United States Environmental Protection Agency	Office Of Air Quality Planning And Standards Research Triangle Park, NC 27711	EPA-452/R-01-010 July 2001 FINAL REPORT

Air

Economic Impact Analysis of the Proposed Asphalt Roofing and Processing NESHAP

Final Report

Economic Impact Analysis of the Proposed Asphalt Roofing and Processing NESHAP

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Innovative Strategies and Economics Group, MD-15
Research Triangle Park, NC 27711

July 2001

This report has been reviewed by the Emission Standards Division of the Office of Air Quality Planning and Standards of the United States Environmental Protection Agency and approved for publication. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use. Copies of this report are available through the Library Services (MD-35), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, or from the National Technical Information Services 5285 Port Royal Road, Springfield, VA 22161.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1

INTRODUCTION AND EXECUTIVE SUMMARY

The Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS) is developing 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 and processing of asphalt roofing products. This document analyzes the economic impacts of the proposed NESHAP on the asphalt industry and its customers.

Asphalt roofing products fall under North American Industry Classification System (NAICS) Code 324122, Asphalt Shingle and Coating Materials Manufacturing, as well as the U.S. Standard Industrial Classification (SIC) 2952, Asphalt Felts and Coatings. According to the 1997 Economic Census of Manufacturing, 248 establishments owned by 149 companies manufactured products categorized in NAICS 324122 (U.S. Department of Commerce, Bureau of the Census, 1999) in 1997. During this year, these firms employed 13,316 workers and shipped products valued at $4.9 billion (U.S. Department of Commerce, Bureau of the Census, 1997). EPA has identified 123 facilities owned by 34 companies that may be subject to the proposed standards because they produce asphalt roofing products. In addition, eight refineries owned by six companies may be subject to the proposed rule because they produce and sell blown asphalt. The identified facilities produce one or more of five asphalt roofing products:

- blown asphalt,
- fiberglass shingles,
- organic shingles,
- roll roofing (including asphalt felts), and
- modified bitumen roofing.

EPA's economic impact analysis (EIA) assesses the impacts of the estimated costs of complying with the proposed NESHAP on prices and market quantities in the markets listed above; on facility and company production, employment, and profits; and on economic welfare. To perform this assessment, EPA used an integrated partial equilibrium market simulation model that produces consistent estimates of impacts on facilities, companies, markets, and economic welfare.

Based on its analysis of baseline facility operations, EPA estimates that only six asphalt roofing facilities will incur incremental costs associated with installing and operating emissions control equipment. These six roofing manufacturers, together with one additional roofing manufacturer and all eight refineries, will also incur costs to perform monitoring, recordkeeping, and reporting activities associated with the proposed rule.

Because only a small subset of the industry is projected to incur costs due to the proposed regulation, overall costs of the rule are estimated to be small. As shown in Table 1-1, total capital costs are $1.9 million, and total annual costs are less than $1.1 million. The median value for capital costs incurred is approximately $153,000, and the median total annual costs incurred is approximately $53,000.

Because projected costs are relatively low, and because only a small subset of the market is directly affected, price and quantity impacts of the proposed rule are very small. Prices are projected to change by only a few cents, representing hundredths of a percent of baseline prices that range from $161 per ton to $895 per ton. Similarly, market quantities are projected to decline by less than 0.01 percent. (See Section 4.6 for a detailed discussion of the Agency's EIA results.)

Although market impacts are very small, EPA recognized that impacts on individual facilities or companies might be significant. To assess this, EPA examined changes in profitability of facility asphalt operations and of companies owning asphalt roofing facilities or blown asphalt-producing refineries. EPA's analysis shows that impacts, even on facilities incurring compliance costs, are relatively small. Industry-wide, output is only projected to fall by approximately 228 tons per year of asphalt roofing products. Industry-wide profits are projected to fall by roughly $42,000. Facilities incurring compliance costs experience a decline in profit of $83,000. Industry-wide, the gains in profitability at facilities that do not incur compliance costs are what partially offset this loss. No facilities are projected to close, and no change in employment is expected, because increases in employment (totaling less

Table 1-1. National Control Costs Estimates

	Facility	Refinery	Total
Emission Control Cost for Existing Facilities			
Total capital cost	$1,890,494		$1,890,494
Total annualized emission control costs	$730,383	–	$730,383
Annualized capital costs	$222,123	–	$222,123
O&M costs	$508,260	–	$508,260
Monitoring, Recordkeeping, and Reporting (MRR) Costs			
Average annual cost	$151,287	$172,899	$324,187
Year 1 total annual cost	$7,587	$8,671	$16,259
Year 2 total annual cost	–	–	–
Year 3 total annual cost	$446,274	$510,027	$956,301
Total Annual Cost	$881,670	$172,899	$1,054,569

Notes: Total Annualized Emission Control Costs = Annualized Capital Costs + O&M Costs
Average Annual MRR Cost = (Year 1 Total Annual Cost + Year 2 Total Annual Cost + Year 3 Total Annual Cost)/3
Total Annual Cost = Total Annualized Emission Control Costs + Monitoring, Recordkeeping, and Reporting Costs

Source: U.S. Environmental Protection Agency (EPA). 2001. National Costs and Environmental Impacts for the Proposed Asphalt Roofing Manufacturing NESHAP."

than two full-time equivalent employees hired) at facilities that do not incur costs roughly offset decreases in employment (approximately one full-time equivalent employee lost) at facilities that do incur compliance costs.

The Agency is particularly concerned about potential impacts to small companies. Pursuant to the Small Business Regulatory Enforcement Fairness Act (SBREFA) and the Regulatory Flexibility Act, EPA conducted a preliminary regulatory flexibility analysis to examine potential impacts on small entities, in this case, small businesses. Section 5 provides the details of the Agency's analysis of potential impacts on small businesses. The asphalt roofing industry has many small businesses: 26 of 40, including 22 roofing manufacturers and four refineries. EPA conducted a screening analysis by comparing compliance costs to company sales. None of the small businesses are expected to incur costs of compliance exceeding 1 percent of baseline sales. EPA then examined the impacts of the proposed regulation on small business revenues, costs, profits, and employment. As a result of the regulation, EPA projects that small business revenues will increase by $20,000, while costs are projected to increase by $36,000. Profits at small businesses are projected to decline by 0.1 percent. No facilities owned by small businesses are projected to close, and no changes in employment are projected at facilities owned by small businesses.

Overall, EPA projects that the costs and economic impacts of the proposed Asphalt Roofing and Processing NESHAP will be relatively small. Only approximately 15 refineries and roofing manufacturers are estimated to incur compliance costs. The relatively small reductions in output and profit will be concentrated at those 15 facilities, while many other asphalt roofing manufacturers are projected to experience increased output and profits. No facilities are projected to close and no net change in industry employment is projected. New sources are required to comply with the standards at start-up; average total annualized costs for a new facility are projected to be $539,000. EPA's analysis projects that these costs will not be sufficient to delay the opening of new asphalt plants.

SECTION 2

INDUSTRY PROFILE

This section provides information to support the EIA of a proposed NESHAP on asphalt roofing and processes. Asphalt roofing products fall under NAICS 324122 Asphalt Shingle and Coating Materials Manufacturing. According to the 1997 Economic Census of Manufacturing, 248 establishments owned by 149 companies produced products that are categorized in NAICS 324122 (U.S. Department of Commerce, Bureau of the Census, 1999) in 1997. In this same year, these firms employed 13,316 workers and shipped products valued at $4.9 billion (U.S. Department of Commerce, Bureau of the Census, 1997).

Asphalts are desired in roofing products primarily for their waterproofing properties. They are used as saturants and coatings for shingle and roll goods, as mopping asphalts in membrane roofing, and as roof coatings. The various products classified under the Asphalt Shingle and Coating Materials Manufacturing Industry (NAICS 324122) are listed in Table 2-1. Asphalt roof coatings and mopping asphalts, which are melted and used in applying built-up roofing, will not be covered by this NESHAP rule; therefore, they are not included in this section except where economic data include these products and more disaggregated data are unavailable. The rule primarily affects the production of asphalt-saturated felt, roll roofing, shingles, and modified bitumen membranes.

Asphalt shingles are widely used because they are one of the least expensive roofing options (Kroschwitz and Howe-Grant, 1991). Asphalt shingles represent approximately 52 percent of the value of shipments of the entire asphalt shingle and coating materials manufacturing industry (NAICS 324122). Other significant findings of this section are that the asphalt shingle and coating materials manufacturing industry is unconcentrated, and that foreign trade represents an insignificant fraction of the activity in the U.S. asphalt roofing product market.

Table 2-1. Types of Products in Asphalt Shingle and Coating Materials Manufacturing Industry (NAICS 324122)

Product	8-Digit NAICS Code
Roofing asphalts and pitches, coatings, and cements (NAICS 3241221)	
Roofing asphalt	324122 1 1
Fibrated and nonfibrated asphaltic roofing coatings	324122 1 2
Other roofing asphalts and pitches, coatings, and cements	324122 1 3
Prepared asphalt and tar roofing and siding products, including saturated felts and boards for nonbuilding use (NAICS 3241222)	
Asphalt smooth-surfaced roll roofing and cap sheets, organic and fiberglass base	324122 2 1
Asphalt mineral-surfaced roll roofing and cap sheets, organic and fiberglass base	324122 2 2
Asphalt strip shingles, organic base (excluding laminated), all weights	324122 2 3
Asphalt strip shingles, inorganic base (excluding laminated), 215 to 235 lb-sales square	324122 2 4
Asphalt strip shingles, inorganic base (excluding laminated), all other weights	324122 2 5
Laminated or multilayered asphalt strip shingles and individual shingles	324122 2 6
Other prepared asphalt and tar products for roofing and siding	324122 2 7

Source: U.S. Department of Commerce, Bureau of the Census. 1999. *1997 Economic Census: Manufacturing Industry Series—Asphalt Shingle and Coating Materials Manufacturing*. EC97M-3241C. Washington, DC: Government Printing Office. <http://www.census.gov/prod/ec97/97m3241c.pdf>.

This section is organized as follows. Section 2.1 includes a detailed description of the production process for the individual asphalt roofing products, with a brief discussion of the inputs to the production process and costs of production. Section 2.2 describes the characteristics, uses, and consumers of asphalt roofing products as well as substitution possibilities. Section 2.3 discusses the organization of the industry and provides facility- and company-level data. In addition, small businesses are reported separately for use in evaluating the impact on small businesses to meet the requirements of the Regulatory Flexibility Act (RFA) as amended in 1996 by SBREFA. Finally, Section 2.4 contains market-level data on prices and quantities and discusses trends and projections for the industry.

2.1 The Supply Side

The asphalt roofing products affected by the proposed NESHAP include blow asphalt, surfaced and smooth roll roofing, fiberglass and organic (felt-based) shingles, and modified bitumen membranes. With the exception of modified bitumen membranes, most asphalt roofing products are produced in a similar manner. The production process typically involves six stages, and asphalt is the primary input. The production process and the associated costs of production are the focus of this section.

2.1.1 Types of Products and Services

As noted above, the asphalt roofing products potentially affected by the rule are blown asphalt, asphalt shingles (fiberglass or organic shingles), roll roofing (asphalt felts), and modified bitumen roofing (MBR).

Asphalt felts are used as inner roof coverings and serve as protectants and sealants. They are suited for this use because they are water repellent, able to tolerate temperature fluctuations, and resistant to breakdown and decay caused by exposure to the elements (Hillstrom and Ruby, 1994).

Both surfaced and smooth roll roofing are outer roof coverings commonly used for low-cost housing and utility buildings in place of asphalt shingles. They are purchased in rolls that are 36 to 38 feet long and approximately 36 inches wide, thereby simplifying the roof application process (Scharff, 1996).

Asphalt shingles have different characteristics depending on whether their base mat is organic felt or glass-fiber. Organic felts are produced from paper fibers, rags, wood, or a combination of the three, while glass-fiber base mats are manufactured from inorganic, thin glass fibers. If the base is organic, the shingle has the lowest possible American Society Testing and Materials (ASTM) fire-resistant rating, referred to as a Class C rating. The organic-based shingle is also considered to be flexible, even in cold weather. The fiberglass shingle has the highest fire-resistance rating (Class A), which means roofing is able to tolerate severe exposure to fire originated from sources outside the building (Scharff, 1996). Unlike the organic-base shingles, these are quite inflexible in cold weather.

Whether organic or fiberglass, asphalt shingles are commonly manufactured as strip shingles, interlocking shingles, and large individual shingles. Strip shingles are rectangular, measuring about 12 inches in width and 36 inches in length. The three-tab shingle is the most common strip shingle. The three-tab shingle gives the appearance of three separate shingles and is stronger and easier to apply. Interlocking shingles come in various shapes and with different locking devices, which provide not only a mechanic interlock but also resistance to strong winds (Scharff, 1996). As for large individual shingles, they are generally rectangular or hexagonal in shape (Kroschwitz and Howe-Grant, 1991).

Modified bitumen membranes have a number of uses. They can be applied as the primary material for new roofs, as a cover for existing roofs, and as cap sheets in built-up roofing (BUR) applications (Scharff, 1996). For each of these applications, styrene-butadiene-styrene (SBS)-based membranes are installed using hot asphalt, a torch, cold process adhesives, or self-adhesives. Atactic polypropylene (APP)-based membranes are usually installed with a torch or cold process adhesives. Both SBS- and APP-based membranes are purchased in rolls and are usually applied in multiple layers (Kroschwitz and Howe-Grant, 1991). Advantages of modified bitumen membranes over other roofing materials are their versatility in both steep and low-slope roofing applications and their puncture resistance, durability, and weatherability.

2.1.2 Asphalt as a Primary Input

Asphalt is the primary material input to the production of asphalt roofing products. It is made of saturants, asphaltenes, and resins. The properties that make asphalt suitable for roofing are its softness, flexibility, and strength. Asphalt has the ability to expand and contract with the application surface. This is because asphalt contains saturants, which are light oils that make it soft and flexible. On the other hand, asphaltenes (high molecular weight cyclic aromatic compounds containing nitrogen, oxygen, and/or sulfur in their molecular structure [Phoenix Chemical Corporation, 2001]) provide asphalt body, rigidity, and strength while resins bond the saturants and asphaltenes and give asphalt its resilience (Scharff, 1996).

The quality of the asphalt depends on the source of the crude oil used in its production. A crude oil with a high flash point is desired, because combustion and vaporization of such light oils are most probable at higher flash points. Lower flash points result in a harder asphalt flux that is better suited for paving applications than for roofing (Hillstrom and Ruby, 1994).

2.1.3 Asphalt Blowing

Prior to initiating the operations necessary for producing asphalt roofing products, the asphalt is prepared through a process called "blowing." Asphalt is blown or oxidized to increase its softening temperature and its consistency, or penetration value, so that it will not flow off the roof in hot weather (Kroschwitz and Howe-Grant, 1991). The blowing process, which involves the oxidation of asphalt flux by bubbling air through it when it is in liquid form, results in an exothermic reaction that requires cooling. Oxidation may take place over a time period spanning from 1 to 10 hours, depending on the desired characteristics of the roofing asphalt. The softening point and penetration rate of asphalt depend on how long it is allowed to oxidize (MRI, 1995). In addition, the presence of catalysts affects the rate of oxidation because catalysts speed up this process. After oxidation occurs, the asphalt is ready to enter into the asphalt roofing production process.

Figure 2-1 illustrates the emissions sources of the blowing process, which are the asphalt flux storage tanks and the blowing stills (Kroschwitz and Howe-Grant, 1991). Both particulate matter (PM) and volatile organic compounds (VOCs) are emitted from these sources. The oxidation of asphalt may also contribute to the emission of hazardous air pollutants (HAPs) if catalysts are present during oxidation.

2.1.4 Production Processes for Asphalt Roofing Products

After asphalt is prepared through the blowing process, it is used in the production of asphalt-saturated felt, surfaced and smooth roll roofing, fiberglass and organic (felt-based) shingles, and modified bitumen membranes. For each of these products, with the exception of modified bitumen membranes, production typically consists of the following six primary operations:

- **felt saturation**: using asphalt with a low softening point to saturate either organic or fiberglass felts/mats;
- **coating**: applying coating/modified asphalt and a mineral stabilizer on the felts/mats;
- **mineral surfacing**: applying mineral surfacings to the bottom of the felts/mats;
- **cooling and drying**: using water-cooling and air-drying procedures to bring the product to ambient temperatures;

EMISSION SOURCE	SCC
ASPHALT BLOWING: SATURANT	3-05-001-01
ASPHALT BLOWING: COATING	3-05-001-02
ASPHALT BLOWING: (GENERAL)	3-05-001-10
FIXED ROOF ASPHALT STORAGE TANKS	3-05-001-30, -31
FLOATING ROOF ASPHALT STORAGE TANKS	3-05-001-32, -33

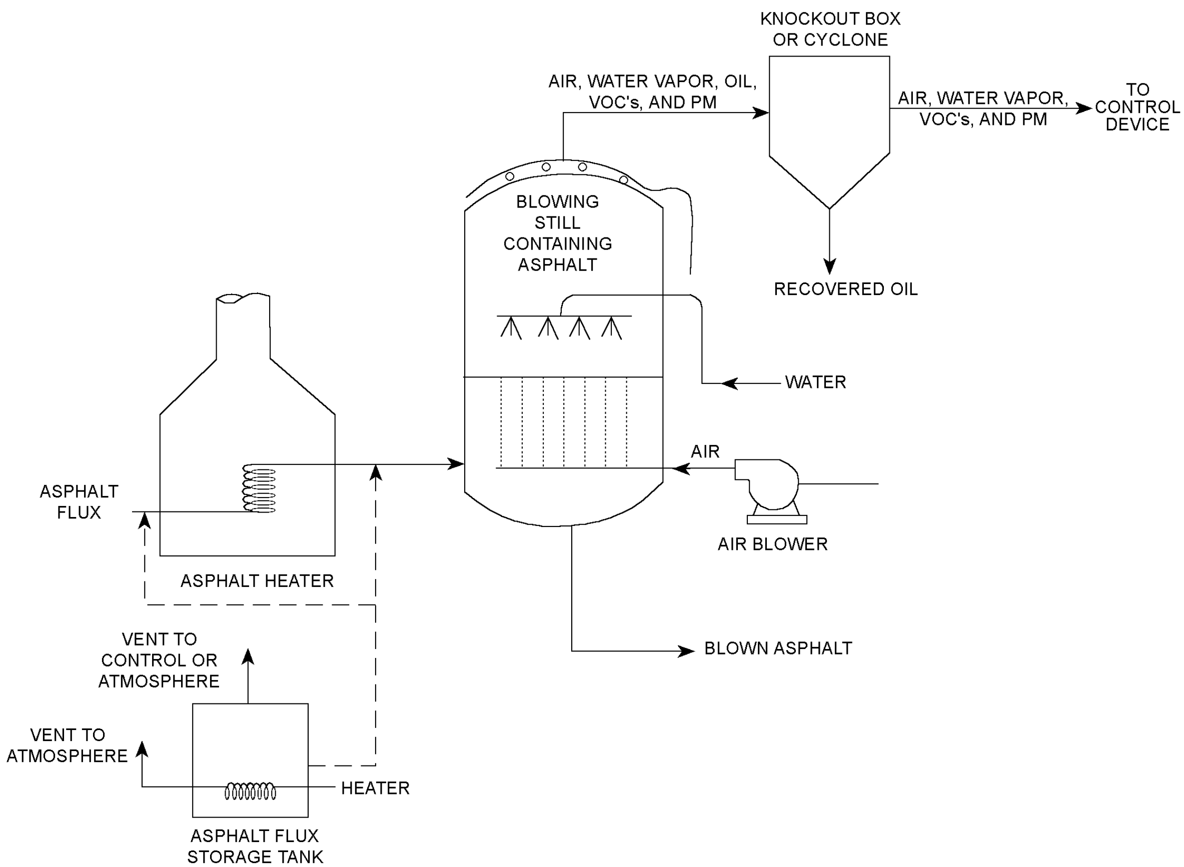


Figure 2-1. Flow Diagram of the Asphalt Blowing Process

Source: Midwest Research Institute (MRI). 1995. AP-42, 5th Edition, Volume 1, Chapter 11 Mineral Products Industry. Prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Cary, NC: Midwest Research Institute.

- **product finishing**: formatting the designated asphalt roofing products; and
- **packaging**.

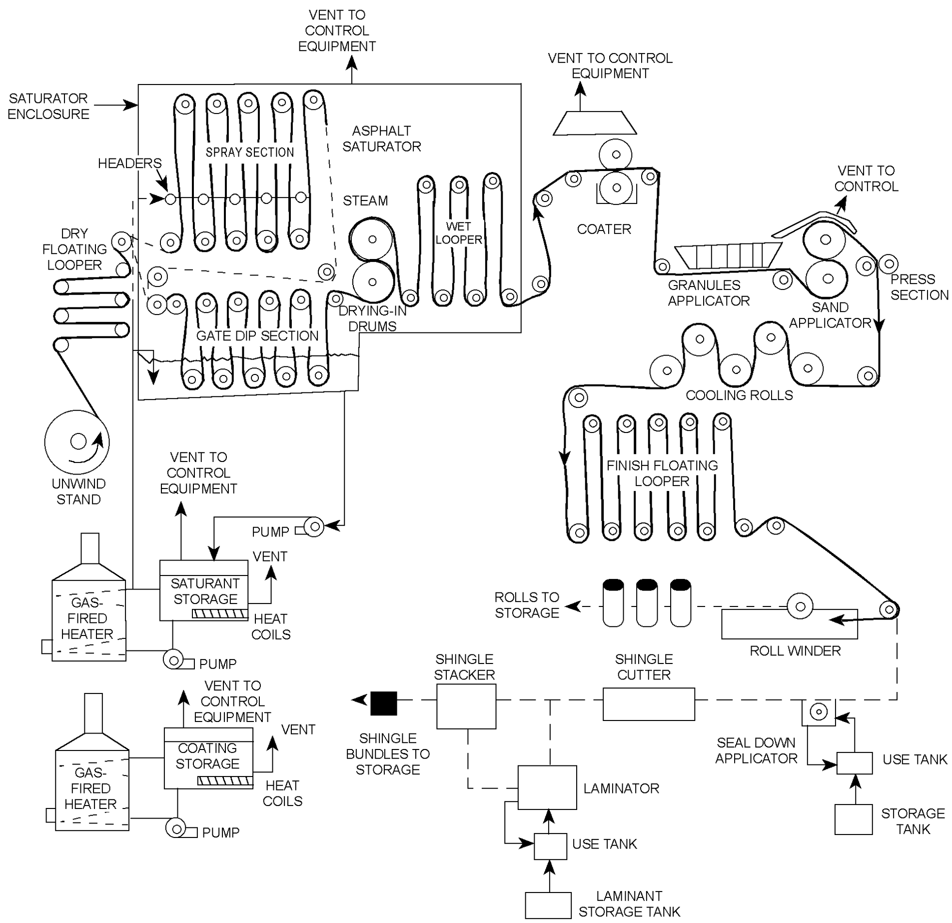
The specific production process for each of the asphalt roofing products is the focus of the remainder of this section.

2.1.4.1 Asphalt-Saturated Felt

One of the most basic asphalt roofing products is asphalt-saturated felt. It is produced using a blotter-like paper, called felt, that is made of cellulosic materials. The production process, as shown in Figure 2-2, begins with the unwind stand, where the felt is unrolled onto the dry looper (Kroschwitz and Howe-Grant, 1991). From the dry looper, the felt passes through the saturator, which is a tank filled with a very soft or low softening point asphalt called saturant (Kroschwitz and Howe-Grant, 1991). The felt then moves over a series of rollers, where the bottom rollers are submerged into hot asphalt at a temperature of 205 to 250°C (400 to 480°F). The next step in the production process involves heating the asphalt to ensure that it has penetrated the felt. The felt would not pass through the granule applicator unlike the production of surfaced and smooth roll roofing or shingles which are described in the Sections 2.1.4.2 and 2.1.4.3. Finally, the saturated felt passes through water-cooled rolls onto the finish floating looper and then is rolled and cut on the roll winder (Kroschwitz and Howe-Grant, 1991). As Figure 2-2 shows, PM and VOC emissions from this process are primarily generated by the saturator and the heaters.

2.1.4.2 Surfaced and Smooth Rolls

Surfaced and smooth rolls can be produced using either organic felt or a fiberglass mat as the base or substrate. Figure 2-2 illustrates the typical production process for surfaced or smooth rolls that use organic felt as the substrate (Kroschwitz and Howe-Grant, 1991). The first stage in the production process is asphalt saturation of felt. If a fiberglass mat is the substrate, however, then the felt saturation step is excluded. After this step is completed, either the saturated felt or fiberglass mat passes into the coater. The coater applies a filled asphalt coating, which is prepared by mixing coating asphalt or modified asphalt and a mineral stabilizer in approximately equal proportions. The coater releases the filled coating onto the top of the felt or mat. Squeeze rollers then apply filled coating to the bottom of the felt or mat and distribute it evenly to form a thick base coating onto which surfacing materials will adhere.



EMISSION SOURCE	SCC
FELT SATURATION: DIPPING ONLY	3-05-001-03
FELT SATURATION: DIPPING/SPRAYING	3-05-001-04
DIPPING ONLY	3-05-001-11
SPRAYING ONLY	3-05-001-12
DIPPING/SPRAYING	3-05-001-13
DIP SATURATOR, DRYING-IN DRUM, WET LOOPER, AND COATER	3-05-001-16
DIP SATURATOR, DRYING-IN DRUM, AND COATER	3-05-001-17
DIP SATURATOR, DRYING-IN DRUM, AND WET LOOPER	3-05-001-18
SPRAY/DIP SATURATOR, DRYING-IN DRUM, WET LOOPER, COATER, AND STORAGE TANKS	3-05-001-19
FIXED ROOF ASPHALT STORAGE TANKS	3-05-001-30, 31
FLOATING ROOF ASPHALT STORAGE TANKS	3-05-001-32, -33

Figure 2-2. Flow Diagram of the Organic Shingle and Roll Manufacturing Production Process

Source: Midwest Research Institute (MRI). 1995. AP-42, 5th Edition, Volume 1, Chapter 11 Mineral Products Industry. Prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Cary, NC: Midwest Research Institute.

If surfaced rolls are being manufactured, the asphalt sheet produced by the coater passes through the granule applicator next. Smooth roll production excludes this step. During the granule application stage, surfacing material is applied by dispensing granules onto the hot, coated surface of the asphalt sheet. Sand, talc, or mica is also applied to the sheet as it passes through the press roll, which forces the granules into the coating (Kroschwitz and Howe-Grant, 1991).

Following the application of surfacing material for surfaced roll production, or the coating stage for smooth roll production, the asphalt sheet passes through the final production stages. The sheet is first cooled rapidly on water-cooled rolls and/or by using water sprays. Then, if surfaced rolls are being produced, the sheet passes through air pressure-operated press rolls used to embed the granules firmly into the coating. Asphalt sheets for both surfaced and smooth roll production are then air dried. A strip of asphalt adhesive is applied next, the purpose of which is to seal the loose edge of the roofing after it is installed. These processes are facilitated by a finish looper, which allows continuous movement of the sheet as it passes through each of these final production stages. It also serves to further cool and dry the sheet. The final stage of roll roofing production is the formation of the rolls. This takes place by passing the roofing sheet through a winder, where rolls are formed.

Figure 2-2 illustrates the emission points of this production process. The asphalt storage tanks, blowing stills, saturators, coater-mixer tanks, and coaters emit both PM and VOCs. Adhesive applicators are also sources of trace quantities of PM and VOCs. PM is emitted by surfacing operations and materials handling as well (Kroschwitz and Howe-Grant, 1991).

2.1.4.3 Shingles

Organic felt and fiberglass mat-based shingle manufacturing involves the same production processes as surfaced and smooth roll roofing, with the exception of the final roll formation step. Instead of forming rolls with the roofing sheets, the sheets are passed through a cutter, which cuts the sheet into individual shingles. If the shingles are going to be made into laminated products, they must also pass through a lamination stage where laminant is applied in narrow strips to the bottom of the sheet (Kroschwitz and Howe-Grant, 1991).

Each of the emissions sources from the manufacture of surfaced and smooth roll roofing is applicable to shingle production as well. These sources are indicated in Figure 2-2.

In addition to these sources, emissions are produced by the laminant applicators used in shingle production. These applicators are sources of trace quantities of PM and VOCs.

2.1.4.4 Modified Bitumen Membranes

The production of modified bitumen membranes consists of modifying the asphalt (also known as bitumen); combining the modified asphalt with a reinforcement; and then applying fillers, fire retardant additives, and/or surfacing. Asphalt is generally modified by either thermoplastic or elastomeric polymer, such as APP, styrene block copolymer (SBC), or SBS (Scharff, 1996). The most commonly used polymers are APP and SBS. SBS is an elastomer that has better cold-weather flexibility and melts at a low temperature. It also has higher tensile strength but poorer elongation than the APP modifier. APP is a thermoplastic polymer that softens when heated and melts at a very high temperature (FacilitiesNet, 2000b). APP modifiers can be exposed to the weather, whereas SBS modifiers must have surface protection against ultraviolet radiation. Both of these modifiers raise the softening point of asphalt without reducing its flexibility or weatherability (FacilitiesNet, 2000a).

After the asphalt has been modified, a reinforcement is added. The reinforcements most commonly used in modified bitumen production are polyester and fiberglass mats. Both polyester and fiberglass mats are used with SBS-modified bitumen, while polyester mats are most commonly used with APP-modified bitumen (Kroschwitz and Howe-Grant, 1991). Polyester mats are superior to fiberglass mats as reinforcements in modified bitumen membranes because polyester has higher elongation and higher puncture resistance than fiberglass. However, fiberglass has higher tensile strength than polyester.

Following the addition of reinforcement to the modified asphalt, fillers, fire-retardant additives, and/or surfacing may be applied. Surfacing is an important component of the membrane because it protects the membrane from external elements. Surfacing may either be applied during production of the membrane or during installation of the product. If it is applied during production, possible surfacing materials include granules that are pressed onto the top surface of the membrane; a thin layer of fiberglass; or sheets of copper, aluminum, or stainless steel. Surfacing applied during application of the membrane may consist of a coat of asphalt, loose aggregate, or a liquid aluminum roof coating (Kroschwitz and Howe-Grant, 1991).

2.1.5 Major By-Products, Co-Products, and Input Substitution Possibilities

The asphalt roofing production process produces no significant by-products or co-products, and there are very few input substitution possibilities. One type of input that does allow for substitution opportunities is the type of mat used in manufacturing asphalt shingles, roll roofing, and modified bitumen membranes. This mat may have either an organic or a fiberglass base. As described above, organic felts are less fire-resistant and more flexible than fiberglass felts. The mineral surfacing found on asphalt products can also vary. Talc and mica are the most frequently used mineral surfacings, but coarse mineral granules, such as slate and rock granules, can be used as well (Hillstrom and Ruby, 1994). Alternative surfacing granules mainly affect the appearance of the roof. The polymer used in modifying asphalt for modified bitumen production also has input substitution possibilities because APP, SBC, SBS, or SBR can be used as the modifier (Scharff, 1996). However, APP and SBS are the most popular modifiers and offer different flexibility and strength characteristics (FacilitiesNet, 2000b).

2.1.6 Costs of Production and Plant Size Efficiency

In this section, the costs of producing asphalt roofing products, historical costs for the industry, and plant size efficiency are examined. These figures are reported for NAICS 324122, Asphalt Shingle and Coating Materials Manufacturing, which includes asphalt coatings and mopping asphalts. These two products are included in Section 2.1.6 because more disaggregated data are not available.

2.1.6.1 Historical Statistics for Costs of Production

Table 2-2 provides the primary costs of production for the asphalt roofing industry for the years 1990 through 1998 in both current and constant 1999 dollars. In general, costs of production in real terms have increased over the past 9 years. Costs as a percentage of value of shipments have been relatively flat, fluctuating between 73 percent and 79 percent. In 1998, costs of production accounted for 73 percent of the value of shipments.

Table 2-2. Historical Costs of Production for NAICS 324122, Asphalt Shingle and Coating Materials Manufacturing: 1990-1998

	Total Cost of Production ($$10^6$)		Payroll Expenses ($$10^6$)		Capital Expenditures ($$10^6$)		Cost of Materials ($$10^6$)		Value of Shipments ($$10^6$)		Cost of Production as a Percentage of Value of Shipments
Year	Current $	1999 $	Current $	1999 $	Current $	1999 $	Current $	1999 $	Current $	1999 $	
1990	$2,759	$3,078	$381	$425	$66	$74	$2,312	$2,579	$3,585	$4,000	77%
1991	$2,642	$2,887	$382	$417	$63	$69	$2,197	$2,401	$3,438	$3,757	77%
1992	$2,840	$3,066	$413	$445	$69	$75	$2,359	$2,546	$3,913	$4,224	73%
1993	$3,054	$3,257	$441	$470	$74	$78	$2,539	$2,708	$4,173	$4,451	73%
1994	$3,095	$3,280	$434	$460	$97	$103	$2,564	$2,717	$4,043	$4,285	77%
1995	$3,274	$3,404	$446	$463	$102	$106	$2,726	$2,835	$4,272	$4,443	77%
1996	$3,533	$3,579	$471	$477	$128	$130	$2,934	$2,971	$4,488	$4,546	79%
1997	$3,722	$3,755	$499	$504	$150	$151	$3,072	$3,100	$5,095	$5,141	73%
1998	$3,887	$3,956	$523	$532	$149	$151	$3,216	$3,272	$5,350	$5,444	73%

Sources: U.S. Department of Commerce, Bureau of the Census. 1995b. *1992 Census of Manufactures, Industry Series—Petroleum and Coal Products*. MC92-I-29A. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 2000. *1998 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M98(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1998. *1996 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M96(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1997. *1995 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M95(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1996. *1994 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M94(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1995c. *1993 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M93(AS)-1. Washington, DC: Government Printing Office.
U.S. Bureau of Labor Statistics. 2000a. "Producer Price Index Revision—Commodities: WPUSOP3000, Finished Goods: 1990-1999." <http://146.142.4.24/cgi-bin/surveymost>.

2.1.6.2 Economies of Size

Table 2-3 provides information on the efficiency of plant size for those facilities in NAICS 324122. Using the value added per production worker as a measure of efficiency, there are no apparent economies of size for this industry. As Table 2-2 shows, the value added per production worker hour peaks at $97.50 for those facilities with 5 to 9 employees, and it generally drops for the following categories. The 1 to 4 employees category has the lowest value added, which is $55 per production worker hour. For the 250 to 499 employees and 500 to 999 employees categories, the information is withheld to avoid disclosing data on individual companies.

Table 2-3. Efficiency of Plant Size for Facilities in NAICS 324122, Asphalt Shingle and Coating Materials Manufacturing

Employees	Value Added by Manufacturer ($$10^6$)	Number of Production Worker Hours (hrs)	Value Added/Production Worker Hour
1 to 4 employees	$11.0	0.2	$55.00
5 to 9 employees	$19.5	0.2	$97.50
10 to 19 employees	$71.3	0.8	$89.13
20 to 49 employees	$225.8	2.4	$94.08
50 to 99 employees	$477.9	5.7	$83.84
100 to 249 employees	$869.3	10.2	$85.23
250 to 499 employees	NA	NA	NA
500 to 999 employees	NA	NA	NA

NA = Not available.

Source: U.S. Department of Commerce, Bureau of the Census. 1999. *1997 Economic Census: Manufacturing Industry Series—Asphalt Shingle and Coating Materials Manufacturing*. EC97M-3241C. Washington, DC: Government Printing Office. <http://www.census.gov/prod/ec97/97m3241c.pdf>.

2.2 The Demand Side

The primary consumers of asphalt roofing products are those in the construction industry. This industry selects asphalt-based products for roofing applications for a number of reasons, especially their excellent waterproofing capabilities. In addition to asphalt roofing products, the construction industry also relies on a number of substitute roofing products. The characteristics, uses, and consumers of asphalt roofing products, as well as the substitutes for these products, are the focus of this section.

2.2.1 Product Characteristics

Asphalt roofing products are popular among consumers because of their excellent waterproofing capabilities. The specific type of asphalt product desired by an end user varies depending on a number of factors. These factors include the end-user's budget, the ease of installation, the type of surface area to which the product is being applied, and the climate and weather patterns of the location where the roofing products are installed.

Consumers desiring an inexpensive substitute that is simpler to install than asphalt shingles may use roll roofing as the product of choice. This product comes in rolls instead of cutouts, but it is surfaced similar to shingles.

If climate or weather patterns are of concern to the end user, the type of asphalt shingle desired depends on the climatic conditions. Compared to organic-based asphalt shingles, fiberglass-based shingles are generally better suited for warmer climates because they can stiffen in cold climates. In warmer climates fiberglass-based shingles are preferred because they are more weather resistant and have the highest ASTM fire-resistance rating. This is because fiberglass-based shingles contain more coating asphalt, which provides greater resistence to warping, rotting, blistering, and curling (Hillstrom and Ruby, 1994).

The desired shape of asphalt shingles also varies depending on the geographic area of application. The most common shape is the three-tab shingle, which has two slots cut in its front edge. These slots serve to provide stress relief as the shingle expands and contracts with the weather. In areas often characterized by strong winds, the T-lock shingle may be the shingle of choice. This is a highly wind-resistant slotted T-shaped shingle that locks to the shingle both above and below it (Kroschwitz and Howe-Grant, 1991).

Consumers may select modified bitumen membranes if they desire a product that is versatile and able to suit a wide variety of project needs. These membranes are suitable for both steep and low-slope applications and have the durability and flexibility necessary for free span buildings, such as aircraft hangars and warehouses. In addition, modified bitumen membranes are effective in both cold and warm weather climates (Kroschwitz and Howe-Grant, 1991).

2.2.2 Uses and Consumers

Asphalt roofing products are initially consumed by the construction industry, with only a small percentage going to nonbuilding uses. It is worth noting that asphalt products are also intermediate goods that are inputs into final products, such as housing and other buildings, produced by the construction industry. In addition, asphalt roofing products may be sold to consumers for home improvement. The uses of these products and the demand for asphalt roofing products by the construction industry sector are discussed below.

2.2.2.1 Uses of Asphalt Roofing Products

Table 2-4 lists the primary types of asphalt roofing products. As a percentage of value of shipments, asphalt strip shingles make up the majority of products in this industry (52.1 percent). Roll roofing and cap sheets account for 9.7 percent of the total, while roofing asphalt accounts for 6.4 percent. The "other" asphalt roofing products category includes asphalt roofing cements and pitches, modified bitumen membranes, and asphalt- and tar-saturated felts for nonbuilding uses.

Table 2-4. Major Uses of Products in NAICS 324122, Asphalt Shingle and Coating Materials Manufacturing

Product	Value of Product Shipments ($$10^6$)	Percentage of Total
Total	$4,576.8	100.0%
Roofing asphalt	$292.1	6.4%
Asphaltic roofing coatings	$170.7	3.7%
Asphalt roll roofing and cap sheets	$442.8	9.7%
Asphalt strip shingles	$2,382.6	52.1%
Other	$1,288.6	28.2%

Source: U.S. Department of Commerce, Bureau of the Census. 1999. *1997 Economic Census: Manufacturing Industry Series—Asphalt Shingle and Coating Materials Manufacturing*. EC97M-3241C. Washington, DC: Government Printing Office. <http://www.census.gov/prod/ec97/97m3241c.pdf>.

2.2.2.2 Primary Consumers of Asphalt Roofing Products

About 81 percent of all asphalt roofing products are used in residential construction, while the remaining 19 percent are used in the commercial construction market (Kroschwitz and Howe-Grant, 1991). For the residential market, reroofing jobs consume 79 percent of all asphalt roofing products and the remaining 21 percent are used in new construction applications (Burns and Paulson, 1997).

The majority of these products are used in nonfarm residential structure maintenance (24.4 percent). Two sectors—maintenance of nonfarm buildings not elsewhere classified (n.e.c.) and nonfarm residential one-unit structures—also consume a large portion of asphalt roofing products (22 percent and 13.4 percent, respectively). Other sectors that rely on asphalt roofing products are office buildings (7.1 percent), nonfarm residential additions/alterations (4.7 percent), construction of educational buildings (3.1 percent), and industrial buildings (3.1 percent).

2.2.3 Substitution Possibilities in Consumption

Several substitution possibilities exist for asphalt roofing products. A number of roofing materials can be used in place of asphalt shingles and roll roofing. Popular substitutes for these products include elastomeric roofing (used in single-ply roofing) and metal roofing. Wood shingles, tile, clay, metal, and plastic are other materials that can be used in place of asphalt shingles and roll roofing.

Asphalt-saturated felts and modified bitumen membranes have few substitution possibilities. Coal tar bitumen is the only known suitable replacement for asphalt-saturated felt. Synthetic rubbers can be used in place of modified bitumen membranes in BUR applications. However, synthetic rubbers are less adaptable to repair and maintenance work than modified bitumen membranes (Kroschwitz and Howe-Grant, 1991).

2.3 Industry Organization

This section identifies the characteristics of the asphalt roofing industry in the United States. The issues affecting the asphalt roofing industry's organization are addressed at both the company and the facility levels.

2.3.1 Market Structure

Market structure is of interest because it determines the behavior of producers and consumers in the industry. If an industry is perfectly competitive, then individual producers are not able to influence the price of the outputs they sell or the inputs they purchase. This condition is most likely to hold if the industry has a large number of firms, the products sold are undifferentiated, and entry and exit of firms are unrestricted. Product differentiation can occur both from differences in product attributes and quality and from brand name recognition of products. Entry and exit of firms are unrestricted for most industries except, for example, in cases when government regulates who is able to produce, when one firm holds a patent on a product, when one firm owns the entire stock of a critical input, or when a single firm is able to supply the entire market.

When compared across industries, firms in industries with fewer firms, more product differentiation, and restricted entry are more likely to be able to influence the price they receive for a product by reducing output below perfectly competitive levels. This ability to influence price is referred to as exerting market power. At the extreme, a single monopolistic firm may supply the entire market and hence set the price of the output.

To assess the competitiveness of a market, economists often estimate four-firm concentration ratios (CR4), eight-firm concentration ratios (CR8), and Herfindahl-Hirschman Indexes (HHI) for the subject market or industry. The CR4 and CR8 ratios measure the percentage of sales accounted for by the top four and eight firms in the industry, respectively. The HHI is the sum of the squared market shares of firms in the industry. Unfortunately, there is no objective criterion for determining market structure based on the values of concentration ratios alone. However, there are criteria for determining market structure based on the HHIs as provided in the 1997 Department of Justice's revised Horizontal Merger Guidelines (U.S. Department of Justice and the Federal Trade Commission, 1997). 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). Firms in less-concentrated industries are more likely to be price takers, while firms in more-concentrated industries are more likely to be able to influence market prices.

Table 2-5 presents the various measures of market concentration for the asphalt felts and coatings industry. The HHI for NAICS 324122 is 778, which is less than the Department of Justice's threshold value of 1,000 for market power potential. The unconcentrated nature of the asphalt roofing industry implies that individual producers in this industry are less likely to be able to set the market price of asphalt roofing products.

Table 2-5. Market Concentration Measures for NAICS 324122, Asphalt Shingle and Coating Materials Manufacturing

Category	Value
Herfindahl-Hirschman Index (HHI)	778
Four-firm concentration ratio (CR4)	47
Eight-firm concentration ratio (CR8)	65
Number of companies	149
Number of facilities	248
Value of shipments ($\$10^6$)	4,932

Sources: U.S. Department of Justice and the Federal Trade Commission. Horizontal Merger Guidelines. <http://www.usdoj.gov/atr/public/guidelines/horiz_book/hmg1.html> April 8, 1997.
U.S. Department of Commerce, Bureau of the Census. 1992. *Concentration Ratios in Manufacturing*. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1999. *1997 Economic Census: Manufacturing Industry Series—Asphalt Shingle and Coating Materials Manufacturing*. EC97M-3241C. Washington, DC: Government Printing Office. <http://www.census.gov/prod/ec97/97m3241c.pdf>.

2.3.2 Manufacturing Plants

Table 2-6 lists all of the asphalt roofing manufacturing facilities in the 50 states and the District of Columbia as of 1999 and provides company name, facility location, product type, and sales and employment ranges. Data on plant locations and product types were obtained from the Asphalt Roofing Manufacturing Association (ARMA) and Dun & Bradstreet and complemented with information from American Business Information.

As reported in Table 2-6, 40 companies owned and operated 123 facilities that produce asphalt roofing materials during 1999. Figure 2-3 presents the distribution of the 76

Table 2-6. Facility-Level Product, Sales, and Employment for Asphalt Roofing Manufacturers

Company	Facility Location	Products						Sales Range ($\$10^6$)	Employment Range (number)
		Blown Asphalt	Fiberglass Shingle	Organic Shingle	Built-up Roofing	Modified Bitumen	Saturated Felt		
Atlas Roofing Corp.	Ardmore, OK		Y					10–20	100
Atlas Roofing Corp.	Daingerfield, TX		Y					50–100	138
Atlas Roofing Corp.	Franklin, OH		Y					20–50	170
Atlas Roofing Corp.	Hampton, GA		Y					100–500	160
Atlas Roofing Corp.	Meridian, MS		Y					NA	207
Atlas Roofing Corp.	Quakertown, PA		Y					50–100	90
Bitec	Morrilton, AR					Y		12	45
Carlisle Syntec Systems	Sapulpa, OK					Y		112	750
Certainteed Corp.	Avery, OH		Y	Y				NA	NA
Certainteed Corp.	Birmingham, AL		Y					NA	NA
Certainteed Corp.	Charleston, SC		Y		Y			50–100	120
Certainteed Corp.	Chester, PA					Y		NA	NA
Certainteed Corp.	Cincinnati, OH		Y					NA	NA
Certainteed Corp.	Ennis, TX		Y					NA	NA
Certainteed Corp.	Fremont, CA		Y					NA	NA
Certainteed Corp.	Little Rock, AR				Y	Y	Y	NA	NA
Certainteed Corp.	Los Angeles, CA		Y					NA	NA
Certainteed Corp.	Norwood, MA		Y		Y			50–100	164
Certainteed Corp.	Oxford, NC		Y					10–20	250
Certainteed Corp.	Peachtree City, GA		Y					NA	NA
Certainteed Corp.	Portland, OR		Y			Y		NA	NA
Certainteed Corp.	Shakopee, MN		Y	Y				NA	NA
Certainteed Corp.	Shreveport, LA		Y		Y		Y	50–100	113
Certainteed Corp.	South Gate, CA		Y		Y		Y	NA	NA
Certainteed Corp.	Wilmington, CA		Y					NA	NA
Conglass, Inc.	Bakersfield, CA				Y		Y	NA	NA
Conglass, Inc.	Santa Ana, CA				Y		Y	NA	NA

(continued)

Table 2-6. Facility-Level Product, Sales, and Employment for Asphalt Roofing Manufacturers (continued)

		Products							
Company	Facility Location	Blown Asphalt	Fiberglass Shingle	Organic Shingle	Built-up Roofing	Modified Bitumen	Saturated Felt	Sales Range ($\$10^6$)	Employment Range (number)
Elk Corp.	Ennis, TX		Y					50–100	250
Elk Corp.	Meyerstown, PA		Y					NA	NA
Elk Corp.	Shafter, CA		Y					20-50	100
Elk Corp.	Tuscaloosa, AL		Y					50-100	158
Firestone Building Products	Beech Grove, IN				Y	Y		NA	NA
Firestone Building Products	Bristol, CT					Y		NA	NA
GAF Corp.	Albuquerque, NM						Y	NA	NA
GAF Corp.	Baltimore, MD		Y					100–500	165
GAF Corp.	Corvalis, OR				Y			NA	NA
GAF Corp.	Dallas, TX		Y		Y			20–50	100–249
GAF Corp.	Erie, PA		Y		Y			20–50	140
GAF Corp.	Fontana, CA		Y		Y			NA	NA
GAF Corp.	Goldsboro, NC		Y					NA	NA
GAF Corp.	Hollister,CA						Y	NA	NA
GAF Corp.	Houston, TX		Y					NA	NA
GAF Corp.	Indiana City, IN		Y					NA	NA
GAF Corp.	Millis, MA		Y					50–100	101
GAF Corp.	Minneapolis, MN		Y					50–100	125
GAF Corp.	Mobile, AL		Y					100–500	160
GAF Corp.	Monroe, GA				Y			NA	NA
GAF Corp.	Mt. Vernon, IN		Y			Y		NA	NA
GAF Corp.	North Branch, NJ					Y		NA	NA
GAF Corp.	Port Arthur, TX					Y		NA	NA
GAF Corp.	Savannah, GA		Y			Y		100–500	200
GAF Corp.	Stockton, CA					Y	Y	NA	NA
GAF Corp.	Tampa, FL		Y					20–50	100–249
GAP Roofing	Pryor, OK				Y		Y	1.2	79

(continued)

Table 2-6. Facility-Level Product, Sales, and Employment for Asphalt Roofing Manufacturers (continued)

		Products							
Company	Facility Location	Blown Asphalt	Fiberglass Shingle	Organic Shingle	Built-up Roofing	Modified Bitumen	Saturated Felt	Sales Range ($\$10^6$)	Employment Range (number)
Globe Building Materials, Inc.	St. Paul, MN		Y	Y	Y		Y	50–100	120
Globe Building Materials, Inc.	Whiting, IN		Y	Y	Y		Y	50–100, 100–500	120, 30
Herbert Malarkey Roofing Co.	Portland, OR		Y		Y	Y	Y	38.0	100
Honeywell Inc.	Detroit, MI				Y			NA	NA
Honeywell Inc.	Fairfield, AL				Y			NA	NA
Honeywell Inc.	Ironton, OH				Y			50–100	90
Iko Production, Inc.	Chicago, IL		Y	Y				20–50	100
Iko Production, Inc.	Franklin, OH		Y			Y		20–50	50
Iko Production, Inc.	Sumas, WA		Y			Y		5–10	5
Iko Production, Inc.	Wilmington, DE		Y					20–50	70
Johns Manville Corp.	Kansas City, KS					Y		10–20	30
Johns Manville Corp.	Macon, GA				Y	Y		20–50	50
Johns Manville Corp.	Natchez, MS					Y		50–100	120
Johns Manville Corp.	Oklahoma City, OK				Y			NA	NA
Johns Manville Corp.	Pittsburg, CA				Y			20–50, 50–100	90, 85
Johns Manville Corp.	Plattsburgh, NY					Y		10–20	28
Johns Manville Corp.	Southgate, CA					Y		NA	NA
Johns Manville Corp.	Waukegan, IL					Y		NA	NA
MB Technology	Fresno, CA					Y		NA	NA
Mineral Fiber Manufacturing Corp.	Coshocton, OH				Y		Y	20–50	100–249
Northern Elastomeric Inc.	Brentwood, NH				Y	Y	Y	13.30	75
Owens Corning	Atlanta, GA		Y					20–50	110
Owens Corning	Brookville, IN		Y					50–100	100
Owens Corning	Compton, CA		Y					20–50	110

(continued)

Table 2-6. Facility-Level Product, Sales, and Employment for Asphalt Roofing Manufacturers (continued)

Company	Facility Location	Products: Blown Asphalt	Products: Fiberglass Shingle	Products: Organic Shingle	Products: Built-up Roofing	Products: Modified Bitumen	Products: Saturated Felt	Sales Range ($\$10^6$)	Employment Range (number)
Owens Corning	Denver, CO		Y					50–100	80
Owens Corning	Denver, CO	Y						NA	NA
Owens Corning	Detroit, MI	Y						NA	NA
Owens Corning	Houston, TX		Y					2.5–5	5
Owens Corning	Irving, TX		Y					50–100	115
Owens Corning	Jacksonville, FL		Y					50–100	90
Owens Corning	Jessup, MD		Y					20–50	98
Owens Corning	Kearny, NJ		Y					50–100	100
Owens Corning	Medina, OH		Y					100–500	160
Owens Corning	Memphis, TN		Y					20–50	105
Owens Corning	Memphis, TN	Y						NA	NA
Owens Corning	Minneapolis, MN		Y					20–50	77
Owens Corning	Morehead City, NC	Y						10–20	18
Owens Corning	Oklahoma City, OK	Y						NA	NA
Owens Corning	Portland, OR	Y						50–100	92
Owens Corning	Portland, OR		Y					NA	NA
Owens Corning	Savannah, GA		Y					NA	NA
Owens Corning	Summit, IL		Y					20–50	150
Pabco Roofing	Tacoma, WA		Y					50–100	125
Performance Roof Systems, Inc.	Kansas City, MO					Y		20–50	60
Polyglass U.S.A., Inc.	Fernley, NV					Y		5–10	40
Polyglass U.S.A., Inc.	Hazelton, PA					Y		1–2.5	5
Ridglass Shingle Mfg. Co.	Fresno, CA					Y		14.0	150
Siplast, Inc.	Arkadelphia, AR					Y		19.9	140
Soprema	Wadsworth, OH					Y		21.0	45
Southwestern Petroleum Corp.	Fort Worth, TX					Y		24.4	150

(continued)

Table 2-6. Facility-Level Product, Sales, and Employment for Asphalt Roofing Manufacturers (continued)

		Products							
Company	Facility Location	Blown Asphalt	Fiberglass Shingle	Organic Shingle	Built-up Roofing	Modified Bitumen	Saturated Felt	Sales Range ($\$10^6$)	Employment Range (number)
Tamko Roofing Products, Inc.	Dallas, TX		Y					50–100	150
Tamko Roofing Products, Inc.	Frederick, MD		Y		Y		Y	100–500	200
Tamko Roofing Products, Inc.	Green Cove Springs, FL						Y	NA	NA
Tamko Roofing Products, Inc.	Joplin, MO		Y	Y	Y	Y	Y	100–500	300
Tamko Roofing Products, Inc.	Knoxville, TN						Y	20–50	81
Tamko Roofing Products, Inc.	Naples, TX				Y			NA	NA
Tamko Roofing Products, Inc.	Phillipsburg, KS		Y	Y	Y		Y	100–500	271
Tamko Roofing Products, Inc.	Tuscaloosa, AL		Y		Y			20–50	100–249
Tarco, Inc.	Belton, TX				Y		Y	10–20	50
Tarco, Inc.	Greencastle, PA						Y	1–2.5	5
Tarco, Inc.	N. Little Rock, AR						Y	10–20	30
The Garland Co.	Cleveland, OH					Y		50–100	100
Thermo Manufacturing Co., LP	Chandler, AZ				Y		Y	5.2	20
Tremco	Cleveland, OH					Y		NA	160, 120
Tremco	Vernon, CA					Y		5–10	15
U.S. Single Ply	Fort Worth, TX					Y		2.5–5	7
United Roofing	Eutaw, AL				Y		Y	20.8	65
W. R. Grace & Co.–Connecticut	Chicago, IL					Y		1,528.6	6,300
Warrior Roofing	Tuscaloosa, AL				Y	Y	Y	20–50	43
Refineries									
Gary-Williams Energy Corp.	Wynnedwood, OK	Y						NA	NA
Hunt Refining	Tuscaloosa, AL	Y						NA	250-499
Huntway Refining Co	Benicia, CA	Y						10-20	20-49

(continued)

Table 2-6. Facility-Level Product, Sales, and Employment for Asphalt Roofing Manufacturers (continued)

		Products							
Company	Facility Location	Blown Asphalt	Fiberglass Shingle	Organic Shingle	Built-up Roofing	Modified Bitumen	Saturated Felt	Sales Range ($\$10^6$)	Employment Range (number)
Refineries (continued)									
Inland Refining Inc.	Woods Cross, UT	Y						40.6	85
Marathon Ashland Petroleum LLC	St. Paul Park, MN	Y						500-1000	250-499
Marathon Ashland Petroleum LLC	Cattlesburg, KY	Y						NA	NA
Marathon Ashland Petroleum LLC	Canton, OH	Y						over 1 billion	250-499
Paramount Petroleum Corp	Paramount, CA	Y						239.7	413

NA = Not available.

Sources: Asphalt Roofing Manufacturing Association. 1997. “Manufacturing Plants.” Facsimile on member company plant listing. Calverton, MD. September 24.
Dun & Bradstreet. 2000a. 2000 Dun & Bradstreet Million Dollar Directory Series. America’s Leading Public and Private Companies.
Dun & Bradstreet. 2000b. Electronic database.
American Business Information (ABI). 2000. Electronic database. Omaha, NE.

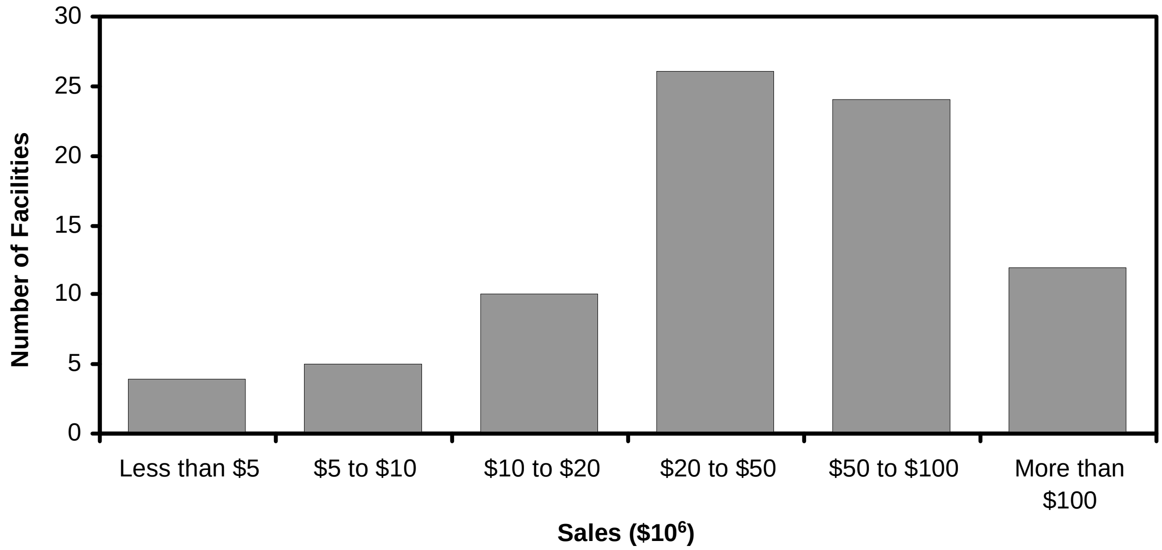


Figure 2-3. Distribution of Facilities by Sales

facilities for which sales data were available by sales ranges. The range with the largest number of facilities (25) is $20 to $50 million, followed by the number of facilities (24) with sales between $50 to 100 million dollars. Four facilities have sales volumes less than $5 million, five between $5 to $10 million, nine between $10 to $20 million, and nine with more than $100 million. Sales data were not available for 47 facilities.

Employment information was not available for 45 of the 123 facilities. Figure 2-4 illustrates the distribution of facility employment for 78 facilities for which employment information is available. Facilities with between 100 and 249 employees are the most numerous (38 establishments), and those employing fewer than 100 employees (36 establishments) make up the second largest segment. Only four facilities employ more than 249 workers.

Besides asphalt roofing manufacturing facilities, Table 2-7 also reports the refineries that process asphalt. In 1999, five companies owned and operated eight refineries that produce blown asphalt as their only asphalt product. Likewise Figures 2-3 and 2-4 incorporate sales and employment data for the identified refineries that have larger sales

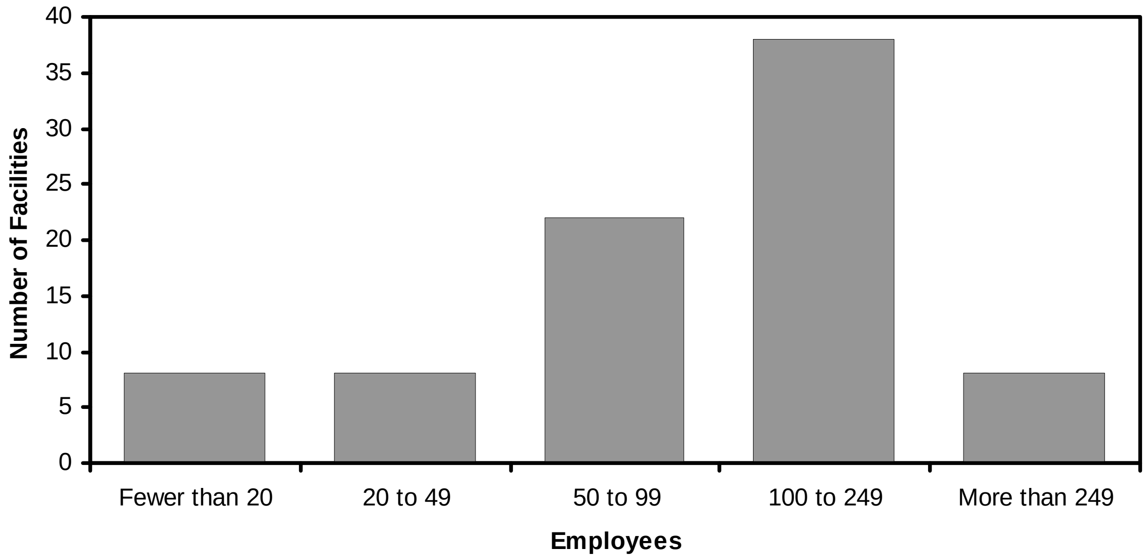


Figure 2-4. Distribution of Facilities by Employment

volumes and employ more workers when compared to asphalt roofing manufacturing facilities. However, sales information was lacking for three refineries, and employment information was lacking for two refineries. Two refineries have sales volumes less than $100 million, while the other three have sales volumes of more than $100 million. Four out of six refineries employ more than 249 workers and the rest employ fewer than 249.

2.3.2.1 Geographic Distribution

Asphalt roofing plants are located in 35 states. Overall, California is the state with the largest number of facilities (18), followed by Texas (13), Ohio (11), Alabama (8), and Georgia (7). These five states are home to approximately 44 percent of the total number of asphalt roofing facilities in the country.

Product information is available for the 123 facilities and eight refineries identified in Table 2-6. In 25 states, 66 asphalt roofing factories produce fiberglass shingles as one of their outputs. California and Texas have the most factories (by state) producing fiberglass

Table 2-7. Location of Asphalt Roofing Products Manufacturing Facilities by State

State/Products	Number of Production Lines [a] Blown Asphalt	Roll Roofing/ Saturated Felts	Fiberglass Shingles	Organic Shingles	MBRs	Total # of Faclities [a]
Alabama	3	6	4		1	8
Arizona		2				1
Arkansas		3			3	4
California	4	10	7		5	18
Colorado	1		1			2
Connecticut					1	1
Delaware	1		1			1
Florida	2	1	2			3
Georgia	2	2	5		2	7
Illinois	2		2	1	2	4
Indiana	1	3	4	1	2	5
Kansas	1	2	1	1	1	2
Kentucky	1					1
Louisiana		2	1			1
Maryland	2	2	3			3
Massachusetts		1	2			2
Michigan	1	1				2
Minnesota	2	2	4	2		5
Mississippi			1		1	2
Missouri		2	1	1	2	2
Nevada					1	1
New Hampshire		2			1	1
New Jersey	1		1		1	2
New Mexico		1				1
New York					1	1
North Carolina	1		2			3
Ohio	3	3	5	1	4	11
Oklahoma	2	3	1		1	6
Oregon	2	3	3		2	5
Pennsylvania	1	2	3		2	6
South Carolina		1	1			1
Tennessee	1	1	1			3
Texas	3	4	8		3	14
Utah	1					1
Washington		2			1	2

[a] Total number of facilities in each state may not add up to the total number of production lines in each state. Some of the facilities have more than one production line.

Source: Asphalt Roofing Manufacturing Association. 1997. "Manufacturing Plants." Facsimile on member company plant listing. Calverton, MD. September 24.

shingles (seven and eight, respectively). Other states with a large number of fiberglass shingle facilities are Georgia and Ohio (five each).

Thirty-seven of the 123 facilities for which product information is available produce MBR as one of their outputs. These facilities that produce MBR are located across 20 states. With five facilities, California has the most factories producing MBR, followed by Ohio, which has four. Arkansas and Texas each have three facilities producing MBR.

Of the 123 facilities for which product data are available, 34 produce built-up roofing. Of the 20 states with facilities producing built-up roofing, California has the most factories (five), followed by Alabama (four) and Texas (three). (Built up roofing is manufactured at the building site with alternating layers of mopping asphalt and roofing felt.)

Twenty-five facilities in the group produce saturated felt. Of the 19 states with saturated felt factories, California (five), Alabama (two), and Arkansas (two) are the only states that have more than one facility.

Seven facilities produce organic shingles. Minnesota (two) is the only state that has more than one asphalt roofing facility with organic shingles as a product. Six states have organic shingles factories.

Besides eight refineries, blown asphalt is also produced in six facilities, representing nearly 5 percent of the 123 asphalt roofing manufacturing facilities for which data are available. The 14 factories are located in Alabama, California (two refineries), Colorado, Kentucky, Michigan, Minnesota, North Carolina, Ohio, Oklahoma (one refinery and one asphalt roofing manufacturing facility), Oregon, Tennessee, and Utah.

2.3.2.2 Current Trends

The U.S. asphalt roofing products industry expanded in the mid-1990s because of new purchases, additions, and plants. Both GAF Corp. and Firestone Building Products increased capacity at their plants in Tampa, FL, and Beech Grove, IN, respectively. Elk Corporation’s new $30 million facility in Shafter, CA, began producing laminated asphalt shingles in 1995 (Straub, 1995). Owens Corning will open its new Fiberteq LLC facility in Danville, IL, in the third quarter of 2001, which is a joint venture with Canada’s IKO Industries. This Fiberteq facility will manufacture high quality wet-formed glass fiber mat, which will be used primarily in the production of asphalt roofing shingles (Owens Corning, 2001).

2.3.3 Firm Characteristics

Facilities comprise a site of land with a plant and equipment that combine inputs to produce output (in this case blown asphalt, fiberglass shingles, organic shingles, built-up roofing, modified bitumen roofing, saturated felt, and glass mat). Companies owning these facilities are legal business entities that have the capacity to conduct transactions and make business decisions that affect that facility. The terms establishment, facility, and plant are synonymous in this study and refer to the physical location where products are manufactured. Likewise, the terms company and firm are synonymous and refer to the legal business entity that owns one or more facilities. This firm characteristics section presents information on the parent companies that own the asphalt roofing manufacturing plants and refineries identified in Section 2.3.2.

2.3.3.1 Ownership

As discussed in Section 2.3.2, currently 34 companies operate 123 facilities that produce various asphalt roofing products for commercial, industrial, and residential use while five companies run eight refineries that produce blown asphalt. Table 2-8 lists companies determined to own and/or operate the previously identified facilities and refineries. With 21 facilities, Owens-Corning operates more factories that produce asphalt roofing products than any other domestic manufacturer. GAF Corp. (20 facilities), Johns Manville Corp. (8), Tamko Roofing Products Inc. (8), and Atlas Roofing Corp. (6) complete the list of top five firms with the most facilities producing asphalt roofing products. Together, these five companies account for more than half of the asphalt roofing facilities in the United States. As for refineries, Marathon Ashland Petroleum L.L.C., a joint venture between USX-Marathon Group and Ashland Inc., operates three refineries producing blown asphalt at its seven refinery operations in the United States (Hoover’s, 2001).

2.3.3.2 Size Distribution

Figure 2-5 presents the distribution of companies by sales ranges and is limited to companies for which data were available. Sales and employment information for four companies is currently unavailable. Twenty-four companies have sales lower than

Table 2-8. Parent Companies

Company	Organization Type	Sales ($\$10^6$)	Employees
Atlas Roofing Corp.	Private	124.5	1,100
Bitec	Private	12	45
Carlisle Companies Inc.[a]	Public	1,611.3	10,430
Certainteed Corp.[b]	Subsidiary	28.6	400
Conglass, Inc.	NA	NA	NA
Elcor Corp.[c]	Public	317.9	1,145
Firestone Building Products	NA	NA	NA
GAF Corp.[d]	Private	852.0	5,000
GAP Roofing, Inc.	Private	1.2	79
Gardland Co.	Private	85.0	300
Globe Building Materials, Inc.	Private	100.0	429
Goldis Holdings Inc.[e]	Private	33.60	194
Honeywell International Inc.[f]	Private	23,735.0	70,400
Johns Manville Corp.	Public	2,161.8	9,740
Malarkey Herbert Roofing Co.	Private	38.0	100
MB Technology	NA	NA	NA
Mineral Fiber Manufacturing Corp.	NA	20–50	100–249
Northern Elastomeric Inc.	Private	13.30	75
Owens-Corning	Public	5,048.0	21,000
Pacific Coast Building Products[g]	Private	360.0	2,500
Performance Roof System, Inc.	Private	20.0	60
Polyglass USA Inc.	Private	23.0	68
Ridglass Shingle Manufacturing Co.	Private	14.0	150
RPM Inc.[h]	Public	1,712.2	7,537
Siplast Inc.	Private	19.9	140
Soprema Inc.	Private	21.0	45
Southwestern Petroleum Corp.	Private	24.4	150

(continued)

Table 2-8. Parent Companies (continued)

Company	Organization Type	Sales ($\$10^6$)	Employees
Tamko Roofing Products Inc.	Private	225.0	1,300
Tarco Inc.	Private	20.0	110
Thermo Manufacturing Systems, L.L.C.	Private	5.2	20
United Roofing Manufacturing Co.	Private	20.8	65
United States Single Ply Co.	Private	2.5–5	7
W. R. Grace & Co.–Connecticut	Public	1,528.6	6,300
Warrior Roofing Manufacturing Co.	Private	20–50	43
Refineries			
Gary-Williams Energy Corporation	Private	NA	NA
Hunt Consolidated Inc.	Private	750.0	2,600
Huntway Refining Company	Private	193.0	90
Marathon Ashland Petroleum L.L.C.	Private	20,293.0	NA
Paramount Petroleum Corp.	Private	239.7	413
Silver Eagle Refining Inc.[i]	Private	40.6	85

NA = Not available.
[a] Owns Carlisle Syntec Systems
[b] Owned by Compagnie de Saint-Gobain
[c] Owns Elk Corp.
[d] Owns GAF Materials Corp.
[e] Owns IKO Production, Inc.
[f] Owns Honeywell Inc.
[g] Owns Pabco Roofing Products
[h] Owns Tremco Inc.
[i] Owns Inland Refining Inc.

Sources: Asphalt Roofing Manufacturing Association. 1997. *Manufacturing Plants*. Facsimile on member company plant listing. Calverton, MD. September 24.
Dun & Bradstreet. 2000a. 2000 Dun & Bradstreet Million Dollar Directory Series. America's Leading Public and Private Companies.
Dun & Bradstreet. 2000b. Electronic database.
American Business Information (ABI). 2000. Electronic database. Omaha, NE.

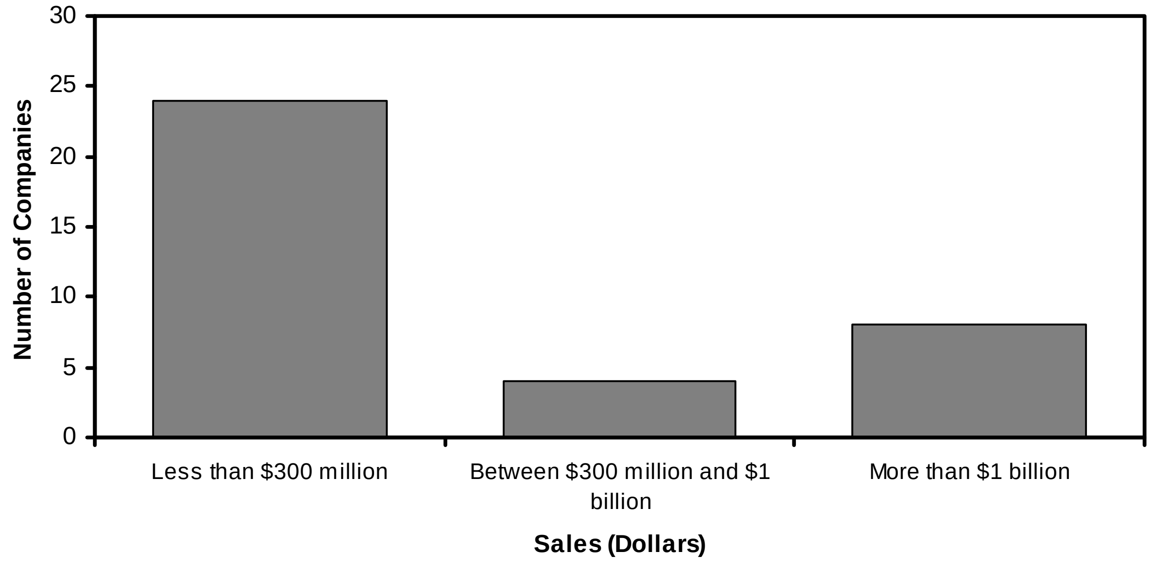


Figure 2-5. Distribution of Companies by Sales

$300 million a year, four have sales between $300 million and $1 billion, and eight have sales greater than $1 billion.

Figure 2-6 presents the distribution of the same companies by employment range. Twenty-two companies employ 749 or fewer people, three employ between 750 and 1,499, and ten companies employ 1,500 or more.

2.3.3.3 Horizontal and Vertical Integration

Whether a firm in this industry is vertically or horizontally integrated depends on the primary business activity of the parent company. Vertically integrated firms may produce the inputs used in their production process or use the product as an input into other production processes. These firms may own several plants and/or operate many subsidiaries, each of which handles a different stage of production or directly or indirectly produces an input or product. For example, Firestone/Bridgestone Corporation (rubber products) and Koch Industries (petroleum refining and products) use asphalt by-products from their production of

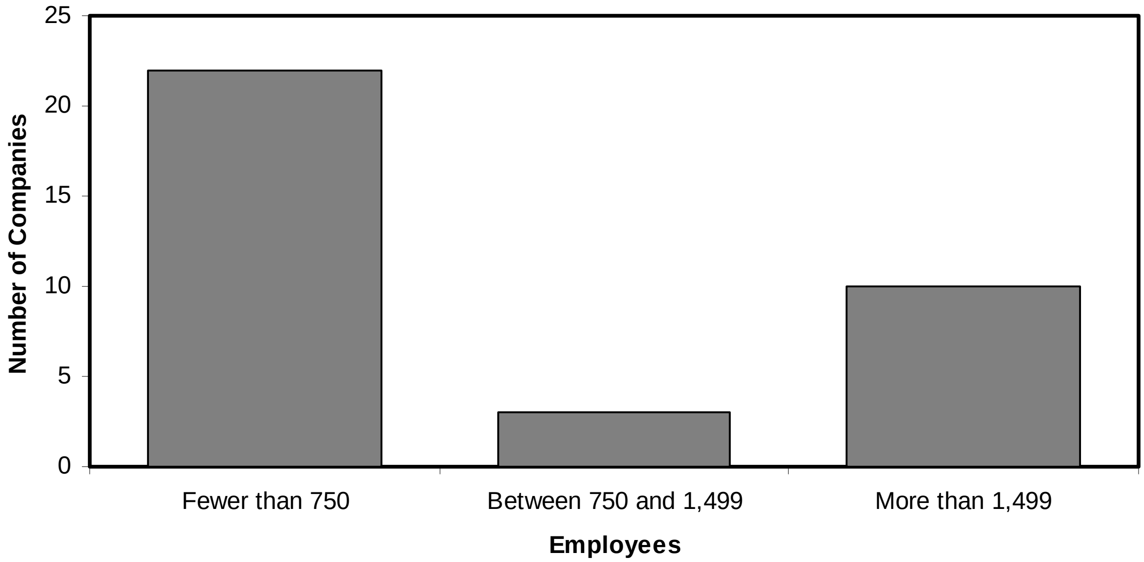


Figure 2-6. Distribution of Companies by Employment

rubber and petroleum products to produce asphalt roofing products. Owens-Corning produces fiberglass fibers for numerous markets, including residential and industrial insulation and asphalt shingles. These companies take cast-offs from one process and use them in another. Nearly all of companies having more than 750 employees (not considered small businesses in this industry) are vertically integrated.

However, vertical and horizontal integration are not mutually exclusive, meaning that a corporation is usually not either in a pure form, but a mixture of both. Perceiving a firm as horizontally or vertically integrated depends on vantage point. The above companies can be seen as vertically integrated because one subsidiary feeds an input into another. However, the products each subsidiary produces may be as varied as tires and asphalt shingles, an aspect of horizontal integration. The smaller companies involved in manufacturing asphalt roofing products are, for the most part, neither vertically nor horizontally integrated; they produce a sole product without having forward or backward corporate linkages. These companies purchase inputs from outside suppliers, not of their corporate tree. Then they manufacture the product and sell it either directly to consumers or through wholesalers. In its pure form, horizontal integration is the situation in which one company produces various, unrelated products rather than specializing in one particular product.

2.3.4 Small Businesses

To determine the possible impacts on small businesses, companies producing asphalt roofing products are categorized as small or large using the Small Business Administration's (SBA's) general size standards definitions. For NAICS 324122, these guidelines indicate a small business employs 750 or fewer workers (U.S. Small Business Administration, 2000), but employing no more than 1,500 workers is the criterion for refineries that process asphalt as well as petroleum. Out of 34 companies listed in Table 2-8, 27 (listed in Table 2-9) are potentially small businesses. Details of small business impact analysis are provided in Section 5.

2.4 Markets

This section examines the historical market statistics and future trends and projections for the asphalt roofing industry. Historical data for this industry are provided for the value of shipments, prices, foreign trade, and consumption of asphalt roofing products. The future trends section focuses on projected demand and employment for the asphalt roofing industry.

2.4.1 Historical Market Data

Data on the value of shipments from 1990 through 1998 for the asphalt roofing industry are available from the Census Bureau. However, historical data on prices and domestic production volumes of asphalt roofing products are not available. Prices were estimated in 1999 constant dollars for asphalt roofing products by using the producer price index (PPI) for asphalt roofing products, which is obtained from the U.S. Department of Labor, Bureau of Labor Statistics. Foreign trade data for individual asphalt roofing products are not reported because of the aggregate nature of the available data. Industry-level import and export data were obtained from the U.S. Department of Commerce and are reported for the years 1990 through 1999.

2.4.1.1 Value of Shipments Data

Table 2-10 provides the value of shipments for the asphalt roofing industry. As the table shows, the value of shipments, in constant 1999 dollars, is highest for the year 1998, at

Table 2-9. Small Companies: 1999

Company	Organization Type	Sales ($\$10^6$)	Employees
Bitec	Private	12	45
Certainteed Corp.[a]	Subsidiary	28.6	400
Conglass, Inc.	NA	NA	NA
Firestone Building Products	NA	NA	NA
GAP Roofing, Inc.	Private	1.2	79
Gardland Co.	Private	85.0	300
Globe Building Materials, Inc.	Private	100.0	429
Goldis Holdings Inc.[b]	Private	33.60	194
Malarkey Herbert Roofing Co.	Private	38.0	100
MB Technology	NA	NA	NA
Mineral Fiber Manufacturing Corp.	NA	20–50	100–249
Northern Elastomeric Inc.	Private	13.30	75
Performance Roof System, Inc.	Private	20.0	60
Polyglass USA Inc.	Private	23.0	68
Ridglass Shingle Manufacturing Co.	Private	14.0	150
Siplast Inc.	Private	19.9	140
Soprema Inc.	Private	21.0	45
Southwestern Petroleum Corp.	Private	24.4	150
Tarco Inc.	Private	20.0	110
Thermo Manufacturing Systems, L.L.C.	Private	5.2	20
United Roofing Manufacturing Co.	Private	20.8	65
United States Single Ply Co.	Private	2.5–5	7
Warrior Roofing Manufacturing Co.	Private	20-50	43
Refineries			
Huntway Refining Co.	Private	193.0	90
Paramount Petroleum Corp.	Private	239.7	413
Gary-Williams Energy Corp.	Private	NA	NA
Silver Eagle Refining Inc.[c]	Private	40.6	85

NA = Not available.

[a] Owned by Compagnie de Saint-Gobain
[b] Owns IKO Production, Inc.
[c] Owns Inland Refining Inc.

Sources: Asphalt Roofing Manufacturing Association. 1997. "Manufacturing Plants." Facsimile on member company plant listing. Calverton, MD. September 24.
Dun & Bradstreet. 2000a. 2000 Dun & Bradstreet Million Dollar Directory Series. America's Leading Public and Private Companies.
Dun & Bradstreet. 2000b. Electronic database.
American Business Information (ABI). 2000. Electronic database. Omaha, NE.

Table 2-10. Value of Shipments for NAICS 324122, Asphalt Shingle and Coating Materials Manufacturing: 1990-1998 ($$10^9$)

	Value of Shipments	
	Current $	**1999 $**
1990	$3.6	$3.8
1991	$3.4	$3.5
1992	$3.9	$4.1
1993	$4.2	$4.3
1994	$4.0	$4.3
1995	$4.3	$4.3
1996	$4.5	$4.5
1997	$5.1	$5.1
1998	$5.4	$5.3

Sources: U.S. Department of Commerce, Bureau of the Census. 2000. *1998 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*." M98(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1998. *1996 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M96(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1997. *1995 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M95(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1996. *1994 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M94(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995c. *1993 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M93(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995a. *1991 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M91(AS)-1. Washington, DC: Government Printing Office.

U.S. Bureau of Labor Statistics. 2000b. "Producer Price Index Revision—Current Series: PCU2952#, Asphalt Felts and Coatings: 1990-1999." <http://146.142.4.24/servlet/SurveyOutputServlet?jrunsessionid=9772358862760607>.

$5.3 billion. After dropping to its lowest value at $3.5 billion in 1991, the value of shipments began to rise. However, the value of shipments was relatively flat over the years 1992 through 1996.

2.4.1.2 Prices

A time series of estimated prices in current dollars for asphalt roofing products is presented in Table 2-11. The products for which prices are provided are smooth and surfaced roll roofing, strip shingles, and individual organic or inorganic shingles. The 1992 price for each product was estimated by dividing the 1992 value of shipments by the 1992 volume of shipments for that product. The 1992 price was then multiplied by the PPI for asphalt felts and coatings for the years 1990 through 1999 to obtain prices for other years.

As Table 2-11 shows, the estimated prices for asphalt roofing products are characterized by moderate fluctuations over the 1990 through 1999 time period. Prices were at their peak in 1997 and at their lowest in 1994. Estimated 1999 prices for asphalt roofing products range from $6.78 to $11.21 per square.

2.4.1.3 Foreign Trade

U.S. exports and imports of asphalt roofing products make up only a small portion of the total asphalt roofing product market. In 1998, the domestic value of shipments of this industry was $5 billion. By comparison, only $75 million worth of asphalt roofing products were exported, and $46 million worth were imported in 1998.

Although the total value of imports to the United States (see Table 2-12) over the 1989 through 1996 time period was higher than the total value of exports, the value of exports was higher on a per-kilogram basis. The price range of the value of exports in 1999 dollars was $0.40 to $0.58, while the price range for the value of imports was only $0.18 to $0.29. Therefore, asphalt roofing products exported from the United States have a higher value than U.S. imports of these products.

A small number of countries make up the majority of U.S. import sources and export destinations for U.S. asphalt roofing products. Canada's exports of asphalt roofing products to the United States, which were valued at $27 million in 1999, make up over 55 percent of the total U.S. imports of these products. Other countries from which the United States imports asphalt roofing products are Mexico (26.5 percent) and Venezuela (8.8 percent).

Table 2-11. Historical Prices of Asphalt Roofing Products: 1990-1999[a]

Year	Roll Roofing (current dollars/square)	Strip Shingles (current dollars/square)	Individual Shingles, Organic or Inorganic, All Styles (current dollars/square)
1990	$6.48	$10.71	$10.06
1991	$6.59	$10.91	$10.24
1992	$6.47	$10.70	$10.05
1993	$6.51	$10.77	$10.11
1994	$6.42	$10.62	$9.98
1995	$6.70	$11.08	$10.41
1996	$6.77	$11.20	$10.52
1997	$6.80	$11.25	$10.57
1998	$6.79	$11.23	$10.55
1999	$6.78	$11.21	$10.53

[a] Prices were calculated by dividing 1992 value of shipments by quantities and then multiplying by the PPI for the relevant year for asphalt felts and coatings divided by 100.

Source: U.S. Department of Commerce, Bureau of the Census. 1995b. *1992 Census of Manufactures, Industry Series—Petroleum and Coal Products*. MC92-I-29A. Washington, DC: Government Printing Office.

Among the primary importers of U.S. asphalt roofing products are Canada, Korea, and Mexico. Exports to Canada make up 48.1 percent of all U.S. exports of these products, while exports to Korea and Mexico make up much smaller shares of the total value of U.S. exports of asphalt roofing products (13 percent and 6.2 percent, respectively).

2.4.1.4 Consumption

Apparent U.S. consumption of asphalt roofing products is measured by computing U.S. shipments minus U.S. exports plus U.S. imports. Table 2-12 provides apparent U.S. consumption for the years 1990 through 1998. The value of apparent U.S. consumption, in 1999 dollars, was $3.7 billion in 1990 and $5.3 billion in 1998, an increase of 5 percent over this time period. However, several decreases in apparent U.S. consumption occurred between 1990 and 1998. Consumption levels dropped in 1991 (0.6 percent decrease) and in

Table 2-12. Apparent U.S. Consumption and Import Concentration of Asphalt Roofing Products: 1990-1998 ($$10^3$)

Year	U.S. Shipments ($1999)	U.S. Exports ($1999)	U.S. Imports ($1999)	Apparent U.S. Consumption ($1999)[a]	Import Concentration (%)[b]
1990	$3,751,808	$40,475	$53,180	$3,764,513	1.41%
1991	$3,533,895	$44,857	$55,289	$3,544,327	1.56%
1992	$4,099,333	$62,532	$61,177	$4,097,978	1.49%
1993	$4,345,299	$73,068	$66,944	$4,339,175	1.54%
1994	$4,265,672	$82,054	$73,800	$4,257,418	1.73%
1995	$4,322,565	$68,567	$71,954	$4,325,953	1.66%
1996	$4,492,044	$77,549	$86,140	$4,500,635	1.91%
1997	$5,074,949	$95,844	$86,226	$5,065,331	1.70%
1998	$5,339,711	$74,610	$45,803	$5,310,903	0.86%

[a] Apparent consumption = U.S. shipments – U.S. exports + U.S. imports.
[b] Import concentration was calculated as the ratio of imports to apparent U.S. consumption.

Sources: U.S. Department of Commerce, Bureau of the Census. 2000. *1998 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*." M98(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1998. *1996 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M96(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1997. *1995 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M95(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1996. *1994 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M94(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1995c. *1993 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M93(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1995a. *1991 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M91(AS)-1. Washington, DC: Government Printing Office.
U.S. Bureau of Labor Statistics. 2000b. "Producer Price Index Revision—Current Series: PCU2952#, Asphalt Felts and Coatings: 1990-1999." <http://146.142.4.24/servlet/SurveyOutputServlet?jrunsessionid=9772358862760607>.

1994 (2 percent decrease), which is most likely a result of declines in housing starts for these years. Apparent U.S. consumption of asphalt roofing products was at its highest in 1998 at $5.3 billion.

Table 2-12 also provides the import concentration for asphalt roofing products, which indicates the percentage of total U.S. consumption that comprises imports. As the table shows, imports made up only a small percentage of apparent U.S. consumption of asphalt roofing products. The import concentrations ranged from only 0.86 percent to 1.91 percent over the 1990 through 1998 time period.

2.4.2 Trends and Projections

Limited information is available on future trends and projections for the asphalt roofing industry. Based on the forecasts of the Freedonia Group (1997) and Gale Research (1995), the industry is expected to see a moderate increase in the demand for its products, while employment in the industry is projected to decline. Demand for asphalt roofing is expected to increase slightly into the next century as the market for building materials improves. However, competition from new synthetic roofing materials is expected to keep the rise in demand for asphalt roofing products at a minimum. Employment in the asphalt roofing industry is expected to decline into the 21st century as a result of productivity improvements from increased automation and layoffs by manufacturers. According to the U.S. Bureau of Labor Statistics, positions in the asphalt roofing industry are expected to decrease by 10 to 20 percent between 1990 and 2005.

SECTION 3

REGULATORY CONTROL COSTS

EPA identified 123 asphalt roofing manufacturing plants and eight refineries in the United States and estimated the costs for each to comply with the proposed NESHAP for asphalt roofing manufacturing. Only seven of the asphalt roofing manufacturing facilities are directly affected by the rule. However, all the refineries are subject to the rule.

3.1 National Control Cost Estimates

3.1.1 Compliance Costs for Existing Facilities and Refineries

EPA estimated the total annual compliance cost of this rule to be $1 million for existing asphalt roofing manufacturing facilities and refineries. These estimates are based on the number of facilities and refineries expected to incur emission control costs which are made up of capital costs and operating and maintenance (O&M) costs; monitoring, record keeping, and reporting (MRR) costs; or both. Table 3-1 presents the estimated annual compliance costs for both asphalt roofing manufacturing plants and refineries in terms of emission control costs and MRR costs. For asphalt roofing manufacturing facilities, the estimated total capital costs for emission control is $2.2 million and the total annualized costs are $0.9 million. The total annualized emission control cost is about $0.8 million and the average annual MRR cost is approximately $0.3 million. Refineries are not expected to incur any emissions control costs. EPA estimated the average MRR costs incurred by refineries to be about $0.1 million. Table 3-2 summarizes estimated emission control costs for the nine facilities that are projected to incur this cost because of the proposed rule. The average total capital cost is $0.2 million while the average annualized emission control cost is about $76,000. The total capital costs range from less than $48,000 to $0.7 million. The total annualized emission control costs vary from $19,000 to $0.3 million.

Table 3-1. National Control Costs Estimates for Existing Facilities

	Facility	Refinery	Total
Emission Control Cost for Existing Facilities			
Total capital cost	$2,160,703		$2,160,703
Total annualized emission control costs	$758,026	–	$758,026
Annualized capital costs	$275,204	–	$275,204
O&M costs	$482,822	–	$482,822
Monitoring, Recordkeeping, and Reporting (MRR) Costs			
Average annual cost	$139,040	$111,232	$250,272
Year 1 total annual cost	$24,390	$19,512	$43,902
Year 2 total annual cost	–	–	–
Year 3 total annual cost	$392,740	$314,192	$706,932
Total Annual Cost	$897,072	$111,232	$1,008,304

Notes: Total Annualized Emission Control Costs = Annualized Capital Costs + O&M Costs
Average Annual MRR Cost = (Year 1 Total Annual Cost + Year 2 Total Annual Cost + Year 3 Total Annual Cost)/3
Total Annual Cost = Total Annualized Emission Control Costs + Monitoring, Recordkeeping, and Reporting Costs

Source: U.S. Environmental Protection Agency (EPA). 2001. National Costs and Environmental Impacts for the Proposed Asphalt Roofing Manufacturing NESHAP."

3.1.2 Compliance Costs for New Asphalt Roofing Manufacturing Facilities

EPA also calculated the compliance costs for new asphalt roofing manufacturing plants. Table 3-3 lists the estimated compliance costs based on the year when the new manufacturing plants begin production. If a manufacturing facility comes in the market in year 1, year 2, or year 3, the estimated total annual cost would be about $0.4 million. Even though the total annual costs are about the same regardless of the year, the MRR costs are less for those facilities that enter the market later.

Table 3-2. Summary of Facility-Level Emission Control Costs Estimates

Emission Control Cost	Minimum	Median	Maximum	Average
Total Capital Cost ($)	47,486	144,818	666,444	240,078
Total Annualized Emission Control Costs ($)	13,737	37,223	265,953	84,225
Annualized Capital Costs ($)	5,269	15,252	87,606	30,578
O&M Costs ($)	8,468	21,971	178,364	53,647

Source: U.S. Environmental Protection Agency (EPA). 2001. "National Costs and Environmental Impacts for the Proposed Asphalt Roofing Manufacturing NESHAP."

Table 3-3. Control Costs Estimates for New Facilities[a]

	Facility 1	Facility 2	Facility 3
Emission Control Cost			
Total capital cost ($)	939,900	939,900	939,900
Total annualized emission control costs ($)	400,230	400,230	400,230
Annualized capital costs ($)	109,342	109,342	109,342
O&M costs ($)	398,482	398,482	398,482
Monitoring, Recordkeeping, and Reporting (MRR) Costs			
Average annual cost ($)	26,538	18,600	10,844
Year 1 total annual cost ($)	32,533		
Year 2 total annual cost ($)	23,266	32,533	
Year 3 total annual cost ($)	23,816	23,266	32,533
Total Annual Cost ($)	426,768	418,830	411,074

[a]EPA assumes one new facility per year.

Notes: Total Annualized Emission Control Costs = Annualized Capital Costs + O&M Costs
Average Annual MRR Cost = (Year 1 Total Annual Cost + Year 2 Total Annual Cost + Year 3 Total Annual Cost)/3
Total Annual Cost = Total Annualized Emission Control Costs + Monitoring, Recordkeeping, and Reporting Costs

Source: U.S. Environmental Protection Agency (EPA). 2001. "National Costs and Environmental Impacts for the Proposed Asphalt Roofing Manufacturing NESHAP."

SECTION 4

ECONOMIC IMPACT ANALYSIS: METHODS AND RESULTS

This section describes the methodology used to estimate the economic impacts on society resulting from the proposed regulation. This framework employs standard microeconomic concepts to model behavioral responses expected to occur with regulation and is consistent with other economic analyses performed by the Agency.

4.1 Overview of EIA Modeling Approaches

The Agency uses several types of economic impact modeling approaches to support regulatory development. Models incorporating different levels of economic decisionmaking can generally be categorized as without-behavior responses (nonbehavioral/accounting approach) and with-behavior responses (behavioral approach).

The nonbehavioral/accounting approach essentially holds fixed all interaction between facility production and market forces. In this approach, a simplifying assumption is made that the firm absorbs all control costs, and the analysis assesses the burden of the control costs under this assumption. Typically, engineering control costs are then compared to facility, company, or industry sales and, where available, profits, to evaluate the regulation's economic impact. The use of this approach will be limited to the initial screening analysis of impacts on small businesses using engineering costs and company sales (i.e., cost-to-sales ratio [CSR]). In addition, we performed additional CSR analysis at the facility- or industry-level.

The behavioral approach is grounded in economic theory related to producer and consumer behavior in response to changes in market conditions. In essence, this approach models the expected reallocation of society's resources in response to a regulation. The behavioral approach explicitly models the changes in market prices and production. These changes are used to compute other impact variables, such as changes in producer and consumer surplus and total changes in economic welfare. EPA relied heavily on this approach to develop impact variables for the economic analysis. The conceptual approach and operational model are described below.

4.2 Conceptual Approach

EPA proposed a simple national competitive market model in which buyers and sellers exert no individual influence on market prices for asphalt roofing commodities potentially affected by the rule. Prices in these markets are set by the collective actions of producers and consumers, who take the market price as a given in making their production and consumption choices. The model compared baseline conditions (1999) to with-regulation conditions projected to exist in these markets.

4.2.1 Identify Markets

EPA estimated impacts in five asphalt roofing product markets:

- blown asphalt,
- organic roll roofing (including asphalt felts),
- fiberglass shingles
- organic shingles, and
- MBR.

These are the asphalt roofing products for which EPA's database provides information. For each facility in the industry, EPA has estimated quantities of each of these products manufactured on-site.

4.2.2 Producer Characterization

Many asphalt roofing plants produce multiple asphalt roofing products. Therefore, individual *product-line* supply decisions for existing producers have been modeled in this analysis. Note these decisions have been modeled as intermediate-run decisions, assuming that the plant size, equipment, and technologies are fixed. Given the existence of these fixed production factors, each product line has been characterized by an upward-sloping supply function (see Figure 4-1). A profit-maximizing firm would select its output level according to this schedule as long as the market price is sufficiently high to cover average variable costs (i.e., greater than C_0 in Figure 4-1). Thus, in the short run, a profit-maximizing firm would not pass up an opportunity to recover even part of its fixed investment in plant and

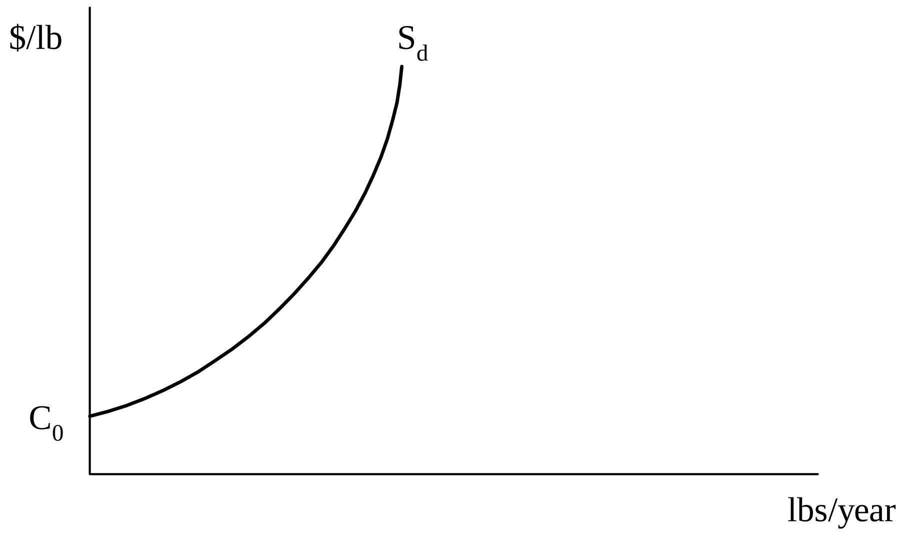


Figure 4-1. Supply Curve for a Representative Directly Affected Facility

equipment. These individual supply decisions have been aggregated (i.e., horizontally summed) to develop a market supply curve for each asphalt roofing product.

4.2.3 Consumer Characterization

Demand for asphalt roofing products comes mainly from the construction industry, although a small share is sold directly to consumers for home improvements and repairs. Eighty-one percent of asphalt roofing products are used in residential construction, while the remaining 19 percent are used in the commercial construction market (Kroschwitz and Howe-Grant, 1991). Of the residential market, re-roofing jobs consume 79 percent of all asphalt roofing products, and the remaining 21 percent are used in new construction applications. Asphalt shingles alone accounted for about 57 percent of the residential new construction market and 68.5 percent of the residential reroofing market (Burns and Paulson, 1997). Substitutes for asphalt shingles and roll roofing in residential applications include wood shingles, metal roofing, and tile roofing. Only coal tar bitumen is a substitute for asphalt-saturated felt. Synthetic rubbers can be used in place of modified bitumen membranes in BUR applications (Kroschwitz and Howe-Grant, 1991). All of these substitutes exhibit somewhat different properties from asphalt products, however, and are not perfect substitutes. Given data limitations, each commodity market has been modeled as having a single aggregate consumer with a downward-sloping market demand curve (see Figure 4-2).

4.2.4 Baseline and With-Regulation Equilibrium

The competitive model of price formation, as shown in Figure 4-2(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 individual supply curves of domestic plants that produce a given asphalt roofing product.

With the regulation, the costs of production increase for affected suppliers. These additional costs include a variable component consisting of the operating and maintenance costs and a fixed component that does not vary with output (i.e., expenditures for control-related capital equipment to comply with the regulatory alternative). The imposition of these regulatory control costs is represented as an upward shift in the supply curve for each directly affected product line. As a result of the upward shift in these individual supply curves, the market supply curve for asphalt roofing products will shift upward as shown in Figure 4-2(b) to reflect the increased costs of production at affected plants.

In baseline without the proposed standards, the industry produces total output, Q, at price, p, with directly affected facilities producing the amount q_a and indirectly affected facilities accounting for Q minus q_a, 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 at directly affected facilities and increases at indirectly affected facilities.

4.3 Baseline Data Set

EPA collected market information to characterize the baseline year, 1999 and provided total domestic production quantities of individual commodities. As described in the industry profile, foreign trade represents an insignificant fraction of the activity in the U.S. asphalt roofing market. Net exports for NAICS 324122 were well below 1 percent of value of shipments during the period 1990 through 1998. Therefore, foreign producers and consumers were not modeled in the economic analysis. Instead, we made the simplifying assumption that the U.S. domestic market for asphalt roofing products is supplied entirely by

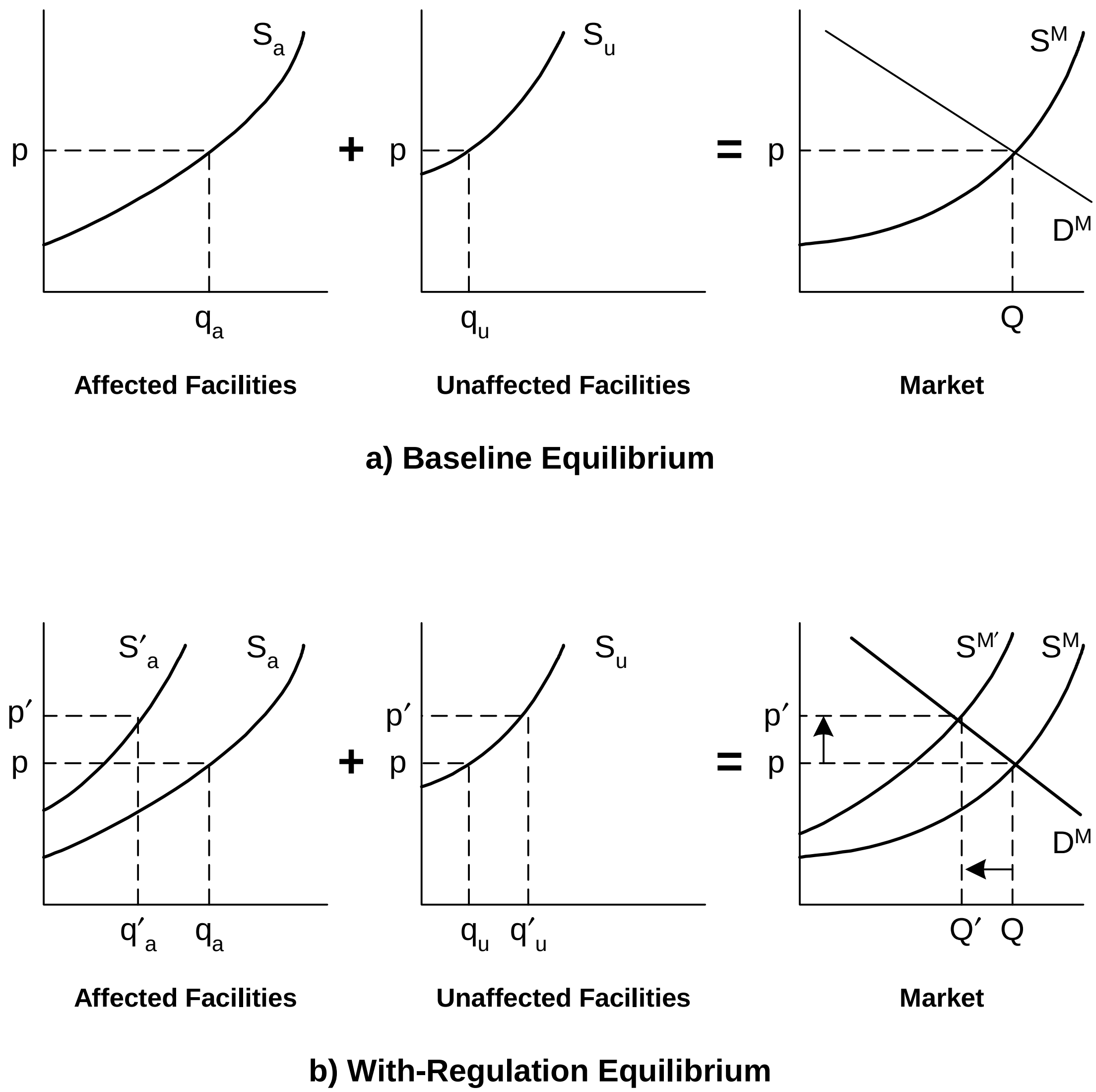


Figure 4-2. Market Equilibrium without and with Regulation

domestic manufacturers and that domestic manufacturers do not export asphalt roofing products to other countries.

To identify the economic impact of the proposed NESHAP on the asphalt roofing industry, we incorporated the facility-level data from various sources into our economic model. One hundred twenty-three asphalt roofing manufacturing plants and eight refineries in the United States have been identified as facilities potentially affected by the proposed rule. Table 4-1 lists the data elements of the asphalt roofing manufacturers dataset, which was compiled from data provided by the Asphalt Roofing Manufacturing Association (ARMA), EPA's Information Collection Request, and public sources. Data on facility locations, product types, and production capacity were obtained from ARMA. EPA's Information Collection Request provided data on production of individual asphalt roofing products at the facility level. In addition, we collected sales volumes and employment data from the available public sources, such as American Business Information, Dun & Bradstreet, and the Freedonia Group, as well as foreign trade information from the Census Bureau and International Trade Commission websites. We also collected and computed an average price for each commodity based on price data we have obtained from statistical publications (i.e., Census of Manufactures, 1995) and from the Freedonia Group (2000).

4.4 Supply and Demand Elasticities

On the supply side, the supply of asphalt roofing products has been relatively stable. The asphalt roofing industry is not as cyclical as the building industry despite the integral relationship between the two industries. The reason that asphalt roofing is not a highly cyclical industry is that there are essentially two roofing markets: the new construction market and the reroofing market. As noted earlier, the reroofing market represented over 75 percent of the total residential roofing market. Thus, reroofing activity dampens swings in new construction activity. Entry into the industry is not difficult because there are no major patent obstacles, and capital requirements are not excessive. However, the ease of entry into the industry is offset by the fact that existing plant capacity is underutilized. The capacity utilization ratio for existing plants in the asphalt felts and coatings industry (NAICS 324122/ SIC 2952) ranged from 68 to 80 percent during the period 1993 to 1998 (U.S. Census Bureau, 2000). These factors indicate that the supply of asphalt roofing products is relatively stable.

On the demand side, several substitution possibilities exist for asphalt roofing products. Popular substitutes include elastomeric roofing (used in single-ply roofing) and

Table 4-1. Types and Sources of Asphalt Roofing and Processing Facility Data

Data Category	Data Element	Data Source
Plant data	Plant name	EPA Asphalt Roofing Industry Database; ARMA
	Plant location	EPA Asphalt Roofing Industry Database; ARMA
	Plant ownership	EPA Asphalt Roofing Industry Database; ARMA
	Types of asphalt roofing products produced	EPA Asphalt Roofing Industry Database; ARMA
	Sales volume	American Business Information; Dun & Bradstreet
	Employment	American Business Information; Dun & Bradstreet
Refinery data	Refinery ownership	EPA Asphalt Roofing Industry Database; ARMA
	Refinery location	EPA Asphalt Roofing Industry Database; ARMA
	Types of asphalt roofing products produced	EPA Asphalt Roofing Industry Database; ARMA
	Production capacity	EPA Asphalt Roofing Industry Database; ARMA
	Sales volume	American Business Information; Dun & Bradstreet; Hoover's
	Employment	American Business Information; Dun & Bradstreet; Hoover's
Company data	Company name	American Business Information; Dun & Bradstreet; Hoover's
	Company sales	American Business Information; Dun & Bradstreet; Hoover's
	Employment	American Business Information; Dun & Bradstreet; Hoover's
Production quantity	Quantity produced of each asphalt roofing product	EPA Asphalt Roofing Information Collection Request Industry Database
Market data	Value of shipments	DOC, Bureau of Census, Annual Survey of Manufacturers, 1995-2000
	Prices	DOC, Bureau of Census, Census of Manufactures, 1995; Freedonia Group, 2000
	Imports	International Trade Commission, Trade Database, 2000
	Exports	International Trade Commission, Trade Database, 2000

Sources: Asphalt Roofing Manufacturing Association (ARMA). 1997. "Manufacturing Plants." Facsimile on member company plant listing. Calverton, MD. September 24.
U.S. Environmental Protection Agency (EPA). 2001. Asphalt Roofing Industry Database.
American Business Information (ABI). 2000. Electronic database. Omaha, NE.
Dun & Bradstreet. 2000a. *2000 Dun & Bradstreet Million Dollar Directory Series: America's Leading Public and Private Companies*.
Dun & Bradstreet. 2000b. Electronic database.
Hoover's Online. 2001. Electronic database.
U.S. Department of Commerce, Bureau of the Census. 1995a. *1991 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M91(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1995b. *1993 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M93(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1996. *1994 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M94(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1997. *1995 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M95(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 1998. *1996 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M96(AS)-1. Washington, DC: Government Printing Office.
U.S. Department of Commerce, Bureau of the Census. 2000. *1998 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M98(AS)-1. Washington, DC: Government Printing Office.
Freedonia Group. February 2000. "Asphalt Products and Markets in the United States to 2003—Introduction, Executive Summary, Market Environment, Technology and Regulation, International Environment, Primary Supply, Demand, Products and Products by Market." Profound WorldSearch <http://www.profound.com>.
U.S. International Trade Commission. Trade Database. <http://dataweb.usitc.gov/scripts/>.

metal roofing. Wood shingles, tile, clay, metal, and plastic are other materials that can be used in place of asphalt shingles and roll roofing. Although several substitutes exist, asphalt roofing products still dominate the market. Asphalt shingles alone accounted for about 57 percent of the residential new construction market and 68.5 percent of the residential reroofing market (Burns and Paulson, 1997). In contrast, wood shingles accounted for only 3.5 percent of the residential new construction market and 3.2 percent of the reroofing market. Asphalt-saturated felts and modified bitumen membranes have few substitution possibilities. Coal tar bitumen is the only known suitable replacement for asphalt-saturated felt. Synthetic rubbers can be used in place of modified bitumen membranes in BUR applications. However, synthetic rubbers are less adaptable to repair and maintenance work than modified bitumen roofing (Kroschwitz and Howe-Grant, 1991).

Unfortunately, empirical estimates of demand or supply elasticities for roofing products are limited. The literature review identified only one demand elasticity estimate for a substitute roofing product (cedar shakes and shingles). The demand for this substitute was estimated to be elastic (ranging from –1.0 to –3.0 [Kelly, 1988]). No data were available for asphalt roofing products. The option of estimating a system of demand and supply equations using three-stage least squares (3SLS) does not appear feasible because of limitations of time-series data. Literature estimates for the construction industry suggest that the short-run supply elasticity for housing investment is one (Topel and Rosen, 1988). Similarly literature estimates the short-run demand elasticity to be –0.579 (i.e., a 1 percent increase in price results in a 0.579 percent decrease in quantity demanded [Glennon, 1989]).

Although data limitations prevent estimation of these parameters, knowledge about the factors influencing the elasticity of derived demand makes it possible to develop informed assumptions about producer and consumer responses to price changes. Economic theory states that the elasticity of the derived demand for an input is a function of the following:

- demand elasticity for the final good it will be used to produce,
- the cost share of the input in total production cost,
- the elasticity of substitution between this input and other inputs in production, and
- the elasticity of supply of other inputs (Hicks, 1961; Hicks, 1966; and Allen, 1938).

Using Hicks' formula,

$$\eta_i = [s(n + e) + Ke(n - s)] / [n + e - K(n - s)] \quad (4.1)$$

where

η_i = elasticity of demand for the asphalt roofing product i,

s = elasticity of substitution between asphalt roofing product i and all other inputs to construction,

n = elasticity of demand for final product (housing and other structures),

e = elasticity of supply of other inputs, and

K = cost share of asphalt roofing product i in total production cost.

In the appendix to *The Theory of Wages*, Hicks (1966) shows that, if $n > s$, the demand for the input is less elastic the smaller its cost share. If the data were available, this formula could be used to actually compute the elasticity of demand for each asphalt roofing product. The final products for which asphalt roofing is an input include housing repair and maintenance services and construction of housing and other structures. Of these, our literature review identified an estimate for the short-run elasticity of demand for housing, which is estimated to be –0.579 (Glennon, 1989). Lacking estimates of other elasticities of final product demand and of the other parameters in the formula makes direct computation of the elasticity of demand, η_i, impossible. In spite of this, the formula is useful because it identifies factors that influence the magnitude of the elasticity of derived demand. Knowledge of the general magnitude of those factors makes it possible to make an educated assumption about the magnitude of η_i.

The elasticity of substitution, s, between asphalt roofing products and other inputs is likely to be low but nonzero. For this analysis, EPA assumes the elasticity of substitution between asphalt roofing products and other inputs to construction to be 0.1. Building owners or builders have some alternative roofing options available, but they are imperfect substitutes for asphalt roofing products. EPA thus expects that the elasticity of demand for the final product exceeds the elasticity of substitution, implying that the magnitude of η_i is proportional to the magnitude of K, the cost share of asphalt roofing in overall building construction. Based on the benchmark input-output accounts for the United States, petroleum and refined products (including asphalt roofing) represent 1.2 percent of new construction and 2.0 percent of maintenance and repair construction (Lawson, 1997). Because re-roofing uses the majority of asphalt roofing products, EPA used the cost share for maintenance and repair construction, and set the cost share, K, for this analysis at 0.02.

Given that the cost share of roofing products in the total production cost of new and maintenance construction is very small (0.02), the elasticity of demand for one of the final products (housing) is relatively low (-0.579), and ease of substitution between inputs imperfect, the elasticity of demand for asphalt roofing products would be inelastic (i.e., less than 1 in absolute value). In fact, it may be substantially lower. Assuming the elasticity of supply of other inputs, e, is 1, and the elasticity of substitution between asphalt roofing and other inputs, s, is 0.1, EPA estimated the elasticity of demand for asphalt roofing products. Using these assumptions and the elasticity of demand for housing (-0.579), EPA computed an estimated elasticity of demand for organic shingles, fiberglass singles, and roll roofing equal to –0.107. For MBR and blown asphalt, which are not so closely associated with housing, EPA computed the elasticity of demand using the same assumptions as mentioned above, but assuming that the elasticity of demand for construction is –1. Under these assumptions, the computed elasticity of demand for those asphalt roofing projects is –0.11.

4.5 Economic Impact Results

The simple analytics presented in Section 4.2 suggest that, when faced with higher costs of asphalt roofing production, producers will attempt to mitigate their impacts by making adjustments to shift as much of the burden to other economic agents as market conditions allow. The adjustments available to facility operators include changing production processes, changing inputs, changing output rates, or closing product lines and/or facilities. This analysis focuses on the last two options because they appear to be the most viable for asphalt roofing facilities, at least in the near term. We would expect upward pressure on prices as producers facing higher costs reduce output rates in response to these costs. Changes in market prices and, through the impact of price on quantity demanded, output for each product will lead to changes in the profitability of product lines, facilities, and firms. These market and industry adjustments will also determine the social costs of the regulation, as described in Appendix B.

4.5.1 National Market-Level Impacts

The increased cost of production due to the regulation is expected to increase the price of asphalt roofing products and reduce production/consumption from baseline levels.

Based on the applicability of engineering compliance costs from Section 3, a total of $1.01 million in compliance costs are applied to firms in the model. As shown in Table 4-2, the proposed regulation is projected to increase the average price of asphalt roofing products by 0.01 percent. Domestic production of asphalt roofing products declines by approximately 337 tons. However, no price or quantity change is projected for organic shingles, because no costs of compliance are assigned to that industry sector.

4.5.2 National Industry-Level Impacts

Revenue, costs, and profitability of the asphalt industry also change as prices and production levels adjust to increased costs associated with compliance. Operating profits are projected to decrease by $0.34 million (see Table 4-3). Operating profit decreases are the net result of three effects: increased revenue ($0.49 million), reductions in production costs as output declines ($0.06 million), and incurred control costs ($0.90 million). Table 4-4 provides the detailed information about distributional impacts across the facilities. Asphalt roofing facilities incurring compliance costs are projected to earn $0.8 million less in profits with the regulation, while facilities that do not incur costs are projected to experience increased profits of $0.46 million.

4.5.2.1 Plant Closure Analysis

One of the most sensitive issues to consider in the EIA is the possibility that the regulation may induce a producer to shut down operations rather than comply with the regulation. The data (such as direct observations of plant-level costs and profits) necessary to make definitive projections of these impacts are unavailable from the survey data. Therefore, EPA employed a method of estimating plant closure decisions using broad industry measures of profitability as described below. EPA defined a plant closure as the cessation of all asphalt roofing manufacturing operations at a site. It is possible that some plant locations may have other activities on-site that are unaffected by the proposed rule and that may continue even if asphalt roofing operations cease.

The plant closure criterion used for this analysis is defined as follows:

$$\pi_j = TR_j - TC_j \leq 0 \qquad (4.2)$$

Table 4-2. Market-Level Impacts: 1999

	Baseline	With Regulation	Change Absolute	Relative
Blown Asphalt				
Price ($/ton)	$168.67	$168.71	$0.04	0.02%
Quantity (tpy)	3,328,394	3,328,308	-86	0.00%
Fiberglass Shingles				
Price ($/ton)	$161.69	$161.71	$0.02	0.01%
Quantity (tpy)	15,138,624	15,138,384	-239	0.00%
Organic Roll Roofing				
Price ($/ton)	$561.91	$561.92	$0.01	0.00%
Quantity (tpy)	8,019,729	8,019,718	-11	0.00%
Organic Shingles				
Price ($/ton)	$161.69	$161.69	$0.00	0.00%
Quantity (tpy)	552,853	552,853	0	0.00%
Modified Bitumen Roll Roofing (MBR)				
Price ($/ton)	$895.27	$895.27	$0.00	0.00%
Quantity (tpy)	1,822,692	1,822,692	0	0.00%
Total				
Price ($/ton)	$320.03	$320.05	$0.02	0.01%
Quantity (tpy)	28,862,292	28,861,955	-337	0.00%

where total revenue (TR_j) is the sum of the product revenue from plant j's product lines, and total cost (TC_j) is the sum of the plant's variable production costs and total avoidable fixed costs, which are estimated using baseline revenues, variable production costs, and estimated

Table 4-3. Industry-Level Impacts: 1999

	Baseline	With Regulation	Absolute	Relative
Total revenue ($\$10^6$/yr)	\$9,236.71	\$9,237.13	\$0.49	0.01%
Total costs ($\$10^6$/yr)	\$8,931.90	\$8,932.74	\$0.84	0.01%
Control	\$0.00	\$0.90	\$0.90	NA
Production	\$8,931.90	\$8,931.84	–\$0.06	0.00%
Pre-tax earnings ($\$10^6$/yr)	\$304.81	\$304.47	–\$0.34	– 0.11%
Facilities (#)	123	123	0	0.00%
Employees (FTEs[a])	12,605	12,607	2	0.01%

[a]Full-time equivalents

profits, which were computed based on an industry-wide profit margin of 3 percent. This profit margin for the asphalt shingles and coating industry (SIC 2952: Asphalt Felts and Coatings Industry) was obtained from Industry Norms and Business Ratios 1999/2000 (Dun and Bradstreet, 2000c). The conceptually correct view would assume the plant also has some positive liquidation value or opportunity value in an alternative use that is not captured in the TC elements used to compute π_j. However, no data are available to estimate these opportunity costs. Therefore, the Agency has assumed that the plant's liquidation value is exactly offset by the costs of closing a plant.

EPA estimated each facility's with-regulation profitability using the method described above. As shown in Tables 4-3 and 4-4, no facilities are projected to become unprofitable as a result of the proposed regulation, so no plant closures are projected.

4.5.2.2 Employment Impacts

Reduction in domestic production leads to changes in industry employment. These changes in employment at each plant were estimated by multiplying the change in production at each plant by baseline employment:

Table 4-4. Distributional Impacts Across Facilities: 1999

	Pre-Tax Earnings			
	Loss	**Gain**	**Close**	**Total**
Facilites (#)	10	93	0	123
Production				
Total (tpy)	3,191,635	24,962,889	0	28,154,524
Average (tons/facility)	319,164	268,418	NA	273,345
Compliance costs				
Total ($\$10^6$/yr)	$897,065	$0	$0	$897,065
Average ($/unit)	$0.28	$0.00	NA	$0.03
Change in Pre-tax Earnings[a] ($\$10^6$/yr)	-$0.80	$0.46	$0.00	-$0.34
Change in Employment (FTEs[b]) (#)	-1	3	0	2

NA = Not available
[a] Earnings before income taxes
[b] Full-time equivalents

$$\Delta E_1 = [\Delta Q/Q] \cdot E_0 \ . \qquad (4.3)$$

Because changes in output at most facilities are very small, EPA projects changes in employment at each facility that are in the range of fractions of a full-time equivalent employee. Overall, employment increases at facilities that do not incur compliance costs are projected to more-or-less offset employment decreases at facilities incurring compliance costs due to the proposed rule. EPA's model essentially projects no change in industry employment as a result of the regulation, as reported in Tables 4-3 and 4-4.

4.5.2.3 Social Costs

The value of a regulatory action is traditionally measured by the change in economic welfare that it generates. The regulation's welfare impacts, or the social costs required to achieve environmental improvements, will extend to consumers and producers alike.

Consumers experience welfare impacts due to changes in market prices and consumption levels for asphalt roofing products associated with the rule. Producers experience welfare impacts resulting from changes in profits corresponding with the changes in production levels and market prices for asphalt roofing products. 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 economic analysis accounts for behavioral responses by producers and consumers to the regulation (i.e., shifting costs to other economic agents). This approach provides insights on how the regulatory burden is distributed across stakeholders. As shown in Table 4-5, the economic model estimates the total social cost of the rule of about $1.01 million. As a result of higher prices and lower consumption levels, consumers are projected to lose $0.55 million. Affected asphalt roofing producers lose $0.8 million in profits overall (see Table 4-4). However, because only 18 producers (ten facilities and eight refineries) are expected to incur compliance costs, most asphalt producers will gain as a result of the proposed rule. They will benefit from the higher market prices for asphalt roofing products, while incurring no increased costs as a result of the rule. Thus, they are expected to realize increased profits of $0.49 million as a result of the proposed rule. Refineries are projected to lose $0.11 million in profits due to the proposed rule. Overall, EPA estimates that the loss in producer surplus will total $0.46 million.

4.6 New Source Analysis

New suppliers of asphalt products have an investment decision: whether to commit to a new facility of a given scale. They have no fixed factors and thus may select any technically feasible facility configuration. Of course, they may also choose not to make an investment in this industry. Economic theory suggests investors are expected to invest in a project only when this investment project generates positive net present value (NPV), or alternatively when the internal rate of return (IRR) is greater than the opportunity cost of capital. Commodity prices and production costs are central to this decision.

The competitive model of price formation is provided in Figure 4-3. In the figure, the willingness of existing suppliers to produce alternative quantities of asphalt products is represented by S_E and the demand for asphalt products is shown as D_0. The equilibrium market price, P_0, is determined by the intersection of these curves. Figure 4-3 shows a

Table 4-5. Distribution of Social Costs: 1999

	Value ($$10^6$/yr)
Consumer Surplus	***-$0.55***
Blown asphalt	-$0.13
Fiberglass shingles	-$0.36
Organic roll roofing	-$0.06
Organic shingles	$0.00
Modified bitumen roll roofing (MBR)	$0.00
Producer Surplus	***-$0.46***
Asphalt roofing producers	-$0.34
Refineries	-$0.11
Total Social Cost	***-$1.01***
Engineering cost estimate	$1.008
Control costs after market adjustment	$1.007

constant cost industry where market price is exactly equal to the unit cost of new facilities, S_N.

In a growing industry, the demand for the commodity shifts outward (e.g., to D_1), placing upward pressure on prices and providing the incentive for investors to add new productive capacity.[1] As new capacity enters the market, the new equilibrium price is P_1, which is exactly equal to the unit cost of supply from new facilities. In this example, it is the same value as the old price, P_0. The new equilibrium quantity, Q_1, includes the additional output supplied by new sources: $(Q_1–Q_0)$.

The proposed NESHAP will increase existing plants' costs of producing asphalt products by shifting existing supply, S_E, up. It will also increase the costs of supply from new facilities. These increases in costs will place upward pressure on prices. As shown in Figure 4-4, with demand curve, D_1, prices would be expected to increase with shifts in supply until the average price of asphalt products, P_1', is equal to the unit cost of supply from new

[1]For simplicity, impacts are considered for one future time period.

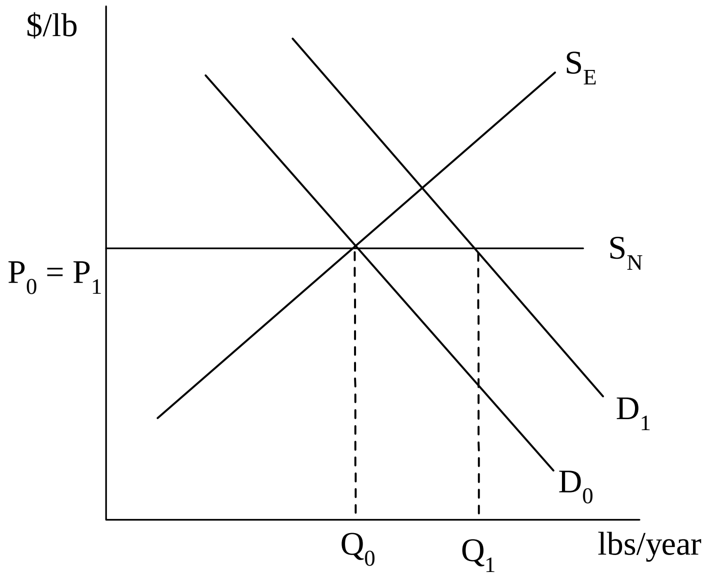


Figure 4-3. Baseline Equilibrium without Regulation

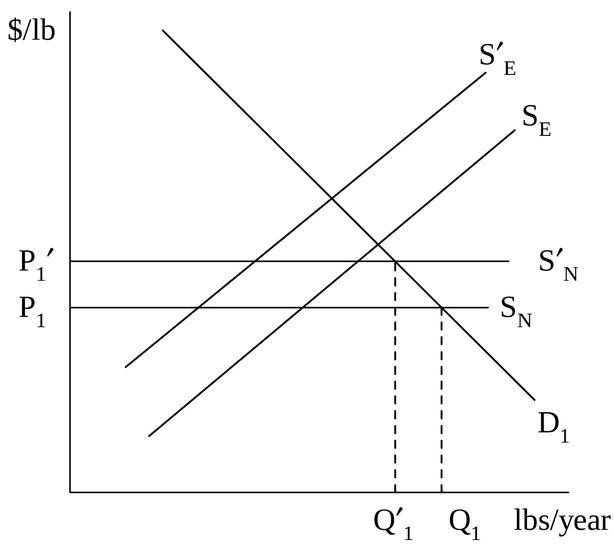


Figure 4-4. With-Regulation Equilibrium Case 1: New Sources Added

facilities including the cost of the NESHAP. However, as shown in Figure 4-5, no new capacity expansion will take place if the per-unit compliance costs at new facilities exceeded P_1'. Thus, the simple analytics presented suggest that the rule will likely cause investors to delay construction of new facilities until the price increases just enough to cover all the costs of production.

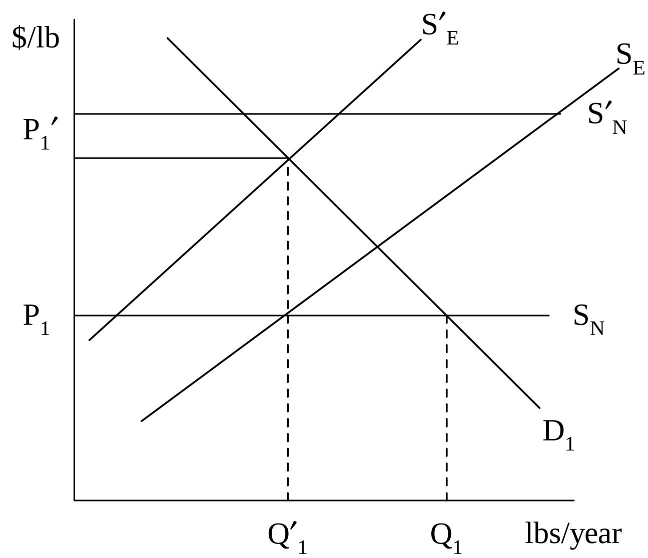


Figure 4-5. With-Regulation Equilibrium Case 2: No New Sources Added

Given the uncertainty about new facility unit costs (production and compliance) and future market conditions, the Agency is limited to general assessments of the rule's impact on the rate of new facility construction. The Agency modeled two types of new manufacturing plants—fiberglass shingles plants and MBR plants. Each new plant will also produce and sell blown asphalt. To inform these assessments, the Agency:

- estimated total annualized compliance costs to be $451,944 for each new facility. The estimated total annualized emission control cost is $400,230. The average annualized MRR cost is estimated to be $51,714 given that the lifetime for the control equipment is 10 years.

- projected changes in equilibrium output with regulation for a future time period (2002). Using the conceptual approach presented in Figures 4-4 and 4-5, the Agency estimated the change in facility construction for the period 2001 to 2002 as follows:

$$\Delta \text{Facilities} = \frac{\Delta Q_{2002}}{Z} = \eta_d \cdot Q_{2002} \cdot \frac{\Delta P}{P}$$

where

η_d = Elasticity of demand

Z = Average size of a new facility

Q_{2002} = For 1995, the blown asphalt demand was estimated to be 3.3 million tons, the fiberglass shingle demand was 15.1 million tons, and the MBR roll roofing was about 2 million tons.[2] For the period 1990 to 1998, the estimated growth rate of asphalt roofing products was 4 percent based on the values of shipments presented in Section 2.4. Using a composite growth rate of 4 percent, the Agency estimated the quantity of blown asphalt for the baseline year of 2002 to be 4.4 million tons while the estimated quantities for fiberglass shingles and MBR roll roofing were 20.1 and 2.4 million tons respectively.

ΔP = Calculated the change of average new source per-unit control costs ($0.71 per ton for the fiberglass shingles plant and $1.40 per ton for the MBR plant).

P = Baseline price for each asphalt product ($168.67 per ton for blown asphalt, $161.69 per ton for fiberglass shingles, and $895.27 per ton for MBR roll roofing).

Using this approach, the Agency projected a very small reduction in the growth of the asphalt industry, represented by a reduction in the equilibrium quantity of asphalt products projected in year 1 (2002). However, the reduction in equilibrium output of asphalt products was only a small fraction of the estimated new plant capacity. Thus, the Agency does not believe that the costs of complying with the regulation will be sufficient to cause a delay in the construction of new facilities. Overall, the control costs are not expected to influence the decision to enter the market for asphalt products, although they may affect the producer's selection of plant size or rate of capacity utilization.

---

[2]Quantity information for each asphalt product was obtained from the EPA Asphalt Roofing Industry Database.

SECTION 5

SMALL BUSINESS ANALYSIS

Although environmental regulations can affect all businesses, small businesses may have special problems complying with such regulations. The RFA of 1980 requires that special consideration be given to these entities. The RFA was amended in 1996 by SBREFA to strengthen its analytical and procedural requirements. Under SBREFA, the Agency must perform a regulatory flexibility analysis for rules that will have a significant impact on a substantial number of small entities (SISNOSE). This section focuses on the compliance burden for the small businesses to determine whether this proposed rule is likely to impose a significant impact on a substantial number of the affected small entities within this industry.

5.1 Identifying Small Businesses

Businesses producing asphalt roofing products are categorized as small or large using the Small Business Administration's (SBA's) general size standards definitions. For Asphalt Shingles and Coating Materials Manufacturing (NAICS 324122), the guidelines indicate companies are considered small businesses if they employ 750 or fewer workers (U.S. Small Business Administration, 2000). In contrast, the small business threshold for petroleum refineries (NAICS 324110) is 1,500 employees. Based on these definitions, the Agency identified 26 companies that are classified as small, or 65 percent of the total number of companies affected by the regulation. Twenty-two of these companies produce asphalt roofing products and the remaining four are refineries (see Table 5-1).

5.2 Screening-Level Analysis

For the purposes of assessing the potential impact of this rule on small businesses, the Agency calculated the share of annual compliance cost relative to baseline sales for each company. When a company owns more than one affected facility, the costs for each facility it owns are summed to develop the numerator of the test ratio. For this screening-level analysis, annual compliance costs were defined as the engineering control costs imposed on these companies. Therefore, they do not reflect the changes in production expected to occur in response to imposing these costs and the resulting market adjustments.

Table 5-1. Small Companies: 1999

Company	Organization Type	Sales ($\$10^6$)	Employees
Bitec	Private	12	45
Conglass, Inc.	NA	NA	NA
Firestone Building Products	NA	NA	NA
GAP Roofing, Inc.	Private	1.2	79
Gardland Co.	Private	85.0	300
Globe Building Materials, Inc.	Private	100.0	429
Goldis Holdings Inc.[a]	Private	33.60	194
Malarkey Herbert Roofing Co.	Private	38.0	100
MB Technology	NA	NA	NA
Mineral Fiber Manufacturing Corp.	NA	20–50	100–249
Northern Elastomeric Inc.	Private	13.30	75
Performance Roof System, Inc.	Private	20.0	60
Polyglass USA Inc.	Private	23.0	68
Ridglass Shingle Manufacturing Co.	Private	14.0	150
Siplast Inc.	Private	19.9	140
Soprema Inc.	Private	21.0	45
Southwestern Petroleum Corp.	Private	24.4	150
Tarco Inc.	Private	20.0	110
Thermo Manufacturing Systems, L.L.C.	Private	5.2	20
United Roofing Manufacturing Co.	Private	20.8	65
United States Single Ply Co.	Private	2.5–5	7
Warrior Roofing Manufacturing Co.	Private	20-50	43
Refineries			
Huntway Refining Co.	Private	193.0	90
Paramount Petroleum Corp.	Private	239.7	413
Gary-Williams Energy Corp.	Private	NA	NA
Silver Eagle Refining Inc.[c]	Private	40.6	85

NA = Not available.

[a] Owns Inland Refining Inc.

Sources: Asphalt Roofing Manufacturing Association. 1997. “Manufacturing Plants.” Facsimile on member company plant listing. Calverton, MD. September 24.
Dun & Bradstreet. 2000a. 2000 Dun & Bradstreet Million Dollar Directory Series. America’s Leading Public and Private Companies.
Dun & Bradstreet. 2000b. Electronic database.
American Business Information (ABI). 2000. Electronic database. Omaha, NE.

As shown in Table 5-2, the aggregate compliance costs for small businesses total $56,000, or 6 percent of the total industry costs of $1.01 million. The average total annual compliance cost was projected at approximately $2,000 per small company as compared to the average of $68,000 per large company. The annual compliance costs for small businesses range from 0.00 to 0.03 percent of sales. The average (median) compliance cost-to-sales ratio (CSR) is 0.002 (0.000) percent for the identified small businesses with sales data and 0.001 (0.000) percent for the large businesses with sales data. As shown, no small or large companies are affected at or above 1 percent. Based on this information, it does not appear that any small businesses will incur significant adverse economic impacts due to the proposed regulation.

5.3 Economic Impacts on Small Businesses

The Agency also analyzed the economic impacts on small businesses under with-regulation conditions expected to result from implementing the proposed NESHAP. Unlike the screening-level analysis described above, this approach examines small business impacts in light of the expected behavioral responses of producers and consumers to the regulation. As shown in Table 5-3, pre-tax earnings for facilities owned by small businesses are projected to decline by $0.08 million, or 0.05 percent. Employment (as measured by full-time equivalents) remains essentially unchanged.

5.4 Assessment

The results from the screening and economic analysis show that potential negative impacts of the proposed rule on small businesses are small. The screening analysis shows that compliance costs for all small companies are less than 1 percent of sales, a conservative measure of profitability. Reported average industry profit margins are higher than this 1 percent threshold, typically exceeding 3 percent (Dun and Bradstreet, 1997). The economic analysis, which accounts for behavioral responses to the regulation, provides additional evidence that the proposed rule will have minimal impacts on company profits and employment. As a result, the Agency has determined that the proposed rule is not likely to impose a significant impact on a substantial number of the affected small entities within this industry.

Table 5-2. Summary Statistics for SBREFA Screening Analysis: 1999

	Small		Large		All Companies	
Total Number of Companies	26		14		40	
Total Annual Compliance Costs (TACC) ($$10^3$)	$56		$953		$1,008	
Average (TACC) per company ($$10^3$)	$2		$68		$25	
	Number	Share	Number	Share	Number	Share
Companies with Sales Data[a]	22	100%	14	100%	36	100%
Compliance costs are <1% of sales	22	100%	14	100%	36	100%
Compliance costs are ≥1 to 3% of sales	0	0%	0	0%	0	0%
Compliance costs are ≥3% of sales	0	0%	0	0%	0	0%
Compliance Cost-to-Sales Ratios						
Average	0.002%		0.001%		0.002%	
Median	0.000%		0.000%		0.000%	
Maximum	0.034%		0.016%		0.034%	
Minimum	0.000%		0.000%		0.000%	

Note: Assumes no market responses (i.e., price and output adjustments) by regulated entities.
[a] Annual sales data were unavailable for four ultimate parent companies. CSRs cannot be computed for these companies.

Table 5-3. Summary of Small Business Impacts: 1999[a]

	Baseline	With Regulation	Absolute Change	Relative Change
Asphalt Roofing Manufacturers				
Revenues ($\$10^6$/yr)	$4,999	$4,999	$0.15	0.00%
Costs ($\$10^6$/yr)	$4,834	$4,834	$0.07	0.00%
Compliance	$0	$0	$0.00	NA
Production	$4,834	$4,834	$0.07	0.00%
Pre-tax Earnings ($\$10^6$/yr)	$165	$165	$0.08	0.05%
Facilities	31	31	0	0.00%
Employment (FTEs)[b]	2,335	2,335	0	0.01%

Note: These estimates incorporate the expected market (i.e., price and output) adjustments of the regulated entities.
[a]Impacts on refineries owned by small firms are not included in the market model.
[b]Full-time equivalents.

REFERENCES

Allen, R.G.D. 1938. *Mathematical Analysis for Economists.* New York: St. Martin's Press.

American Business Information (ABI). 2000. Electronic database. Omaha, NE.

Asphalt Roofing Manufacturing Association (ARMA). 1997. "Manufacturing Plants." Facsimile on member company plant listing. Calverton, MD. September 24.

Burns, Sandy, and Mari A. Paulson. 1997. "NRCA's Market Survey Indicates Roofing Business is Strong." *Professional Roofing* April.

Chambers, Robert G. 1988. *Applied Production Analysis: A Dual Approach*. Cambridge, UK: Cambridge University Press.

Dun & Bradstreet. 2000a. *2000 Dun & Bradstreet Million Dollar Directory Series: America's Leading Public and Private Companies*.

Dun & Bradstreet. 2000b. Electronic database.

Dun & Bradstreet. 2000c. *Industry Norms & Business Ratios 1999/2000*.

Freedonia Group. February 2000. "Asphalt Products and Markets in the United States to 2003—Introduction, Executive Summary, Market Environment, Technology and Regulation, International Environment, Primary Supply, Demand, Products and Products by Market." Profound WorldSearch <http://www.profound.com>.

Glennon, Dennis. 1989. "Estimating the Income, Price, and Interest Elasticities of Housing Demand." *Journal of Urban Economics* 25:219-229.

Hicks, J.R. 1961. "Marshall's Third Rule: A Further Comment." *Oxford Economic Papers* 13:262-65.

Hicks, J.R. 1966. *The Theory of Wages*. 2nd Ed. New York: St. Martin's Press.

Hoover's Online. 2001. Electronic database.

Kelly, Kenneth. 1988. "The Analysis of Causality in Escape Clause Cases." *Journal of Industrial Economics* 37 (2):187-207.

Kroschwitz, Jacqueline I., and Mary Howe-Grant, eds. 1991. *Kirk-Othmer Encyclopedia of Chemical Technology*. New York: John Wiley & Sons.

Lawson, A. 1997. "Benchmark Input-Output Accounts for the U.S. Economy, 1992: Requirements Tables." *Survey of Current Business.* December, pages 22-47.

Owens Corning. "Financial Reorganization." <http://financialreorganization.owenscorning.com/pr425.html>. As obtained on May 2, 2001.

Topel, Robert, and Rosen, Sherwin. 1988. "Housing Investment in the United States." *Journal of Political Economy* 96 (4):718-739.

U.S. Census Bureau. 2000. *Survey of Plant Capacity: 1998.* MQ-C1(98). Washington, DC: U.S. Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995a. *1991 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M91(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995b. *1993 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M93(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1996. *1994 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M94(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1997. *1995 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M95(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1998. *1996 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M96(AS)-1. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 2000. *1998 Annual Survey of Manufactures: Statistics for Industry Groups and Industries*. M98(AS)-1. Washington, DC: Government Printing Office.

U.S. Environmental Protection Agency (EPA). 1999. *OAQPS Economic Analysis Resource Document*. Durham, NC: Innovative Strategies and Economics Group.

U.S. Environmental Protection Agency (EPA). 2001. Asphalt Roofing Industry Database.

U.S. International Trade Commission. Trade Database. <http://dataweb.usitc.gov/scripts/>.

APPENDIX A

OPERATIONAL MODEL FOR ECONOMIC IMPACT ANALYSIS

This appendix describes the operational model used to estimate the economic impacts of the proposed Asphalt Roofing Products NESHAP. Both the market supply and demand in the operational model are characterized here.

A.1 Market Supply

To enable EPA to examine the impact of selecting different functional forms for the supply function, the model includes the ability to express supply using the generalized Leontief functional form. The generalized Leontief functional form is described below.

A.1.1 Using the Generalized Leontief Profit Function to Derive Output Supply

The specification of a facility j's profit function for product n given by the generalized Leontief is as follows:

$$\pi_{jn} = \beta_0 \cdot I_{jn} + \beta_1 \cdot P_n + 2\ \beta_2 \sqrt{I_{jn} P_n} \qquad \text{(A.1)}$$

Equation A.1 is an empirical model to estimate facilities' profit, where P_n is the net market price for product n manufactured by facility j, I_{jn} is the variable production cost variable (described below), β_0, β_1, and β_2 are model parameters, j indexes producers (i.e., affected facilities), and n represents the five products identified in Section 4.2.1 (Chambers, 1988). By applying Hotelling's lemma to the generalized Leontief profit function, the following general form of the product n supply function for facility j is obtained:

$$q_{jn} = \frac{\partial \pi_{jn}}{\partial P_n} = \gamma_{jn} + \beta_n \left[\frac{I_{jn}}{P_n}\right]^{\frac{1}{2}} \qquad \text{(A.2)}$$

where q_{jn} is the quantity of product n produced by facility j, P_n is the net market price for each product, I_{jn} is the variable production cost variable (described below), $\gamma_{jn} = \beta_1$ and $\beta_n = \beta_2$ are model parameters, j indexes producers (i.e., affected facilities), and n represents the five products mentioned in Section 4.2.1. The theoretical restrictions on the model parameters that ensure upward-sloping supply curves are $\gamma_{jn} \geq 0$ and $\beta_n < 0$.

Figure A-1 illustrates the theoretical supply function for product i represented by Eq. (A.2). As shown, the upward-sloping supply curve is specified over a productive range with a lower bound of zero that corresponds with a shutdown price equal to $\frac{\beta_n^2}{\gamma_{jn}^2} \cdot I_n$ and an upper bound given by the productive capacity of q_j^M that is approximated by the supply parameter γ_{jn}. The curvature of the supply function is determined by the β_n parameter.

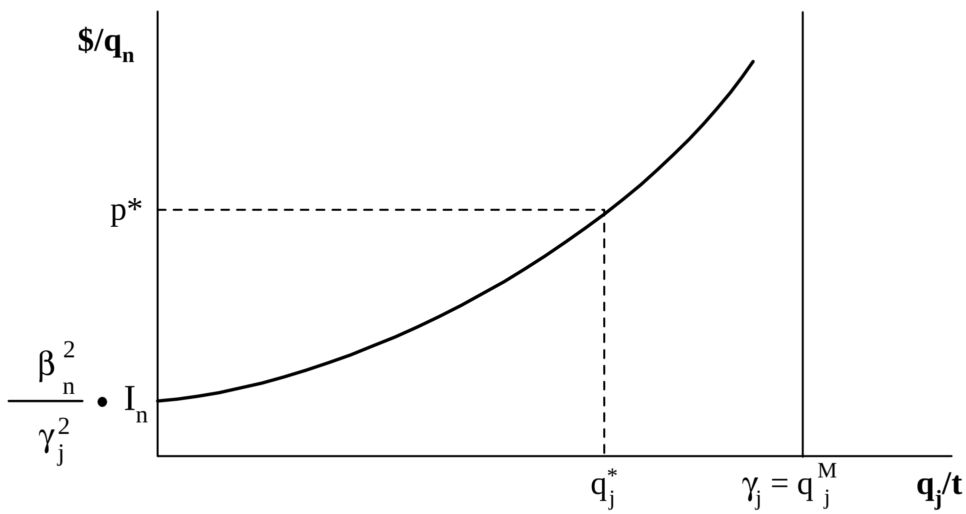


Figure A-1. Facility-Level Supply Function for Product n

A.1.2 Cost-Share-Weighted Variable Production Cost Index

An aggregate measure of the cost of variable inputs that are not used in fixed proportions (price I_{jn}) can be constructed as a cost-share-weighted index of regional- and state-level average hourly earnings (w_j), average fuel prices (f_j), and electricity prices (e_j). The I_{jn} variable varies across facilities because of all three variables (w,f,e). The cost shares used to weight the variable cost components also vary by NAICS code. In EPA's economic impact estimation model, this was not done. The model assumed I=1.

A.1.3 Supply Parameters

The β parameter is related to the facility j's supply elasticity for product i, which can be expressed as

$$\xi_{jn} = \frac{\dfrac{\partial q_{jn}}{q_{jn}}}{\dfrac{\partial P_n}{P_n}} = \frac{\partial q_{jn}}{\partial P_n} \cdot \frac{P_n}{q_{jn}} \quad . \tag{A.3}$$

Taking the derivative of the facility supply function (Eq. [A.2]) with respect to price shows

$$\frac{\partial q_{jn}}{\partial P_n} = -\frac{\beta_n}{2} \left[\frac{I_{jn}}{P_n^{\ 3}}\right]^{\frac{1}{2}} \quad . \tag{A.4}$$

Multiplying this expression by P_n/q_n results in the expression for the supply elasticity:

$$\xi_{jn} = -\frac{\beta_n}{2 \cdot q_{jn}} \left[\frac{I_{jn}}{P_n}\right]^{\frac{1}{2}} \quad . \tag{A.5}$$

By rearranging terms, β_n can be expressed as follows:

$$\beta_n = -\ 2\ q_{jn}\ \xi_{jn} \left[\frac{I_{jn}}{P_n}\right]^{-\frac{1}{2}} \quad . \tag{A.6}$$

Values for the β parameter can be computed in two ways: econometric estimation using facility survey data or substitution of an econometrically estimated or assumed market supply elasticity for product n (ξ_{jn}), the average annual production level of facilities (q_{jn}), the variable production cost index (I_{jn}), and the market price of the product n (P_n). Note that unlike the product-specific β, the facility supply elasticity is not constant but varies with q, p, and I.

The remaining supply function parameter, γ_{jn}, approximates the productive capacity and varies across products at each facility. This parameter does not influence the facility's production responsiveness to price changes as does the β parameter. Thus, the parameter γ_{jn} is used to calibrate the model so that each facility's supply equation replicates the baseline production data.

A.1.4 Regulatory Response

The production decisions at asphalt roofing manufacturing facilities are affected by the total annual compliance costs, c_j, which are expressed per ton of product.[1] Each supply equation is directly affected by the regulatory control costs, which enter as a net price change (i.e., $p_j - c_j$). Thus, the supply function for each existing facility from Eq. (A.2) becomes the total annual compliance costs per ton are calculated given the annual production per facility and the regulatory cost estimates for each facility provided by the engineering analysis.

$$q_j^s = \gamma_j + \beta \left[\frac{I_j}{p_j - c_j} \right]^{\frac{1}{2}} . \tag{A.7}$$

A.2 Market Demand

Domestic demand is expressed as follows:

$$q^{D_n} = B_n \bullet P_n^{\eta^{D_n}} \tag{A.8}$$

where

q^{D_n} = domestic demand for product n,

---

[1]Total annual compliance cost estimates, provided by EPA's engineering analysis, include capital costs, annual operating and maintenance costs, and applicable monitoring costs.

B_n = a parameter that calibrates the demand equation to replicate the 1999 level of domestic demand,

P_n = the 1999 average market price for product n, and

η^{D_n} = the domestic demand elasticity for product n.

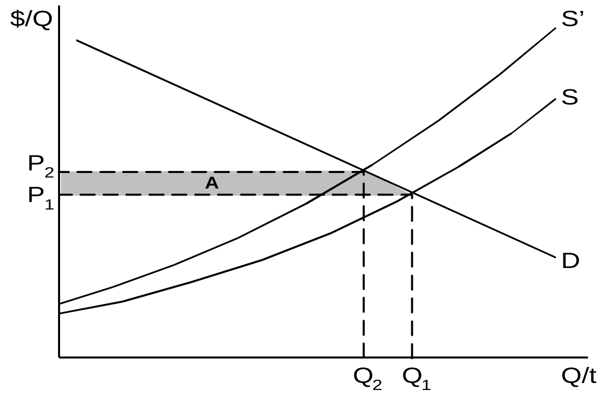
APPENDIX B

ECONOMIC WELFARE IMPACTS ON ASPHALT INDUSTRY

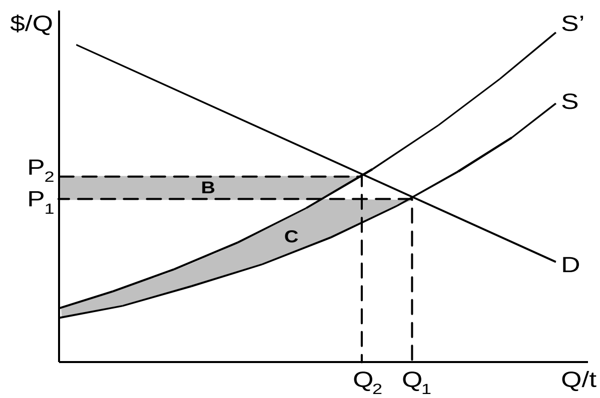
The economic welfare implications of the market price and output changes with the regulation can be examined using two different strategies, each giving a somewhat different insight but the same implications: changes in the net benefits of consumers and producers based on the price changes and changes in the total benefits and costs of these products based on the quantity changes. This analysis focuses on the first measure—the changes in the net benefits of consumers and producers. Figure B-1 depicts the change in economic welfare by first measuring the change in consumer surplus and then the change in producer surplus. In essence, the demand and supply curves previously used as predictive devices are now being used as a valuation tool.

This method of estimating the change in economic welfare with the regulation divides society into consumers and producers. In a market environment, consumers and producers of the good or service derive welfare from a market transaction. The difference between the maximum price consumers are willing to pay for a good and the price they actually pay is referred to as "consumer surplus." Consumer surplus is measured as the area under the demand curve and above the price of the product. Similarly, the difference between the minimum price producers are willing to accept for a good and the price they actually receive is referred to as "producer surplus" or profits. Producer surplus is measured as the area above the supply curve and below the price of the product. These areas can be thought of as consumers' net benefits of consumption and producers' net benefits of production, respectively.

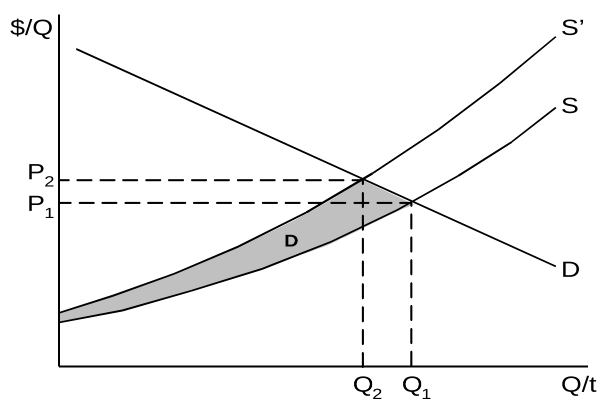
In Figure B-1, baseline equilibrium occurs at the intersection of the demand curve, D, and supply curve, S. Price is P_1 with quantity Q_1. The increased cost of production with the regulation will cause the market supply curve to shift upward to S′. The new equilibrium price of the product is P_2. With a higher price for the product, there is less consumer welfare, all else being unchanged as real incomes are reduced. In Figure B-1(a), area A represents the dollar value of the annual net loss in consumers' benefits with the increased price. The rectangular portion represents the loss in consumer surplus on the quantity still consumed, Q_2, while the triangular area represents the foregone surplus resulting from the reduced quantity consumed, Q_1–Q_2.



(a) Change in Consumer Surplus with Regulation



(b) Change in Producer Surplus with Regulation



(c) Net Change in Economic Welfare with Regulation

Figure B-1. Economic Welfare Changes with Regulation: Consumer and Producer Surplus

In addition to the changes in consumer welfare, producer welfare also changes with the regulation. With the increase in market price, producers receive higher revenues on the quantity still purchased, Q_2. In Figure B-1(b), area B represents the increase in revenues due to this increase in price. The difference in the area under the supply curve up to the original market price, area C, measures the loss in producer surplus, which includes the loss associated with the quantity no longer produced. The net change in producer welfare is represented by area B–C.

The change in economic welfare attributable to the compliance costs of the regulation is the sum of consumer and producer surplus changes, that is, – (A) + (B–C). Figure B-1(c) shows the net (negative) change in economic welfare associated with the regulation as area D. However, this analysis does not include the benefits that occur outside the market (i.e., the value of the reduced levels of air pollution with the regulation). Including this benefit may reduce the net cost of the regulation or even make it positive.

TECHNICAL REPORT DATA

(Please read Instructions on reverse before completing)

EPA-452/R-01-010

Economic Impact Analysis for the Proposed Asphalt Roofing and Processing NESHAP	**July 2001**
U.S. Environmental Protection Agency **Office of Air Quality Planning and Standards** **Air Quality Strategies and Standards Division** **Research Triangle Park, NC 27711**	
Director **Office of Air Quality Planning and Standards** **Office of Air and Radiation** **U.S. Environmental Protection Agency** **Research Triangle Park, NC 27711**	**Final report** **EPA/200/04**

Pursuant to Section 112 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) is developing a National Emissions Standard for Hazardous Air Pollutants (NESHAP) to control emissions released from the domestic production of asphalt roofing products. In 1999, 40 companies owned and operated 123 facilities that produce asphalt roofing materials. EPA estimated that six of these facilities will incur costs associated with installing and operating emissions control equipment. These six roofing manufacturers and eight refineries will also incur co: to perform monitoring, recordkeeping, and reporting activities associated with this rule.

The total annual costs of the rule are estimated to be small. They are less than $1.1 million. Price and quantity impacts on the various asphalt roofing products markets are also very small. Prices are expected to change by only a few cents, representing hundredths of a percent of base prices. Similarly, market quantities are projected to decline by less than 0.01 percent. Industry-wide profits are projected to decline by rough $42,000. No facilities are projected to close, and no change in employment is expected.

Of the 40 companies owning asphalt roofing products facilities, 26 are small business based on the Small Business Administration definition c a small business for companies within NAICS code 324122 (Roofing asphalts and pitches, coatings, and cements). The economic impacts of this rule on small businesses is also examined pursuant to the Small Business Regulatory Enforcement Fairness Act (SBREFA) and the Regulatory Flexibility Act. None of the 26 small companies are expected to incur regulatory costs exceeding 1 percent of baseline sales.

	Air Pollution control, environmental regulation, asphalt roofing and processing, economic impact analysis	
Release Unlimited	**Unclassified**	**87**
	Unclassified	