c).

- NAICS 313210 (Broadwoven Fabric Mills)—this industry comprises establishments primarily engaged in weaving broadwoven fabrics and felts (except tire fabrics and rugs). Establishments in this industry may weave only; weave and finish; or weave, finish, and further fabricate fabric products (U.S. Census Bureau, 1999a). However, only part of this industry is selected for economic impact analysis.

Although fabric finishing may take place in specialized shops represented in NAICS 313311 and 313312, fabric finishing also occurs in NAICS 313210 as one of the final steps in the overall fabric manufacturing process. Thus, the profile includes data from all three NAICS.

The economic impacts of the rule on the identified industries and related product markets are examined in the following sections using both a conceptual approach and operational model. The conceptual approach is described in detail in Section 4.2, followed by Section 4.3, which presents the economic impact results based on the operational model.

4.2 Conceptual Approach

The Agency developed two national competitive market models to estimate the economic impacts on society resulting from the regulation. We assume that the commodities of interest are homogeneous (e.g., perfectly substitutable) and that the number of buyers and sellers is large enough that no individual buyer or seller has market power (i.e., influence on market prices). As a result of these conditions, producers and consumers take the market price as a given when making their production and consumption choices.

4.2.1 Supply

After critical review, the Agency determined that survey and compliance cost data support a limited characterization of supply using two aggregate groups: domestic and foreign (imports) within each market. These supply segments have some fixed factors of production (e.g., plant and equipment) that are augmented with variable factors inputs (e.g., materials, labor) to produce coated and finished fabrics. These fixed factors are the source of diminishing marginal returns, hence, increasing marginal costs. Therefore each supply segment can be characterized by an upward-sloping supply curve.

An important measure of the magnitude of this response is the price elasticity of supply, computed as the percentage change in quantity supplied divided by the percentage change in price. EPA identified one estimate of domestic supply elasticity used in a textile model (Warfield et al., 2001). The value is approximately 0.4, which means a 1 percent increase in price would only lead to a 0.4 percent increase in quantity supplied. Because research indicates that import supply may be more responsive than domestic, EPA assumed a value of 0.8 for the import supply elasticity in the market for coated fabric.

Comment on the rule emphasized the pressure that foreign producers have put on domestic textile manufacturers throughout the 1990s. As a result, the commenters doubt that any increase in domestic prices of textiles, including finished textiles, is possible as a result of the rule. In response to these comments, EPA has elected to model the market for finished fabrics and textiles (NAICS 31331) using the assumption that increased imports will compensate for any reduction in domestic production. As a result, no change in market price or quantity occurs in that market in response to the rule, only a change in market shares.

4.2.2 Demand

Consumption choices are a function of the price of the commodity, income, prices of related goods, tastes, and expectations about the future. In this analysis, EPA considered how these choices change in response to higher prices resulting from regulation, holding other variables constant. The economic model includes both domestic and foreign demand and assumes that the law of demand holds (i.e., the quantity demanded for a good falls when price rises).

EPA identified several estimates of domestic demand elasticity used in textile models, ranging from approximately –0.4 to –0.9. EPA selected a domestic elasticity of demand value of approximately –0.8, which means a 1 percent increase in price would lead to a 0.8 percent decline in quantity demanded, because the model generating that estimate also has a consistently estimated domestic elasticity of supply, which EPA also used in the model. In contrast, literature estimates for export demand indicate foreign consumers are more responsive to changes in the market price. EPA's model uses a value of –1.5 for the elasticity of export demand.

4.2.3 Baseline and With-Regulation Market Equilibrium

Market responses to the rule are shown in Figures 4-1 (Fabric Coating, NAICS 31332) and 4-2 (Fabric and Textile Finishing, NAICS 31331). A graphical representation of the competitive model of price formation, as shown in Figure 4-1(a), posits that market prices and quantities are determined by the intersection of the market supply and demand curves. Under the baseline scenario, a market price and quantity (p,Q) are determined by the downward-sloping market demand curve (D) and the upward-sloping market supply curve (S) that reflects the sum of the domestic and import supply curves. EPA's model includes domestic (affected) supply and foreign (unaffected) supply. While there are also unaffected domestic producers, EPA did not have sufficient data to subdivide domestic production into affected and unaffected domestic supply. Thus, EPA grouped all domestic supply into a single segment, and assumed the costs were borne by all domestic suppliers. In fact, the impacts of the regulation will be concentrated on the affected major sources in each subcategory.

With the regulation, the costs of production increase for domestic suppliers. The imposition of these regulatory control costs is represented as an upward shift in the supply curve for domestic supply. As a result of the upward shift in this supply curve, the market supply curve for coated and finished fabrics products will also shift upward as shown in Figure 4-1(b) to reflect the increased costs of production for domestic supply.

In baseline without the standards, the industry produces total output, Q, at price, p, with domestic producers supplying the amount q_a and imports accounting for Q minus q_d, or q_u. With the regulation, the market price increases from p to p′, and market output (as determined from the market demand curve, D) declines from Q to Q′. This reduction in market output is the net result of reductions in domestic supply and increased imports (foreign supply).

In Figure 4-2, increased imports compensate for any reduction in domestic supply. Thus, the market supply curve is essentially perfectly elastic in the relevant range. As costs increase in response to the rule, domestic producers reduce their output. Foreign producers increase their output in response, so that market price and quantity remain unchanged. The

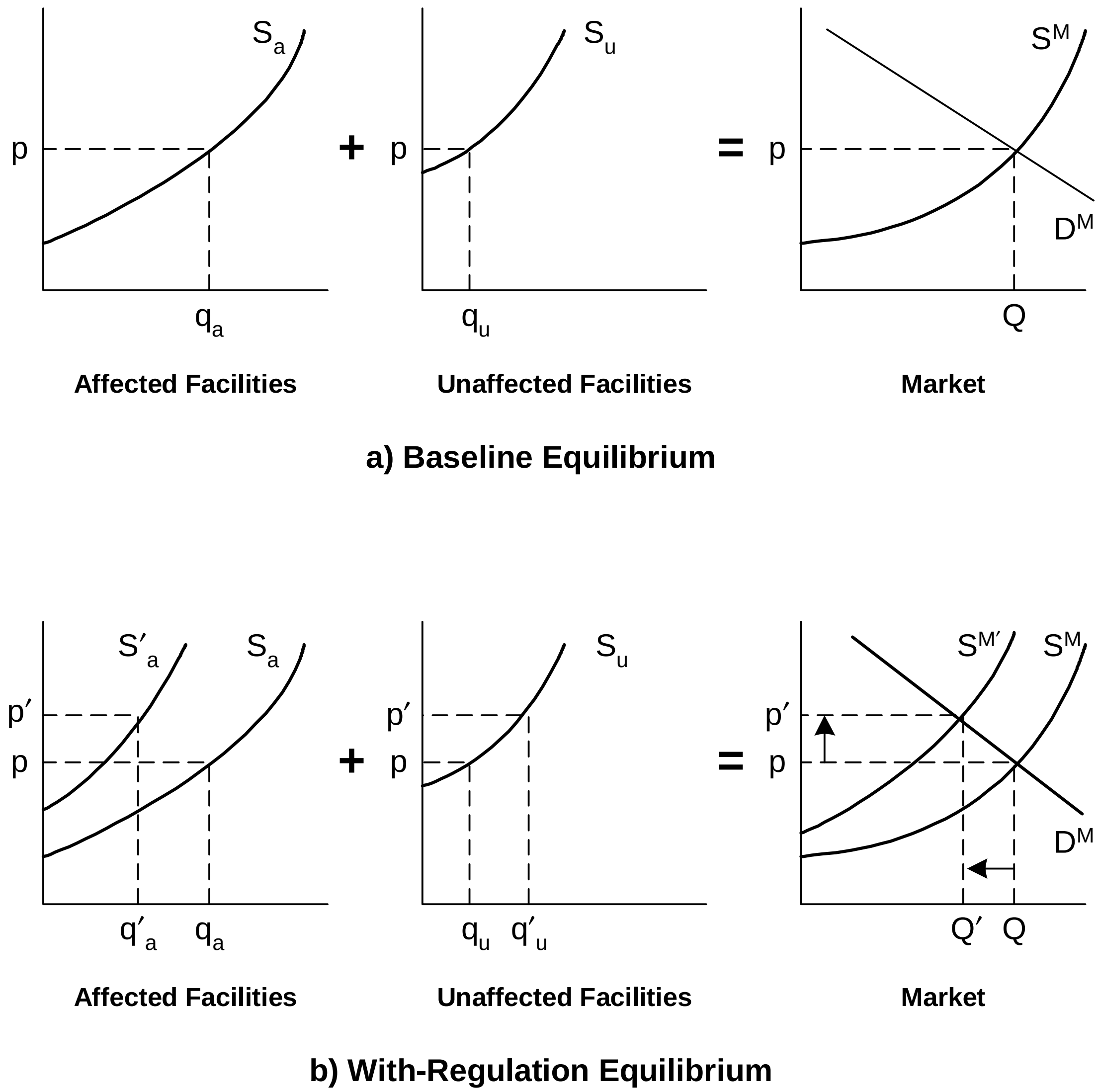


Figure 4-1. Market Equilibrium without and with Regulation: Printing and Coating Subcategory

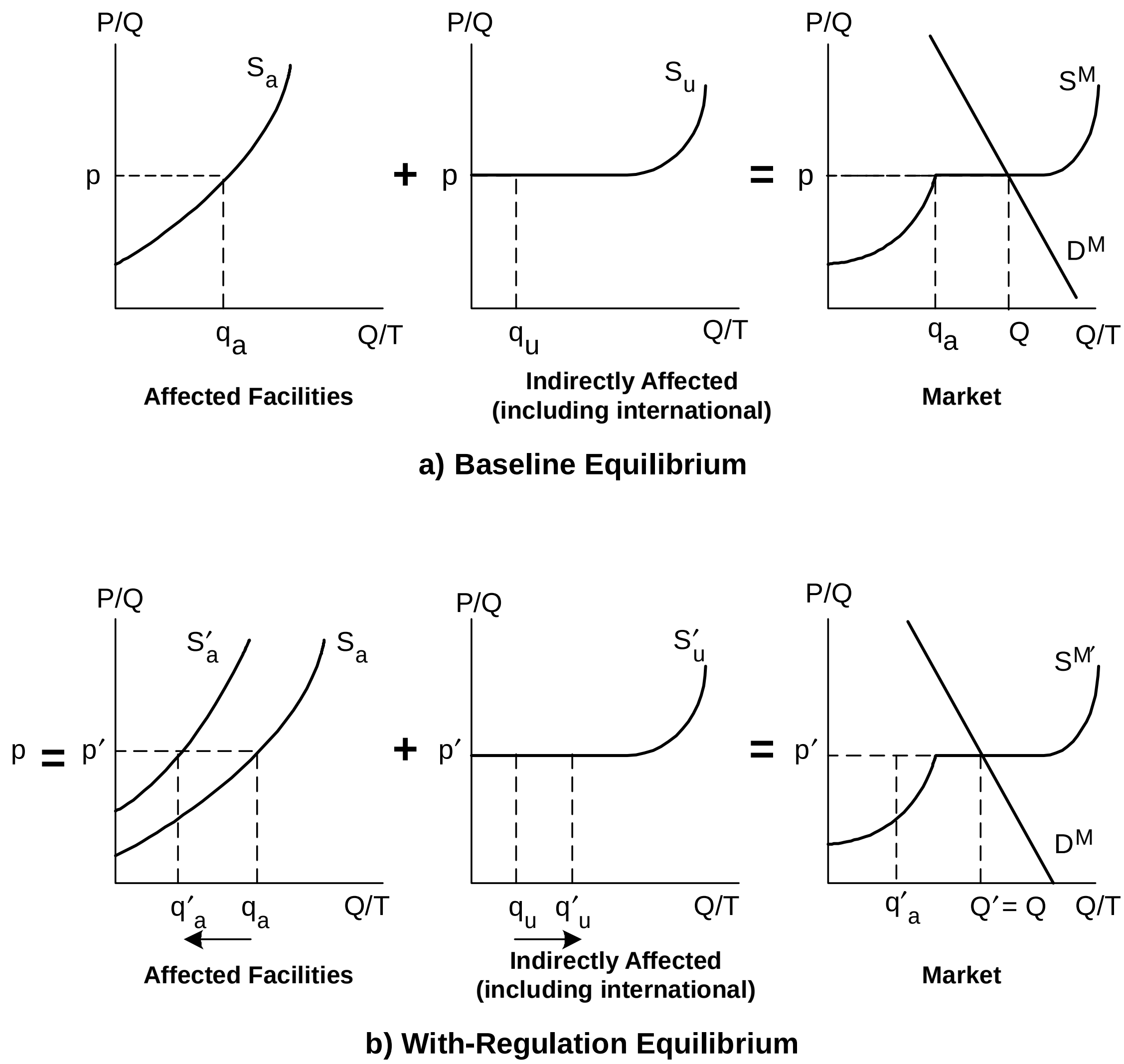


Figure 4-2. Market Equilibrium without and with Regulation: Slashing, Dyeing, and Finishing Subcategory

with-regulation equilibrium shows that the market share of domestic producers has fallen, and the market share of foreign producers had increased.

4.2.4 Company-Level Impacts

EPA has detailed facility-level data from the fabric coating and printing MACT database that permit estimation of a range of possible costs to comply with the regulation. However, the database does not provide information about the location or ownership of many of the facilities. Thus, EPA was able to estimate national costs but was not able to identify which facilities, owned by which companies, would bear which costs. The methodology outlined above assesses the impacts of the rule on the markets for coated and finished fabrics and on producers and consumers of those fabrics as a group. It does not, however, address impacts on individual facilities or companies. To provide some company-specific impact estimates, EPA compared the range of possible facility-specific costs to sales revenues for companies owning fabric coating and finishing facilities.

4.3 Economic Impact Results

To develop quantitative estimates of these impacts, we developed a computer model using the conceptual approach described above.[1] Using this model, EPA characterized supply and demand of two affected commodities for the baseline year, 1997; introduced a policy "shock" into the model by using control cost-induced shifts in the domestic supply functions of these markets; and used the market model to determine a new with-regulation equilibrium in each coated and finished fabrics market. We report the market, industry, and societal impacts projected by the model below.

4.3.1 Market-Level Impacts

The prices of coated and finished fabrics are expected to increase slightly and production and consumption decline from 1997 baseline levels. As shown in Table 4-1, the regulation is projected to increase the prices of coated fabrics by less than 0.1 percent. Domestic production of coated and finished fabrics is projected to decline, respectively, by 0.08 percent and 0.02 percent.

[1]Appendix A includes a description of the model's baseline data set and specification.

Table 4-1. Market-Level Impacts: 1997

	Change (%)
Fabric Coating Mills (NAICS 31332)	
Price	0.06%
Output	–0.06%
Domestic	–0.08%
Imports	0.04%
Fabric and Textile Finishing Mills (NAICS 31331)	
Price	0.00%
Output	–0.00%
Domestic	–0.02%
Imports	6.48%

4.3.2 Social Cost

The social impact of a regulatory action is traditionally measured by the change in economic welfare that it generates. The social costs of the rule will be distributed across producers and their customers. Consumers experience welfare impacts due to changes in market prices and consumption levels associated with the rule. Producers experience welfare impacts resulting from changes in profits corresponding with the changes in production levels and market prices. However, it is important to emphasize that this measure does not include benefits that occur outside the market, that is, the value of reduced levels of air pollution with the regulation.

The national compliance cost estimates are often used as an approximation of the social cost of the rule. The engineering analysis estimated annual costs of $14.5 million in 1997 dollars. In cases where the engineering costs of compliance are used to estimate social cost, the burden of the regulation is measured as falling solely on the affected producers, which experience a loss exactly equal to these cost estimates. Thus, the entire loss is a change in producer surplus with no change (by assumption) in consumer surplus, because no change in market price and quantity are estimated. This is typically referred to as a “full-cost absorption” scenario in which all factors of production are assumed to be fixed and firms are unable to adjust their output levels when faced with additional costs. In response to industry comments that foreign competition makes any price increases for textiles unlikely, EPA is using this approach in modeling the impacts int the finishing sector.

In contrast, the economic analysis conducted by the Agency in the coating sector accounts for behavioral responses to the regulation by producers and consumers, as affected producers shift costs to other economic agents. This approach results in a social cost estimate that may differ from the engineering compliance cost estimate and also provides insights on how the regulatory burden is distributed across stakeholders.

As shown in Table 4-2, the economic model estimates the total social cost of the rule to be $14.5 million. Although society reallocates resources as a result of the increased cost of production, with-regulation social cost approximates the engineering costs. Consumers experience a decline in welfare of $1.6 million, because of increased prices and decreased consumption. All of the loss of consumer welfare is projected in the coating market, because prices of finished fabrics are unchanged. Domestic producers of coated fabrics are projected to lose $4.8 million in producers' surplus, and domestic producers of finished fabrics are estimated to lose $8.5 million in producers' surplus. Foreign producers of coated fabrics are projected to experience small increases in producers' surplus; foreign producers of finished fabrics are projected to experience an increase in sales to the U.S., but no increase in their producers surplus because prices are unchanged.

4.3.3 Estimated Company Impacts

EPA compared estimated costs of complying with the rule to sales revenues for companies owning fabric coating or finishing facilities. Because EPA was unable to identify facility-specific costs, EPA's cost-to-sales analysis compares the range of possible facility-level costs for each subcategory to each owner-company's sales revenues. EPA's database also had incomplete information about companies owning facilities in the two subcategories. To identify companies potentially affected by the rule, company data were collected from *Ward's Business Directory* for 248 companies, including 64 in the coating NAICS, 165 in the finishing NAICS codes, and 19 with operations in both coating and finishing NAICS codes. Table 4-3 presents descriptive statistics for the cost-to-sales ratios for companies owning fabric coating and/or finishing facilities, based on minimum, median, mean, and maximum estimated facility costs. There is a substantial range of facility costs in each subcategory. Because the maximum costs are so high, the mean costs are higher than the median costs in each subcategory. Clearly, the maximum costs would present a problem for the finishers, in particular. For the finishing subcategory, EPA recognizes that its facility-specific costs are clearly overstated. As described in Section 3, the facility-level costs are

Table 4-2. Distribution of Social Costs: 1997

	Value ($\$10^6$/yr)
Change in Consumer Surplus	**–1.59**
Fabric Coating Mills	–1.59
Domestic	–1.24
Foreign	–0.35
Fabric and Textile Finishing Mills	–0.00
Domestic	–0.00
Foreign	–0.00
Change in Producer Surplus	**–12.94**
Fabric Coating Mills	–4.49
Domestic	–4.76
Foreign	0.28
Fabric and Textile Finishing Mills	–8.45
Domestic	–8.45
Foreign	0.00
Total Social Cost	**–14.53**

overstated because they are estimated assuming the total volume of finished fabric at a facility is finished with noncompliant materials. In fact, overall only a very small share is noncompliant (approximately 13 percent). Thus, EPA believes that the best representation of the impacts a typical company in the industry would face is the median cost-to-sales ratio.

For the coating subcategory, the median cost-to-sales ratio is less than 3 percent for 60 of the 64 companies. For only one company in the coating subcategory do median estimated costs represent 3 percent or more of the company's baseline revenues (the other three companies have no sales data). Similarly, for the finishing subcategory, of the 105 companies with sales data, none of them would experience costs exceeding 3 percent of baseline sales, if incurring the median compliance costs. Likewise, for all companies with both coating and finishing operations, median costs are less than 3 percent of sales. Overall, for only one company out of 185 companies with sales data are median costs more than 3 percent of their baseline sales. EPA thus believes that companies typically would find these regulations affordable. This is confirmed by a comparison of costs of compliance with

Table 4-3. Estimated Company Impacts

	Coaters—31332		Finishers—31331, 313311, 313312, and 31321		2 NAICS		All Companies	
Minimum Cost to Sales Ratios	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**
CSR < 1%	58	91%	102	62%	17	89%	177	71%
1% < CSR < 3%	2	3%	3	2%	2	11%	7	3%
CSR > 3%	1	2%	0	0%	0	0%	1	0%
Data Not Available	3	5%	60	36%	0	0%	63	25%
Total	64	100%	165	100%	19	95%	248	100%
Median Cost to Sales Ratios	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**
CSR < 1%	58	91%	102	62%	17	89%	177	71%
1% < CSR < 3%	2	3%	3	2%	2	11%	7	3%
CSR > 3%	1	2%	0	0%	0	0%	1	0%
Data Not Available	3	5%	60	36%	0	0%	63	25%
Total	64	100%	165	100%	19	100%	248	100%
Mean Cost to Sales Ratios	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**
CSR < 1%	58	91%	32	19%	13	68%	103	42%
1% < CSR < 3%	2	3%	30	18%	2	11%	34	14%
CSR > 3%	1	2%	43	26%	4	22%	48	19%
Data Not Available	3	5%	60	36%	0	0%	63	25%
Total	64	100%	165	100%	19	100%	248	100%
Maximum Cost to Sales Ratios	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**	**Number of Companies**	**% of Total**
CSR < 1%	58	91%	4	2%	8	42%	70	28%
1% < CSR < 3%	2	3%	5	3%	4	21%	11	4%
CSR > 3%	1	2%	96	58%	7	37%	104	42%
Data Not Available	3	5%	60	36%	0	0%	63	25%
Total	64	100%	165	100%	19	100%	248	100%

industry profits. Comparing the compliance costs to industry profits indicates that the costs are sufficiently small to have little overall impact on the profitability of the industry. Over the period 1995 to 2000, industry profits for SIC 22, Textile Mill Products (broadly equivalent to NAICS 313), ranged from losses of $349 million to profits of $4.8 billion, depending on the year and the profit measure selected. The costs of compliance represent only 1 or 2 percent of industry profits (although for 2000, when industry profits were negative, investment in compliance capital might have been difficult).

SECTION 5

OTHER IMPACT ANALYSES

The economic impacts associated with the NESHAP were described in the previous section. Statements discussing additional impacts on small businesses, energy use, and unfunded mandates are presented below.

5.1 Small Business Impacts

The Regulatory Flexibility Act (RFA) of 1980 as amended in 1996 by the Small Business Regulatory Enforcement Fairness Act (SBREFA) generally requires an agency to prepare a regulatory flexibility analysis of a rule unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of the rule on small entities, a small entity is defined as: (1) a small business according to Small Business Administration (SBA) size standards for NAICS codes 31332, 313311, or 31321 with 1,000 or fewer employees, or 313312, with 500 or fewer employees; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

Based on the above definition of small entities and data reported in Section 2 of this report, the Agency has determined that, of the 248 companies owning facilities in the fabric coating and finishing industries, there may be as many as 181 small companies. (Companies with no employment data were assumed small, but if EPA also has no sales data, no CSR could be computed for them.) Of these 181 small companies, there are 40 in NAICS 31332, Fabric Coating, 133 in the NAICS codes for fabric slashing, dyeing, and finishing, and 8 with operations in both subcategories. In the coating subcategory, costs are estimated based on model plants, and EPA does not generally have sufficient data to estimate the costs for individual facilities. To assess potential impacts on small businesses owning fabric coating facilities, therefore, EPA collected additional process and control data for small businesses that could potentially incur costs. EPA estimated facility-specific compliance costs for 18 small businesses. The other 22 facilities owned by small companies are not projected to incur costs.

EPA uses the ratio of costs of compliance to company sales to assess the severity of impacts on small businesses. Table 5-1 shows the cost-to-sales ratio (CSR) analysis for the coating subcategory. For the 18 identified small businesses in the coating subcategory for which EPA has estimated facility-specific costs, 15 have costs less than 1 percent of company sales. Two others have costs between 1 percent and 3 percent of company sales and one has a cost-to-sales ratio greater than 3 percent (3.2 percent). The remaining 22 small companies in the coating subcategory are not estimated to incur costs due to the regulation.

Table 5-1. Cost-to-Sales Ratios for Small Companies in the Fabric Coating Subcategory

Cost-to-Sales Ratio	Number of Small Businesses	Percent of Small Businesses
Zero costs	22	55.0%
Less than 1%	15	37.5%
1% < CSR < 3%	2	5.0%
Over 3%	1	2.5%
Total	40	100.0%

In the finishing sector, only seven facilities, owned by five companies, are estimated to incur compliance costs exceeding MRR costs. Only one of these five businesses is identified, and it is a large company. Thus, at most four small companies in the finishing subcategory will incur costs greater than MRR costs. EPA does not have sufficient information to identify which (if any) small companies with finishing operations will incur these costs; however, if they are all small companies, they would represent only 3 percent of the small businesses that own fabric slashing, dyeing, and finishing operations.

With only one small company in the coating subcategory projected to incur costs exceeding 3 percent of sales (3.2 percent), and at most four small companies in the finishing subcategory possibly incurring costs beyond MRR costs, EPA does not believe that a substantial number of small entities will incur significant impacts.

5.2 Energy Impacts

Executive Order 13211 "Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use" (66 Fed. Reg. 28355, May 22, 2001) requires federal agencies to estimate the energy impact of significant regulatory actions. The NESHAP will trigger both an increase in energy use due to the operation of new abatement equipment as well as a decrease in energy use due to a small decline in production of coated and finished fabrics. These impacts are discussed below in greater detail.

5.2.1 Increase in Energy Consumption

Energy requirements for implementing the compliance options for fabric coating and printing facilities include electricity to collect and treat ventilation air, electricity to light permanent total enclosures, and natural gas to provide supplemental fuel for stable operation of oxidizers and to generate the steam required for carbon regeneration. Table 5-2 presents a summary of increased fabric coating and printing model plant and nationwide energy requirements associated with implementing the compliance options. It should be noted that no incremental electricity usage is estimated for the upgrade of catalytic oxidizer model plants. This is because the air flow does not change. Similarly, no incremental energy usage is estimated for the upgrade of carbon adsorber Models 3 and Model 4. For each model plant, the increased efficiency comes from adding a carbon bed, reducing the cycle time between carbon bed regenerations, and therefore reducing the HAPs released to the atmosphere from breakthrough. There is no change in air flow or in the amount of steam used for regeneration, which is a function of the organic HAP load entering the carbon bed.

5.2.2 Reduction in Energy Consumption

The economic model described in Section 4.2 predicts that increased compliance costs will result in an annual production decline of 0.08 percent for coated fabrics and 0.02 percent for finished fabrics. This production decline will lead to a corresponding very small decline in energy usage by manufacturers.

5.2.3 Net Impact on Energy Consumption

Given the very small reductions in energy use expected to result from market responses to the rule, the estimated energy use shown in Table 5-2 is probably a reasonable estimate of the overall energy impact of the regulation. The total electricity generation capacity in the U.S. was 785,990 Megawatts in 1999 (DOE, 1999a). Thus, the electricity

Table 5-2. Summary of Fabric Coating and Printing Subcategory Model and Nationwide Energy Impacts

Model	Number of Plants [a]	Model Incremental Electricity Usage, Kwh/y	Nationwide Total Electricity Usage, Kwh/y	Model Incremental Natural Gas Usage, scf/y	Nationwide Total Natural Gas Usage, scf/y
New add-on control device					
Model 1, carbon adsorber	2	8,933	17,866	418,941	837,882
Model 1, catalytic oxidizer	1	11,293	11,293	2,360,755	2,360,755
Model 2, thermal oxidizer	2	28,857	57,714	36,332,289	72,664,578
Model 3, carbon adsorber	4	119,517	478,068	2,714,142	10,856,568
Upgrade of add-on control device					
Model 2, catalytic oxidizer	1	0	0	691,592	691,592
Model 3, catalytic oxidizer	2	0	0	1,090,910	2,181,820
Model 3, carbon adsorber	3	0	0	0	0
Model 4, catalytic oxidizer	2	0	0	1,723,795	3,447,590
Model 4, carbon adsorber	1	0	0	0	0
New coating room (pte)					
Small	14	11,200	156,800	0	0
Medium	13	12,250	159,250	0	0
Large	29	12,600	365,400	0	0
Total energy impacts for model plants except methylene chloride model plants			1,246,391		93,040,785
Nationwide total energy impacts except methylene chloride energy impacts [b]			2,567,565		191,664,017
New add-on control system for methylene chloride emissions [c]					
Model 1, carbon adsorber	1	15,742	15,742	418,941	418,941
Model 3, carbon adsorber	1	186,588	186,588	2,714,142	2,714,142
Total methylene chloride control energy impacts			202,330		3,133,083
Nationwide total energy impacts with methylene chloride energy impacts [d]			2,769,895		194,797,10

(continued)

Table 5-2 Footnotes

[a] Number of model plants assigned to 14 facilities in the fabric coating MACT database and to 12 fabric coating major facilities owned by small businesses to estimate the incremental energy requirement of achieving the emission limits with add-on controls.

[b] Nationwide totals for all plants in the fabric coating and printing industry, except plants with methylene chloride emissions, are based on factoring the total energy usage for model plants except methylene chloride model plants by the ratio of HAP emissions estimated for major HAP emission sources in the fabric coating and printing subcategory (minus methylene chloride emissions) to the HAP emissions reported by facilities in the fabric coating MACT database and major facilities owned by small businesses (the ratio is 2.06).

[c] Includes energy usage of add-on control system and coating room.

[d] Sum of nationwide total energy impacts except methylene chloride energy impacts and total methylene chloride control energy impacts.

requirements associated with the abatement capital represent a small fraction of domestic generation capacity. Similarly, the natural gas requirements associated with the NESHAP are insignificant given the 23,755 billion cubic feet of natural gas produced domestically in the U.S. in 1999 (DOE, 1999b). Hence, the NESHAP is not likely to have any significant adverse impact on energy prices, distribution, availability, or use.

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APPENDIX A

MODEL DATA SET AND SPECIFICATION

The primary purpose of the EIA for the proposed textile coating, printing, slashing, dyeing and finishing NESHAP is to describe and quantify the economic impacts associated with the rule. The Agency used a basic framework that is consistent with economic analyses performed for other rules to develop estimates of these impacts. This approach employs standard microeconomic concepts to model behavioral responses expected to occur with regulation. This appendix describes the spreadsheet model in detail and discusses how the Agency

- collected the baseline data set for the model,
- characterized market supply and demand for two markets—Fabric Coating Mills (NAICS 31332) and Fabric and Textile Finishing Mills (NAICS 31331, 3132109, 313210P, 313210U),
- introduced a policy "shock" into the model by using control cost-induced shifts in the domestic supply functions, and
- used a solution algorithm to determine a new with-regulation equilibrium for each market.

A.1 Baseline Data Set

EPA collected the following data to characterize the baseline year, 1997:

- *Baseline quantity and prices*—Value of shipments, import and export data from for each market. We selected units for output such that the price in each market equals one (see Table A-1).
- *Domestic supply and demand elasticities*—Warfield et al. (2001) report supply and demand elasticity estimates used in the NTC-MFA model. Domestic consumers are more responsive to small changes in price (demand elasticity = –0.852) than domestic producers (supply estimate = 0.372).

Table A-1. Baseline Data Set, 1997

Market	Value ($\$10^6$)[a]	Import Value (10^6)[b]	Export Value (10^6)[b]
Fabric Coating Mills (NAICS 31332)	2,259	474	603
Fabric and Textile Finishing Mills (NAICS 31331, 3132109, 313210P, 313210U)[c]	17,200	49	41

[a] U.S. Bureau of the Census. 2000. "Bridge Between NAICs and SIC." *1997 Economic Census Core Business Statistics Series.* EC97X-CS3. Washington, DC: Government Printing Office.
[b] U.S. International Trade Commission. 2001. Interactive Tariff and Trade DataWeb. <http://205.197.120.17/>. As obtained August 22, 2001.
[c] Foreign trade values are reported for NAICS 31331 only.

- *Import supply and export demand elasticities*—Supply and demand elasticities used are shown in Table A-2. EPA was unable to identify empirical estimates of import supply; therefore the Agency assumed import supply elasticity in the coating market was double the domestic supply elasticity (= 0.744). Import supply was assumed essentially perfectly elastic in the finishing market. Ho and Jorgenson (1998) report export demand elasticities ranging from of –1.2 to –1.6 for textile mill industry. For this analysis, we used an average of –1.45.

A.2 Market Supply

Market supply is composed of domestic production (d) and imports (m):

$$Q^{s} = q^{s_d} + q^{s_m} . \tag{A.1}$$

A.2.1 Domestic and Import Supply

The change in quantity supplied by domestic producers can be approximated as follows:

$$\Delta q^{s_d} = q_0^{s_d} \cdot \varepsilon^{s_d} \cdot \frac{\Delta p - c}{p_0} \tag{A.2}$$

Table A-2. Textile Supply and Demand Elasticities Used for the Market Models

Market	Supply	Demand
Domestic	0.372[a]	–0.852[a]
Foreign	0.744[b]	–1.450[c]

[a] Warfield, et al (2001). “Multifiber Arrangement Phaseout: Implications for the U.S. Fibers/Textiles/Fabricated Products Complex.” www.fibronet.com.tw/mirron/ncs/9312/mar.html> As obtained September 19, 2001.

[b] Assumed value (2*domestic supply elasticity) for the coating market.

[c] Ho, M., and Jorgenson, D. 1998. “Modeling Trade Policies and U.S. Growth: Some Methodological Issues.” Presented at USITC Conference on Evaluating APEC Trade Liberalization: Tariff and Nontariff Barriers. September 11-12, 1997. <http://www.usitc.gov/wais/reports/arc/w3101.htm>.

where $q_0^{S_d}$ is the baseline quantity, ε^{S_d} is the domestic supply elasticity, the term (Δp–c) is the change in the producer’s net price, and p_0 is the baseline price. This is composed of the change in baseline price resulting from the regulation (Δ p) and the shift in the domestic supply function (c). The shift is calculated by taking the annual compliance cost estimate and dividing it by baseline value of shipments (see Table A-3).

Table A-3. Domestic Supply Shifts, 1997

Market	Value of Shipments ($$10^6$)	TACC ($$10^6$)	Supply Shift (TACC/Value of Shipments)
Fabric Coating Mills (NAICS 31332)	2,259	6.1	0.269%
Fabric and Textile Finishing Mills (NAICS 31331, 3132109, 313210P, 313210U)	17,200	8.5	0.049%

The change in quantity supplied by foreign producers of coated fabrics can be approximated as follows:

$$\Delta q^{S_m} = q_0^{S_m} \cdot \varepsilon^{S_m} \cdot \frac{\Delta p}{p_0} \tag{A.3}$$

where $q_0^{S_m}$ is the baseline level of imports, ε^{S_m} is the import supply elasticity, and p_0 is the baseline price. Foreign coated fabric producers do not face additional pollution control costs, therefore their net price change equals the gross price change which is positive. As a result, foreign producers increase output in response to higher prices. Foreign producers of finished fabrics are assumed to increase their supply to compensate completely for reductions in domestic production of finished fabrics. Insert equation Delta qsm=-Delta qsd

$$\Delta Q^{sm} = \Delta Q^{sd}$$

Import supply of finished fabrics is assumed to be essentially perfectly elastic over the relevant range, so that market price and quantity of finished fabrics is unchanged by the rule.

A.2.1.1 Producer Welfare Measurement

For affected domestic supply, the change in producer surplus can be approximated with the following equation:

$$\Delta PS_d = q_{d1} \cdot (\Delta p - c) + 0.5 \cdot \Delta q_d \cdot (\Delta p - c) . \tag{A.4}$$

Increased control costs and output declines have a negative effect on domestic producer surplus. However, these losses are mitigated to some degree as a result of higher market prices.

In contrast to domestic producers, foreign producers of coated fabrics do not face additional pollution controls and their change in producer surplus can be approximated as follows:

$$\Delta PS_m = q_{m0} \cdot \Delta p + 0.5 \cdot \Delta q_m \cdot \Delta p \tag{A.5}$$

With regulation, both price and output increase for these producers leading to unambiguous producer surplus gains. For foreign producers of finished fabrics, quantity increases but producers surplus remains unchanged because price is unchanged.

A.2.2 Market Demand

Market demand is composed of domestic consumption (d) and exports (x):

$$Q^{D_d} = q^{D_d} + q^{D_x} \tag{A.6}$$

A.2.2.1 Domestic and Export Demand

The change in quantity demanded by domestic and foreign consumers can be approximated as follows:

$$\Delta q^{D_i} = q_0^{D_i} \cdot \eta^{D_i} \cdot \frac{\Delta p}{p_0} \tag{A.7}$$

where q_0^D is baseline consumption, η^D is the demand elasticity of the respective consumer (i), and (Δ p) is the change in the market price.

A.2.2.2 Consumer Welfare Measurement

The change in domestic and foreign consumer surplus is approximated as follows:

$$\Delta CS_i = - q_{i1} \cdot \Delta p + 0.5 \cdot \Delta q_i \cdot \Delta p \ . \tag{A.8}$$

As shown, higher market prices and reduced consumption lead to welfare losses for domestic and foreign consumers of coated fabrics. Because the market price and quantity of finished fabrics is unchanged by the rule, no change in consumer surplus occurs in that market.

A.3 With Regulation Market Equilibrium Solution

The new with-regulation equilibrium arises where change in total market supply equals the change in market demand (i.e., $\Delta Q^s = \Delta Q^D$). EPA used the model equations outlined above and a solver application available in commercial spreadsheets to compute the new equilibrium in prices and quantities.

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16. ABSTRACT

This report presents a technical analysis of the economic impacts associated with the National Emissions Standard for Hazardous Air Pollutants to control emissions of air toxic pollutants from the Fabric and Textile Printing, Coating, and Dyeing industry. The analysis evaluates adjustments in the fabric printing, coating, and dyeing markets (through price and production changes), social cost, and the resulting affects on employment, international trade, and small businesses.

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