United States Environmental Protection Agency

Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

FINAL REPORT
EPA-452/R-01-011
June 2001

Air

ECONOMIC IMPACT ANALYSIS OF THE BOAT MANUFACTURING NESHAP

Economic Impact Analysis of the Boat Manufacturing NESHAP

U.S. Environmental Protection Agency
Office of Air and Radiation
Office of Air Quality Planning and Standards
Air Quality Strategies and Standards Division
Research Triangle Park, NC

June 2001

Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

D&B - Dun & Bradstreet
EPA - U.S. Environmental Protection Agency
FRP - fiber-reinforced plastic
HAP(s) - Hazardous Air Pollutant(s)
ITC - International Trade Commission
MACT - Maximum Achievable Control Technology
NMMA - National Marine Manufacturers Association
NESHAP(s) - National Emission Standard(s) for Hazardous Air Pollutants
PPE - personal protective equipment
PWC - personal watercraft
RFA - Regulatory Flexibility Act
SBA - U.S. Small Business Administration
SBREFA - Small Business Regulatory Enforcement Fairness Act
SIC - Standard Industrial Classification
TRI - Toxics Release Inventory

1. Introduction

The U.S. Environmental Protection Agency (EPA) is required under Section 112 of the Clean Air Act to develop National Emission Standards for Hazardous Air Pollutants (NESHAPs) for major and area sources of hazardous air pollutants (HAPs). EPA is currently developing regulations on emissions of HAPs from the boat manufacturing industry. In November 1999, the EPA provided an analysis of the proposed rule's impact on the boat manufacturing industry. Although there are no changes to the analysis from that prepared at proposal, this document provides the analysis of the likely economic impacts of the final regulation on the industry.

1.1 Scope and Purpose

The boat production process can results in emission of HAPs. These emissions impose costs on society however these costs are not accounted for when producers and consumers make decisions regarding the quantity of boats to produce and purchase. The costs of pollution are external to the market mechanisms that determine the price and quantity of boats sold and thus these costs are often referred to as externalities. The rule is designed to internalize these external costs by establishing limits on the HAP content of materials used in the manufacture of boats and limits for the amount of HAP released during certain manufacturing processes. These limits will impose costs on the producers and consumers of boats but will also result in a decrease in the external cost of pollution.

The limits set by the rule are based on the Maximum Achievable Control Technology (MACT) for the industry. The term "MACT floor" refers the minimum control technology on which MACT can be based. For existing major sources, the MACT floor is the average emissions limitation achieved by the best performing 12 percent of sources (if there are 30 or more sources in the category or subcategory), or best performing 5 sources (if there are fewer than 30 sources in the category or subcategory). For the boat manufacturing category the MACT floor was based on emissions at the top 12 percent of sources.

The MACT standards will apply to all existing major sources of HAP emissions. EPA used data from the Toxic Release Inventory (TRI) to define major sources for this analysis. All facilities in SIC 3732 "Boat Manufacturing and Repair" that were listed as major sources of styrene emissions in the 1997 TRI were considered facilities potentially affected by the regulation. All potentially affected facilities whose current practices do not meet the MACT floor standards will be required to alter their practices to comply with the rule. These facilities will incur compliance costs and these compliance costs will have effects on producers, consumers, and society as a whole.

This document provides analysis on the likely economic effects of the rule on affected and non-affected producers, consumers and society as a whole. In addition, the analysis provides an indication of the effects of the rule on international trade, employment, and small businesses. While the EIA focuses on the cost of pollution reduction it is important to keep in mind that these costs are being imposed in order to reduce the external or hidden costs of pollution.

1.2 Organization of the Report

The remainder of this report is organized into five chapters:

˜ **Chapter 2: Industry Profile**. This section provides an overview of the boat manufacturing industry. It presents data on products and markets, foreign trade, market concentration, costs and profit margins, and forecasts growth in the industry over the next five years.

- **Chapter 3: Compliance Costs**. This chapter summarizes the methodology used to estimate total facility-level compliance costs. A detailed summary of the calculation of compliance costs can be found in the "Final Cost Procedures Documentation Memorandum" (U.S. EPA, 1999).

- **Chapter 4: Economic Impact Analysis**. Chapter 4 describes the methodology for estimating the total social cost of the regulation and provides the results of this analysis. Additional discussion is provided on the likely impacts of the rule on facility closures and employment.

- **Chapter 5: Small Business Regulatory Enforcement and Fairness Act (SBREFA) Analysis**. The Regulatory Flexibility Act (RFA) and the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA) require EPA to determine whether the rules will impose significant impacts on a substantial number of small entities, and to take certain procedural steps if the rules might impose such impacts. Chapter 5 presents an analysis of the likely effects of the regulation on small businesses.

- **Appendices**. Three appendices are provided with the analysis. Appendix A provides information on how EPA estimated sales at the facility level. Appendix B provides a sensitivity analysis for the economic analysis presented in Chapter 4. Appendix C presents the mathematical derivation of equations used in the economic analysis presented in Chapter 4.

2. Industry Profile: Boat Manufacturing Source Category

The industry profile provides the foundation for the development of the economic analysis. The major purposes of the profile include the following:

- To present relevant industry financial and economic characteristics and trends—past, present, and future;

- To provide an understanding of the industry organization, including market structure and the conduct and performance of affected firms;

- To identify the key factors and trends that may influence the nature and magnitude of the economic impacts and that should be addressed in the economic analysis (e.g., the significance of international trade); and

- to provide information necessary to identify and characterize special populations in accordance with legislative and administrative directives (e.g., small businesses under SBREFA; state, local, and tribal governments under UMRA; and minority and low-income groups under E.O. 12898 on environmental justice).

This National Emission Standards for Hazardous Air Pollutants (NESHAP) will affect major sources of HAPs in the boat manufacturing source category, which includes establishments involved in the manufacture of boats and ships. The boat building industry is characterized by facilities engaged in the production of boats, primarily for recreational use. In contrast, the ship building industry is engaged in the production of ships, barges and lighters, primarily for military and commercial use. A major source, as defined in Section 112 of the Clean Air Act, is any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants.

This industry profile focuses primarily on Standard Industrial Classification (SIC) 3732, the boat building and repairing sector. The ship building and repairing industry (SIC 3731) will also be affected to a minimal extent by this rule, however, the use of reinforced plastics in ships is very minor in comparison to other input materials. Therefore, the profile of the shipbuilding industry presented here is less detailed than that for the boat manufacturing industry.

2.1 Production Processes

Most boat manufacturing facilities are dedicated to either power boats or non-power boats (sailboats, canoes and kayaks) and rarely manufacture both. Boat hulls are usually produced by hand lay-up and/or spray-up on open molds. After the mold is treated with wax, a pigmented gel coat is applied, forming the outer skin of the boat hull. Once the gel coat has been laid down, boat resin is applied in conjunction with the reinforcement. Major structural components that make up the inside, deck and cabin of the boat are built from fiber-reinforced plastic (FRP) in one piece and then joined with the hull. (SRI International, 1996).

Most facilities use only one primary material, including FRP, aluminum, wood, or rotationally-molded polyethylene. FRP is the most common material used for boat manufacturing, especially for power boats and sailboats, because it can be easily molded to complex shapes, has a smooth glossy surface, and is practically maintenance free.

However, aluminum is also used in manufacturing a large portion of smaller boats, such as rowboats, canoes, and freshwater utility and fishing boats. Aluminum is used because it is lightweight, durable, and low maintenance. Rotationally-molded (roto-molded) polyethylene has been used for about two decades to build kayaks and canoes, and is now alos being used by a handful of manufacturers to build small sailboats and power boats less than 20 feet long. Polyethylene can also be molded to complex shapes and is very durable, but does not have the smooth glossy finish of FRP. Wood is used in custom building of all sizes and types of boats, primarily by small independent builders.

2.2 Facilities and Employment

Table 2-1 provides information on the number of establishments (i.e., facilities), the number of employees, and the distribution of facilities by employment range, for both SIC 3731 (ships) and 3732 (boats) for 1990 and 1995, as well as the percent change from 1990 to 1995. Both the boat building and shipbuilding industries experienced growth in the number of establishments over the five year period.

The number of boat building establishments grew by 14.8% while the number of shipbuilding establishments grew by 5.8%. This growth came primarily from an increase in the number of small establishments with less than 20 employees. Larger establishments with more than 20 employees declined in number during the period. Overall the two industries experienced a substantial decline in employment from 1990 to 1995. Shipbuilding employment fell 17.8% while boat building employment fell 9.6%.

Table 2-1: Number of Establishments and Employment 1990 - 1995

SIC	Year	Total Number of Establishments	Total Employment	Number of Establishments with < 20 employees	Number of Establishments with 20-99 Employees	Number of Establishments with 100-499 Employees	Number of Establishments with 500 or More Employees
3731-Ships	1990	532	122,025	251	160	96	25
	1995	561	100,318	315	153	75	18
	% change	5.5%	-17.8%	25.5%	-4.4%	-21.9%	-28%
3732-Boats	1990	2,032	56,973	1,581	315	121	15
	1995	2,332	51,527	1,922	300	99	11
	% change	14.8%	-9.6%	21.6%	-4.8%	-18.2%	-26.7%

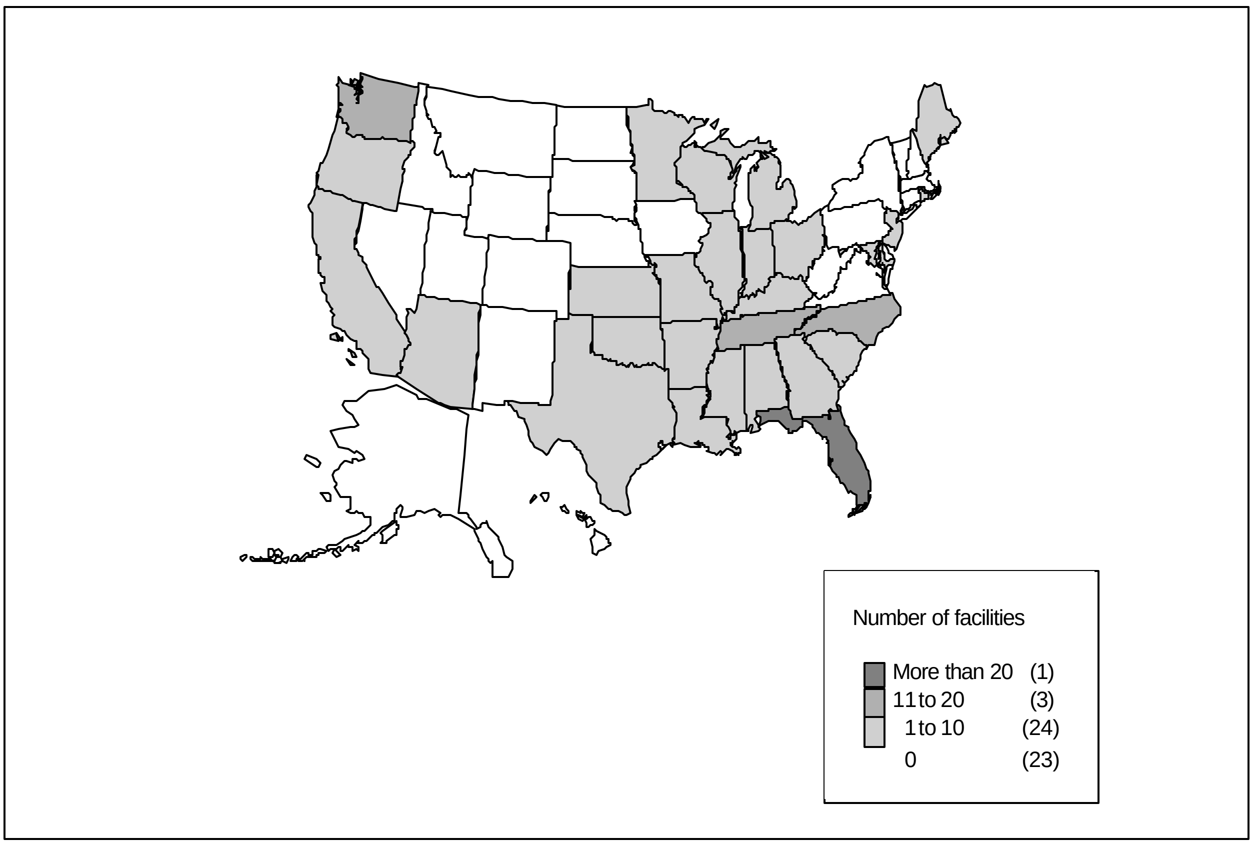
Source: U.S. Department of Commerce. 1996b.

As is indicated in Table 2-1, there were 2,332 facilities involved in boat building and repairing (SIC 3732) in 1995. Only some of these facilities will be affected by the regulation. To determine which facilities would likely be affected by this regulation, EPA used information from the Toxic Release Inventory (TRI) database. In 1995, 172 facilities under SIC 3732 (boats) reported to EPA's TRI, and 140 of these facilities are major sources for

HAP’s. In addition, 51 facilities reported to TRI under SIC 3731 (ships), and of these, 23 facilities are major sources of HAPs.

Figure 2-1 shows the number of facilities in SIC 3732 that reported to TRI, by state. Florida has the most boat manufacturing facilities (39) reporting emissions of HAPs. Five states (Florida, Tennessee, North Carolina, Washington, and California) contain nearly half (83) of all boat manufacturers that report styrene emissions to TRI. Most boat manufacturers reporting to TRI are in rural or suburban areas, although a few are in urban areas. An urban area is an area(s) that, combined with the adjacent densely settled areas, has a minimum of 50,000 persons.

Figure 2-1: Location of Boat Manufacturing Firms Reporting Styrene Emissions in TRI, 1995



The number of small versus large boat building firms is of particular interest for the small business analysis (see Chapter 5), where a firm is defined as the ultimate legal entity owning at least one boat building facility. The Small Business Administration (SBA) provides small business thresholds by 4-digit SIC code. The SBA defines “small” for SIC 3732 (boat manufacturing and repair) as firms with fewer than 500 employees. The Statistics of U.S. Businesses (SUSB) provides annual data on the number of firms that own at least one facility in a given Standard Industrial Category (SIC). Data in the SUSB are reported by the employment size of the parent firm. The 1996 SUSB indicates that there are 2,611 firms with facilities primarily engaged in SIC 3732. Of these, 2,590 firms have fewer than 500 employees and only 21 firms have more than 500 employees. The data for SIC 3732 include both firms that manufacture boats and firms that repair boats. However, the rule will apply only to firms that manufacture boats. The total number of firms from SUSB was adjusted to estimate the number of firms that manufacture boats, using data from the 1992 Census of Manufactures. According to the Census, 283 *facilities* specialized in boat repair in 1992[1]. We do not have any information on the number of firms own these facilities. We assumed that boat repair facilities are all owned by a single-facility firm with fewer than 500 employees. Using these assumptions, the total number of boat *manufacturing* firms is estimated as 2,328, of which 2,307 are small and 21 are large firms. (See Table 2-2.)

Data from Dun and Bradstreet were used to determine firm-level employment for all affected firms. Of the 78 affected firms, 66 employ fewer than 500 people. Table 2-2 below shows the distribution of boat manufacturing firms by employment size for both affected and unaffected firms. Note that, while there are a large number of small boat manufacturing firms, only 2.9% of these firms will be affected by the regulation. There are only 21 large boat manufacturing firms, but 71.4% of these firms own facilities that are major sources of styrene and that will be affected by the rule.

Table 2-2: Estimated Number of Boat Manufacturing Firms by Employment Size

	Total Number of Firms	Number of Affected Firms	Percent of Total Firms That Are Affected
Small Firms–SIC 3732	2,590	66	2.5%
Less Small Firms Specializing in Boat Repair	283	0	0.0%
Total Small Boat Manufacturing Firms	2,307	66	2.9%
Large Firms–SIC 3732	21	15	71.4%
Total Boat Manufacturing Firms	2,328	78	3.4%

2.3 Products and Markets

The U.S. boat manufacturing industry produces a wide range of boats, from small canoes and kayaks to large luxury yachts. For the purposes of this profile, the boat manufacturing industry has been divided into eight separate boat segments according to boat size and location of the engine. They are:

- **Outboard Boats**: Small to medium-sized boats, powered by a self-contained detachable engine and propulsion system, which is attached to the transom. This category of boats includes most runabouts, bass boats, utility boats, offshore fishing boats and pontoons.

[1] The Census of Manufactures reports the number of establishments (facilities) by primary product produced. An establishment is classified in a particular industry if the value of its shipments of the primary products of that industry exceed the value of its shipments of the products of any other single industry. The 283 establishments listed in Table 2-2 are classified as primarily boat repair facilities. See U.S. Department of Commerce, 1992, Table 5a.

- **Inboard Runabouts**: Mid-sized boats powered by an attached engine located inside the hull at the middle or front of the boat, with a prop shaft running through the bottom of the boat. Over 90% of the boats in this category are tournament ski boats (Boating Industry, 1995).

- **Sterndrives**: Mid-sized boats powered by an attached inboard engine combined with a drive unit located on the transom at the stern (rear) of the boat. Also known as inboard/outboards or I/Os.

- **Inboard Cruisers**: Large boats powered by one or more inboard engines. Two engines are found in over 95% of these boats (Boating Industry, 1995).

- **Personal Watercraft (PWC)**: Small boats (most under ten feet long) powered by water jets instead of by an open blade propellor, on which the rider stands or sits (as on a motorcycle). A popular brand of PWC is the "Jet Ski".

- **Jet Boats**: Small to mid-size boats powered by water jets rather than a gas or diesel motor. The jets can be located at either the stern or inboard.

- **Canoes**: Small boats powered by hand-held paddles.

- **Sailboats**: This category of boats includes all sizes of boats powered, at least partially, by wind-driven sails. This category includes both nonpowered sailboats and auxiliary-powered sailboats that include a motor.

Table 2-3 summarizes the number of boats sold in the United States in 1997 by boat type. A total of 610,140 boats were sold in 1997, at a value of approximately $6.8 billion. Outboard boats and PWCs made up approximately 62% of the number of boats sold in 1997 and 40% of all boat sales revenue. Over half of the units sold in 1997 were small power boats 14 to 30 feet long using either outboard engines or sterndrive engines. The next most popular type of boat sold was the personal watercraft (PWC).

Table 2-3: Boat Sales 1995 - 1997 (current $)

Boat Type	Year	Units Sold	Retail Value ($1,000)	Average Price ($)	% Total Units Sold
Outboard Boats	1995	231,000	$1,426,420	$6,175	34.8%
	1996	215,000	$136,240	$6,336	33.9%
	1997	200,000	$1,421,400	$7,107	32.8%
Personal Watercraft	1995	200,000	$1,144,400	$5,722	30.1%
	1996	191,000	$1,208,648	$6,328	30.1%
	1997	176,000	$1,315,904	$6,454	28.8%
Canoes	1995	97,800	$55,941	$572	14.7%
	1996	92,900	$53,789	$579	14.6%

Table 2-3: Boat Sales 1995 - 1997 (current $)					
Boat Type	**Year**	**Units Sold**	**Retail Value ($1,000)**	**Average Price ($)**	**% Total Units Sold**
	1997	103,600	$61,124	$590	17.0%
Sterndrive Powerboats	1995	93,600	$1,791,310	$19,138	14.1%
	1996	94,500	$1,925,248	$20,373	14.9%
	1997	92,000	$2,068,528	$22,484	15.1%
Inboard Runabouts	1995	6,900	$147,660	$21,400	1.0%
	1996	6,000	$126,234	$21,309	0.9%
	1997	6,100	$136,408	$22,362	1.0%
Inboard Cruisers	1995	5,460	$1,169,500	$214,195	0.8%
	1996	5,350	$1,215,268	$227,153	0.8%
	1997	6,300	$1,669,103	$264,937	1.0%
Jet Boats	1995	14,700	$141,796	$9,646	2.2%
	1996	14,100	$143,284	$10,162	2.2%
	1997	11,700	$144,389	$12,341	1.9%
Sailboats*	1995	14,320	N/A	N/A	2.2%
	1996	15,940	N/A	N/A	2.5%
	1997	14,440	N/A	N/A	2.4%
Total 1995		663,780	$5,877,027	---	100%
Total 1996		634,790	$4,808,711	---	100%
Total 1997		610,140	$6,816,856	---	100%

Source: National Marine Manufacturers Association. 1997, pg. 4.
*Represents the number of sailboats produced in North America. Source: The Sailing Company of Miller Sports Group LLC, 1998.

Table 2-4 presents historical data for boat sales from 1988 to 1997. As a recreational (luxury) good, boat sales are influenced by overall economic conditions and normally decline during recessions, such as the one that occurred during the early 1990s. A luxury tax imposed in 1990 (and repealed in 1993) of 10% on the portion of the retail price of a pleasure boat that exceeded $100,000 also affected sales of large boats. (U.S. Department of Commerce, 1994: 37-12) Different market segments are also subject to growth or decline in response to consumer preferences. PWC and jet boat sales, for example, have doubled and tripled, respectively, over the last 5 years. (NMMA, 1996)

Table 2-4: Boat Sales 1988 - 1997 (Thousands of boats / year)											
Boat Type	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**Average Annual Growth 88-97**
Outboard Boats	355	291	227	195	192	205	220	231	215	200	-4.3%
PWC *	NA	NA	NA	NA	79	107	142	200	191	176	20.4%
Canoes*	NA	NA	NA	NA	NA	NA	100	98	93	104	1.0%
Sterndrive Powerboats	148	133	97	73	75	75	90	94	95	92	-3.8%
Inboard Runabouts	7	9	8	6	6	7	7	7	6	6	-1.8%
Inboard Cruisers	14	12	8	4	4	3	4	6	5	6	-5.3%
Jet Boats*	NA	NA	NA	NA	4	8	9	15	14	12	32.1%
Sailboats*	NA	NA	NA	9	11	12	13	13	14	NA	11.0%
Totals	524	445	339	278	370	417	485	565	633	596	1.4%

*Data not available (NA) for all years. Average annual change is based on the longest period of available data.

Table 2-5 presents data on the value of shipments for SICs 3731 and 3732. While the value of shipments for ship building (SIC 3731) rose steadily in the late 1980's and early 1990's, it has been on a fairly steady decline since 1992. Much of this decline may be attributed to a decrease in military procurement. (U.S. Department of Commerce, 1994: 21-1) The value of shipments for the boat manufacturing and repair industry (SIC 3732) has fluctuated throughout the ten years shown. There was a large decline in the early 1990's when the economy was in a recession. However, value of shipments has been steadily increasing since then, and by 1997 was close to its pre-recession peak value of shipments.

Table 2-5: Industry Value of Shipments 1987-1996 (Millions of $)										
SIC	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
3731-Ships	8,504	8,810	9,397	10,915	10,935	10,381	9,801	9,877	9,544	9,811
Annual % Change		3.6%	6.7%	16.2%	0.2%	-5.1%	-5.6%	0.8%	-3.4%	2.8%
3732-Boats	5,353	5,935	5,739	4,998	3,676	4,599	4,975	5,334	5,640	5,823
Annual % Change		10.9%	-3.3%	-12.9%	-26.5%	25.1%	8.2%	7.2%	5.7%	3.2%
Source: U.S. Department of Commerce, 1992 and 1996a.										

2.4 Foreign Trade

Table 2-6 presents the value of imports and exports for both the boat manufacturing and repair industry (SIC 3732) and the shipbuilding and repair industry (SIC 3731) for 1989 to 1996. For SIC 3732, exports today are only one percent greater than they were in 1989. Since 1990, exports have declined every year except 1995, during which they rebounded almost 30% only to decline again in 1996. The share of exports to the total value of shipments declined steadily from a high of almost 21% in 1991, to a low of about 9.5% in 1994. In 1995, export share grew slightly, to 11.7%. In contrast, the value of boat imports has been rising since 1991, and in 1996 totaled almost $1 billion. As a percent of the total value of shipments of the boat building industry, imports have been steadily climbing since 1992, from 5.5%, to over 14% in 1996.

Boat imports come primarily from Canada and Japan. The U.S. imported over $274 million in boats from Canada and over $106 million from Japan in 1995. (Boating Industry Magazine, 1995: 7) Much of the increase in U.S. imports is attributable to personal watercraft imports from Canada. (U.S. Department of Commerce, 1994: 37-12) The bulk of U.S. exports also go to Canada, which received a total of almost $140 million in exports from the U.S. in 1995. (Boating Industry Magazine, 1995: 7)

In the shipbuilding and repair industry (SIC 3731), imports fluctuate from year to year. Exports also fluctuate, but to a lesser degree. In 1996, the total value of imports and exports to value of shipments was only 4.1% of the total value of shipments for the ship building and repairing industry.

Table 2-6: Boat and Ship Imports and Exports 1989-1996 (Millions of $)								
	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Imports	145	14.8	14.4	50.9	517	12.4	29.4	54
Exports	313	434	321	652	379	595	483	346
Deficit/ surplus	168	419.2	306.6	601.1	-138	582.6	453.6	292
SIC 3732 Boat building and repair								
Imports	404	279	207	257	425	564	807	997
Exports	615	793	774	714	534	507	658	621
Deficit/ Surplus	211	514	567	457	109	-57	-149	-376
Source: U.S. Census Bureau. 1996c.								

Table 2-7 shows U.S. imports for consumption and U.S. exports for the different boat types from 1993 -1997 in constant 1997 dollars, and their percentage change from 1993-1997. Data were obtained from the International Trade Commission (ITC). The ITC collects data on exports and imports by boat type and size. In general, these data were directly comparable to the eight boat categories used in this analysis. However, the ITC classification does not include jet boats. The ITC classifies boats by the location and not type of engine. Thus, jet boats are included in the import and export data for inboard runabouts, sterndrives and outboards, depending on the location of the jet engine.

The U.S. primarily exports PWCs, sterndrives and inboard cruisers, based on the value of total exports. These three products accounted for 68% of the value of all boat exports in 1997. The U.S. primarily imports PWCs and inboard cruisers. These two products accounted for 74.2% of the value of total boat imports in 1997. While still relatively small in value, the outboard, canoe and inboard runabout market segments showed remarkable growth in imports over the years 1993 to 1997. Imports of outboards grew by 172%, imports of canoes grew by 112% and reported imports of inboard runabout grew by 235%. However, the growth in inboard runabout imports is likely to be the result of the ITC classification of jet boats as inboard runabouts.

Table 2-7: U.S. Imports for Consumption & U.S. Domestic Exports 1993-1997 (Thousands of 1997 $)												
	Exports					% change 1993-1997	Imports					% change 1993-1997
BOAT TYPE	**1993**	**1994**	**1995**	**1996**	**1997**		**1993**	**1994**	**1995**	**1996**	**1997**	
Outboard Boats	$55,416	$48,055	$40,524	$42,953	$59,331	7.1%	$4,531	$6,482	$8,660	$11,582	$11,096	144.9%
PWC	$118,953	$107,648	$136,880	$108,287	$123,111	3.5%	$255,617	$364,848	$535,121	$602,949	$382,370	49.6%
Canoes	$9,323	$9,939	$9,720	$12,349	$10,651	14.2%	$7,030	$8,734	$10,699	$11,412	$13,475	91.7%
Sterndrive Powerboats	$141,488	$146,452	$196,128	$195,717	$199,364	40.9%	$20,290	$29,805	$31,598	$28,688	$27,051	33.3%
Inboard Runabouts *	$69,696	$73,296	$74,840	$76,328	$78,347	12.4%	$18,639	$22,717	$27,614	$33,527	$40,969	199.8%
Inboard Cruisers	$135,425	$103,540	$127,795	$101,112	$134,860	-0.4%	$97,741	$123,308	$151,253	$145,265	$90,184	-7.7%
Jet Boats	NA	--	$26,365	$16,740	$9,769	NA	--	$100	$31,572	$105,388	$180,528	NA
Sailboats	$63,083	$60,349	$80,468	$81,309	$57,405	-9.9%	$67,821	$55,189	$50,734	$81,199	$68,006	0.3%
Total	$593,384	$549,279	$692,720	$634,795	$672,838		$471,669	$611,183	$847,251	$1,020,010	$813,679	

Source: U.S. International Trade Commission, 1998; provided by fax. Translated to 1997 dollars using the Consumer Price Index (CPI).
* Trade data for the Inboard Runabout market are inconsistent before and after 1995. This is largely due to a change in classification by the ITC (including potential inclusion of jet boats in the trade data for this sector) and does not represent a real increase in trade in inboard runabouts. The percentage changes reported here reflect the data from 1993-1995 only.

2.5 Estimated Domestic Production by Boat Type

The following subsections present historical data on domestic production for each of the boat markets. Domestic production is not reported directly, but was calculated by subtracting imports from domestic sales and adding imports.

Information on domestic sales, imports and exports are listed for each boat market. Data on domestic sales were obtained from the National Marine Manufacturers Association (NMMA, 1996) while trade data were obtained from the International Trade Commission (ITC 1998). An estimate of the value of net domestic production by boat type was calculated as domestic sales plus exports minus imports. This value of production was used to estimate the number of boats produced, dividing by the average price of boat for that boat type. Table 2-8 presents the estimated domestic production by boat type for the years 1993-1997. Figures 2-2 through 2-9 graph the trends in domestic sales from 1988 to 1997, as well as exports, imports and estimated net domestic production by boat type for the period 1993-1997. Domestic sales data for sailboats, PWCs, jet boats, and canoes are presented for the longest time series available (1991-1997 for sailboats, 1992-1997 for PWCs and jet boats, and 1993-1997 for canoes). Note that data are reported by NMMA on the number of boats produced each year, but the estimates of number of boats imported, exported and produced domestically are derived from reported dollar values, translated into constant dollar terms and divided by 1997 average boat prices by boat type. The latter series are therefore approximations and subject to some error. The trends in each market are summarized separately below.

Table 2-8 Trends in Estimated Domestic Production by Boat Type, 1993-1997 (1,000s of units)

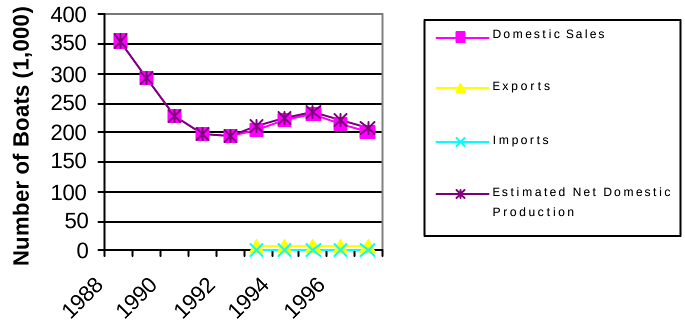
	1993	1994	1995	1996	1997
Outboards	212	226	235	219	207
PWCs	86	102	138	114	136
Canoes	NA	102	96	94	99
Sterndrives	80	95	101	102	100
Inboard Runabouts*	7	7	7	6	6
Inboard Cruisers	4	4	5	5	6
Jet Boats**	8	9	15	14	12
Sailboats	12	13	15	14	14

* Data on imports and exports for the years 1996 and 1997 differ substantially from previous years due to changes in classification of boats. For the remainder of this profile, the data on domestic production from 1996 and 1997 are not used for the inboard runabouts market.
** Data on imports and exports of jet boats are not available as a separate category from the ITC. The ITC classifies boats based on the location and not the type of engine. Thus, jet boats are included in the data on inboard runabouts, sterndrives, and outboards depending on the location of the engine. The data presented here represent domestic *sales* of jet boats only.

2.5.1 Outboards

Domestic sales of outboards declined steadily and rapidly from 1988-1991. The 1991 number of boats sold was just over half of the number sold in 1988. Since 1991, domestic sales have been relatively flat. Both exports and imports have been flat since 1993 and are not significant compared with domestic sales in this sector.

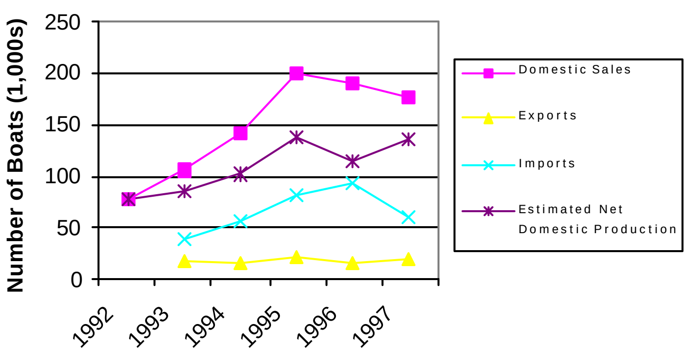
Figure 2-2
Outboard Boats
1988-1997



2.5.2 PWCs

Domestic sales of PWCs rose rapidly from 1992 to 1995 and have been declining since then. PWCs were introduced to the boat market in the early 1990s and the initial rapid growth in sales is consistent with an emerging market segment. International trade is a significant factor in this sector. Exports of PWCs have fluctuated between 16,000 and 23,000 boats per year. Imports rose substantially from an estimated 40,000 boats in 1993 to 93,000 boats in 1996. Imports fell off significantly in 1997 to only 59,000 boats. Estimated net domestic production of PWCs has increased roughly 60% since 1992.

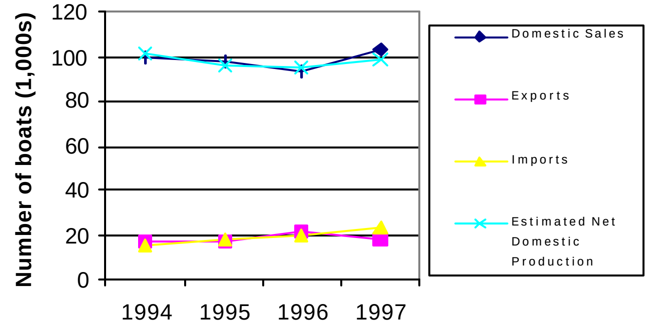
Figure 2-3
PWCs
1992-1997



2.5.3 Canoes

Canoe data are available from 1993 to 1997. The market for canoes has remained relatively stable over that time frame. Domestic sales fluctuate around 100,000 boats per year. Exports fluctuate between 16,000 and 21,0000 canoes per year and imports have been increasing steadily.

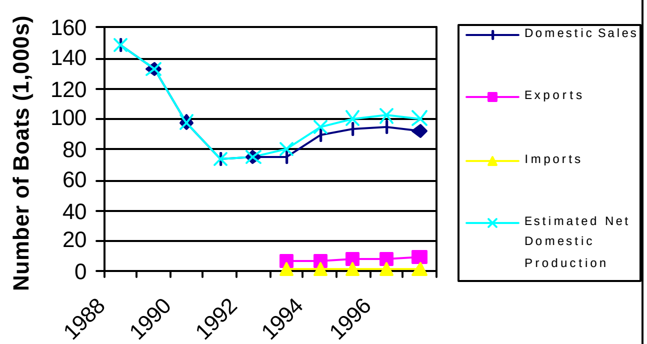
Figure 2-4
Canoes
1994-1997



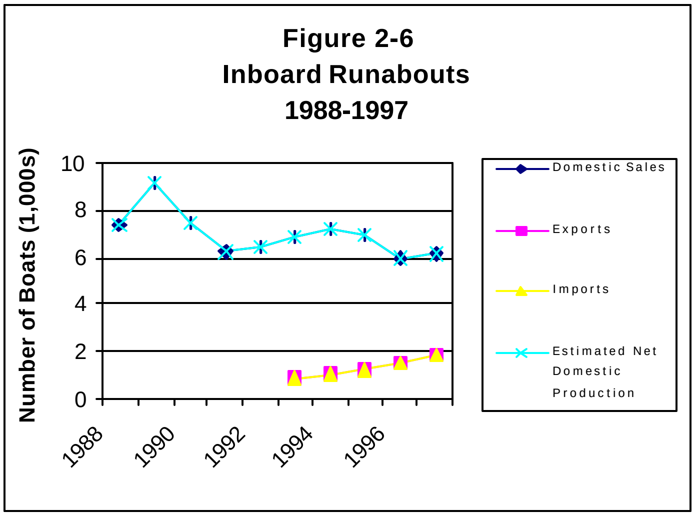
2.5.4 Sterndrives

Domestic sales of sterndrive powerboats fell significantly in the late 1980s and early 1990s. Sales rose again slightly from 1993 to 1994 and have remained relatively flat since 1994. International trade does not play a significant role in this sector, although exports generally exceed imports.

Figure 2-5
Sterndrives
1988-1997

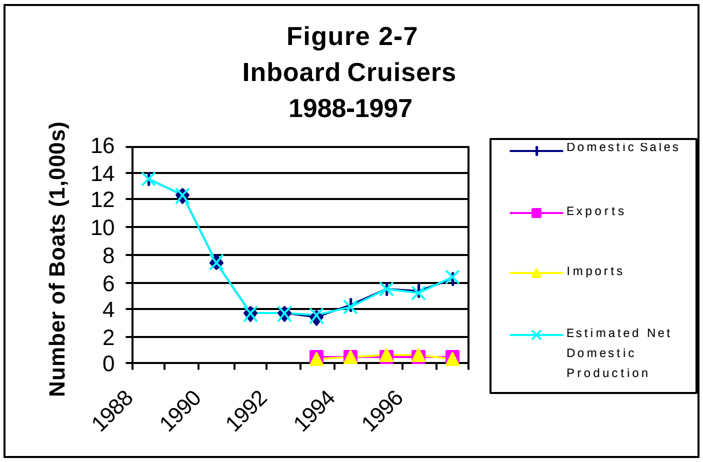


2.5.5 Inboard Runabouts



Domestic sales of inboard runabouts have been relatively stable since 1991. Exports have also been steady, while imports of inboard runabouts appear to have increased substantially in 1996 and 1997. There is no qualitative evidence in the trade literature to confirm this growth rate in imports for the inboard runabout sector. It is suspected that this apparent increase is partially due to changes in classification of the international trade statistics for this category, including potential inclusion of jet boat imports and exports. Data on domestic production are therefore not estimated for inboard runabouts after 1995.

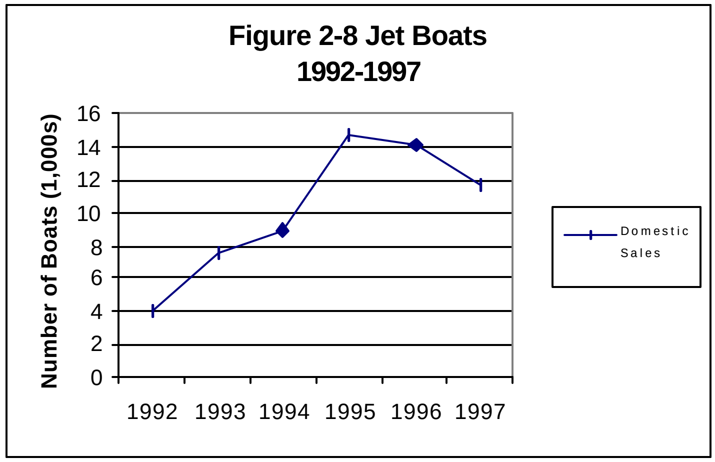
2.5.6 Inboard Cruisers



The inboard cruiser market was hurt severely by the recession of the early 1990s and the imposition of the luxury tax in 1990. Domestic sales of inboard cruisers plummeted from an estimated 14,000 boats in 1988 to 4,000 boats in 1991. The inboard cruiser sector has rebounded slightly since 1991 but sales are still well below the highs of the late 1980s. International trade plays only a limited role in this sector.

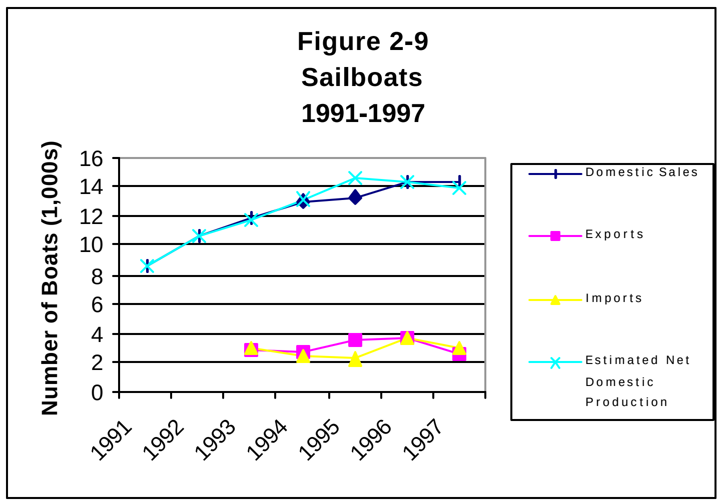
2.5.7 Jet Boats

Domestic sales of jet boats increased sharply from 1994 to 1995 and have fallen off somewhat since then. While no specific international trade data were available on jet boats from the ITC, qualitative evidence indicates that the imports and exports of this boat type have been rising over recent years.



2.5.8 Sailboats

Sales data on the sailboat sector are available only from 1991 to 1996. In general, the sailboat sector has seen a modest but steady growth in domestic sales over this period. Exports and imports have fluctuated slightly but generally have remained between and estimated 2,000 and 4,000 boats per year for exports and between 2,000 and 3,000 units per year for imports.



2.6 Vertical Integration and Specialization

Vertical integration refers to the extent to which a single firm produces raw material or intermediate inputs as well as final goods and services, as opposed to specializing in one stage of production. Specialization refers to the diversity of product lines produced more generally. To the extent that a regulation affects only a small part of a firm's production, that firm may be better able to adjust production to minimize compliance costs or may be better able to absorb the costs (other things being equal.) On the other hand, a vertically-integrated firm which produces an input that is subject to regulation may bear a greater burden from the regulation than a competitor that purchases its inputs and can more readily switch to inputs not affected by the regulation. The extent of vertical and specialization may also affect a firm's supply response in the face of compliance costs. For example, a producer making multiple products using the same production process being addressed by a regulation may have more ability to recover some of its costs through price increases, if it faces inelastic demand in at least some of those markets, than a competitor that is specialized in one of the product markets with more elastic demand. The effect of vertical and horizontal integration on relative compliance costs and on responses to regulation is a complex subject that depends on the characteristics of each industry.

Many boat manufacturing facilities are somewhat vertically integrated in that they manufacture boat parts, assemble the parts, and install the electronic, mechanical, and engine systems. However, some facilities (e.g., many outboard boat manufacturers) specialize in the manufacture of boat bodies or hulls, which are sold without engines or extensive fittings. Virtually all boat manufacturers purchase some inputs, including resins and gels, engines, and mechanical and electrical components, from outside suppliers. In particular, boat manufacturers do not produce the HAP-containing materials that will be affected by the rule, so that the cost of switching materials should not vary much among producers.

Specialization ratios provide a measure of the extent to which an industry specializes in production of its primary product. A specialization ratio is provided by the U.S. Department of Commerce for every industry, and represents the ratio of primary product shipments to total products for the establishments classified in the industry. (U.S. Department of Commerce, 1992: A-4) The specialization ratio for the boat building and repairing industry (SIC 3742) was 99% in 1987 and 98% in 1992, the last year for which these data are available. (U.S. Department of Commerce, 1993: 1-63) This indicates that facilities in this industry are highly specialized in the production of boats, rather than producing diverse products at the same site. Firms owning those facilities may be more diversified, however. Brunswick, which produces boats and a variety of other recreational products (such as bowling equipment), and Kawaskai, Yamaha and Bombadier,which produce motorcycles and snowmobiles as well as jet boats, are prominent examples.

For the ship building and repairing industry, the specialization ratio was 99% for both 1987 and 1992. (U.S. Department of Commerce, 1993: 1-63) However, only a very small percentage of facilities (about 4%) in this SIC will likely be affected by this regulation.

2.7 Market Concentration & Competitiveness

U.S boat manufacturing is relatively concentrated. The three largest boat manufacturing companies, in order of market share, are Brunswick Corporation, Genmar Industries and Outboard Marine Corporation. These three companies account for more than 60% of the total pleasure boat market, with the majority of remaining producers accounting for at most a 1% to 2% market share each. (SRI International, 1996). However, U.S. boat producers face foreign competition in most markets, and also compete with a variety of recreational products and other consumer goods for consumer purchases. (See Section 2.9.1 below.) Therefore, U.S. boat manufacturers face substantial competition in the broader market for recreational goods, and are not likely to be able to exercise substantial market power or to earn excess profits.

2.8 Costs and Profit Margins

Table 2-9 below shows the ratio of cost of materials and payroll to the value of shipments for both the boat building and repair industry (SIC 3732) and ship building and repair (SIC 3731) industry[2]. While this ratio includes most costs, such as all forms of compensation, materials, fuels, etc., it does not include all costs. Other expenses, such as taxes and interest expenses, are not reflected in these figures. The ratio of these expenses to shipments have remained relatively constant, increasing slightly in 1996. The boat industry ratio has declined slightly from a high of 80% in 1993.

Table 2-9: Boat and Ship Costs and Value of Shipments 1990-1996 (Millions of $)

	1990	1991	1992	1993	1994	1995	1996
SIC 3731 Ship building and repair							
Shipments	10,915	10,935	10,381	9,801	9,865	9,544	9,811
Material Costs	4,493	4,495	4,065	4,007	4,103	3,866	4,365
Payroll	3,606	3,680	3,624	3,366	3,326	3,222	3,175
Ratio of material and payroll/shipments	74%	75%	74%	75%	75%	74%	77%
Shipments	4,998	3,676	4,599	4,940	5,334	5,640	5,823
Material Costs	2,792	2,058	2,609	2,910	3,075	3,237	3,396
Payroll	1,061	824	1,006	1,026	1,081	1,098	1,177
Ratio of material and payroll/shipments	77%	78%	79%	80%	78%	77%	78%

Source: U.S. Department of Commerce, 1992 and 1996a.

The financial condition of producers affects their ability to absorb the costs associated with the MACT rule. Each year, Dun and Bradstreet (D&B) publishes *Industry Norms and Key Business Ratios* (Dun and Bradstreet, 1998), which reports certain financial ratios for a sample of firms in different industries. Tables 2-10 and 2-11 present an analysis of selected solvency and profitability ratios for 103 establishments in SIC 3732 from the 1998

[2]Cost of materials refers to direct charges actually paid or payable for items consumed or put into production during the year, including freight charges and other direct charges incurred by the establishment in acquiring these materials. Value of shipments measures the received or receivable net selling values, f.o.b. plant (exclusive of freight and taxes), of all products shipped, both primary and secondary, as well as miscellaneous receipts. This ratio represents a rough measure of profitability, with a higher ratio representing lower profitability.

D&B report.

Solvency, or liquidity, measurements are significant in evaluating a company's ability to meet short and long-term obligations. These figures are of primary interest to credit managers of commercial companies and financial institutions. Exhibit 2-10 below presents three solvency ratios for SIC 3732 and includes a brief analysis of these ratios, based on D&B's guidelines for interpreting the ratios.

Exhibit 2-10: 1998 Solvency Ratios for SIC 3732		
Ratios	**Description**	**1998 Median***
Quick Ratio (Cash + Receivables to Current Liabilities)	Indicates the protection afforded short term creditors, showing the size of liquid assets available to cover debt that falls due within one year.	**0.6** **Analysis:** A ratio of 1 to 1 (1.0) implies that the industry is in a liquid condition. A ratio of less than 1.0 is considered acceptable for short periods of time.
Current Ratio (Current Assets to Current Liabilities)	Measures the degree to which current assets cover liabilities, indicating the ability to retire current liabilities and cover any possible shrinkage in the value of current assets.	**1.9** **Analysis:** A ratio of 2 to 1 (2.0) or better is considered good.
Current Liabilites to Net Worth	Shows the level of risks creditors are assuming with funds that the owners have used to make permanent investments.	**64.0%** **Analysis:** This percentage is considered average. Care should be exercised when extending credit to any firm with current liabilities exceeding 66.6% of net worth.
*Analysis is based on Dun & Bradstreet guidelines for interpreting financial ratios. Dun and Bradstreet, 1998.		

Profitability ratios show how successful a business is in earning returns on invested equity and assets. Exhibit 2-11 below presents three profitability ratios for SIC 3732 and includes a brief analysis of these ratios.

Exhibit 2-11: Profitability Ratios for SIC 3732		
Ratios	**Description**	**Median for 1998***
Return on Sales (Profit Margin)	Shows the profits earned per dollar of sales as a measure of the efficiency of the operation. Indicates the ability of the firms to achieve satisfactory profits for owners and withstand adverse business conditions.	**3.1%** **Analysis:** Higher return on sales margins represent higher profits and a greater ability to absorb compliance costs. A return on sales ratio of 3.1% is considered respectable.
Return on Assets	Measures firm profitability by comparing operating profits with assets available to earn a return. Indicates whether firms are using their assets efficiently.	**7.0%** **Analysis:** Companies efficiently using their assets will have a relatively high return. Seven percent is represents a healthy return on assets.
Return on Net Worth (Return on Equity)	Analyzes the ability of management to realize an adequate return on owners' investments.	**13.4%** **Analysis:** Generally, a relationship of at least 10 percent is regarded as a desirable objective for providing dividends plus funds for future growth.

*Analysis is based on Dun & Bradstreet guidelines for interpreting financial ratios. Dun and Bradstreet, 1998.

2.9 Industry Forecasts

This section discusses expected future trends in domestic sales and production, with an emphasis on projecting the number of new boat manufacturing facilities that might be constructed over the next five years. Any new boat manufacturing facilities, or major expansions of existing facilities, would be subject to the boat manufacturing NESHAP.

The demand for boats is highly correlated with two potentially volatile and difficult to predict phenomena: the business cycle (and its impacts on personal wealth) and the weather. These correlations add uncertainty to any production forecast for this industry. Since recreational boats are a luxury good, demand fluctuates with the business cycle. Recent growth in sales of high-end boats, such as inboard cruisers and yachts, has been attributed in large part to the wealth effect created by a strong stock market. Forecasting long term boat sales based on the sales patterns during a bull market is likely to skew forecasts and to predict more new facilities building more expensive boats. For similar reasons, the retail demand for boats within a given season may not be indicative of future sales because sales of boats within one or two seasons are somewhat correlated with the weather in those seasons. Changes in retail demand due to the weather may have a current as well as a lagging impact on the demand for and production of boats. If the weather is predicted far enough in advance (for example, El NiÁo), then current production may be reduced in anticipation of lower demand. If poor weather is unexpected, current production may not adjust, increasing retail inventories and decreasing production the following season.

Given that the demand for boats is correlated with the business cycle and the weather, rational expectations would suggest that boat manufacturers will react cautiously to changes in current consumption when determining future production. It is expected that increases in demand resulting from unexpectedly good weather or an unexpectedly good economy will be met initially through increased production at existing facilities rather than construction of new capacity, due to the investment associated with establishing a new facility and uncertainty about the sustainability of increased sales. Thus, the key to predicting the construction of new boat manufacturing facilities is predicting sustainable shifts in consumer behavior and preferences. Owners are likely to consider several years' worth of sales data when deciding whether to add capacity. Owners are also likely to consider market research revealing changes in consumer preferences or other consumer characteristics that indicate which segments of the recreational boating industry are likely to continue to grow.

2.9.1 Qualitative Forecasts for the Boat Manufacturing Industry

While specific predictions of sales by sector are not available, a review of several market analyses provided general forecasts for the industry. These sources were used in combination with the historical trend data presented in Section 2.2.3 to project sales to the year 2002. These general trends are summarized below.

- Boats have fallen in consumers' ranking of desired luxury goods. (DeFranco& Porter, 1996: 43) In consumers' ranking of 17 luxury items (including new cars, vacations, remodeled home etc.), boats fell from sixth in 1984 to sixteenth in 1995 and rebounded slightly to fifteenth in 1996. The increase in boat sales over the past few years is likely the result of households purchasing more of all luxury items rather than a change in the relative preference for boats. To the extent that households will purchase any luxury items under less robust economic conditions, they would likely substitute away from boats towards the more highly ranked luxury items.

- PWCs and jet boats have introduced new consumers to the recreational boating market. (Kurowki, 1996: 12) PWCs and jet boats have attracted younger consumers to the recreational boating market. These watercraft are less expensive and more mobile than traditional boats. Sales of PWCs and jet boats have been increasing since their introduction, and sales are expected to continue to grow, albeit at a slightly lower rate than in the last few years.

- The market for used boats is increasingly shaping demand for new boats. (DeFranco, 1996: 10) Consumers are becoming more sophisticated in their boat purchases and the boat market is beginning to resemble the automobile market. Among other trends, consumers are demanding more financing options, including leases. Used boat sales have increased as a percent of total boat sales. A strong used boat market can have various implications for boat manufacturers. To the extent that consumers are trading in used boats for new boats, increased sales of used boats may actually reflect increased demand for new boats. However, used boats may also compete with new boat sales if total demand for boating is not increasing.

- Recent sales figures indicate a trend towards high-end boats with mid-size boats suffering a decline. (DeFranco & Porter, 1996: 43) Luxury boats have been faring well, but sales of mid-size boats targeted at middle class families have been falling. High credit card, mortgage, automobile and other consumer debt is said to be partially responsible for the declining demand for boats by middle class households.

- Exports of boats have been steady while imports have risen substantially. (Boating Industry Magazine, 1997: S1) Imports of PWCs and jet boats (primarily from Canada and Japan) have been largely responsible for the imbalance of trade in the boat manufacturing industry. Exports of boats depend on the weather and businesses cycles as well as consumer preferences in other countries. The European and Japanese economies have not been experiencing high levels of economic growth as the U.S. has over the past few years, and this is likely responsible for the stagnation of exports.

˜ U.S. Industry and Trade Outlook predicts that recreational boat sales will grow at 2% annually over five years. (U.S. Department of Commerce, 1998: 39-17) Imports are expected to increase by four percent annually and exports will increase by six percent annually.

2.9.2   Forecasts of Domestic Boat Production

The information on historical trends in the boat manufacturing industry outlined in Section 2.2.3 was combined with the qualitative forecasts for the boating sector in Section 2.2.8 to project growth in the industry to 2002. In order to determine the growth in net domestic production for the next five years, the quantitative and qualitative information on sales trends was used to determine a high and a low projected rate of growth in domestic sales for each boat sector over the next five years. Total exports for the boat sector based on past export trends was then projected. Finally, the import share of domestic sales was projected based on past trends and qualitative information on import growth or decline.   Net domestic production was then calculated as domestic sales minus the import share plus exports. The change in net domestic production is divided by the average number of boats produced at a single facility to obtain an estimate of the number of new boat manufacturing facilities that may be in operation by 2002. Note that we are assuming that all growth in production requires new facilities. In reality some of the growth in production will be absorbed by current facilities. Thus, these projections should be viewed as upper-bound estimates of the number of new facilities.

Table 2-12 summarizes the forecasts for all eight boat types. As that table shows, only modest overall growth is expected in the number of facilities (major sources) that might be subject to the propsoed NESHAP, ranging from a high of 17 new facilities by the year 2002 to a low of three additional facilities in that year. Projections for each boat type are presented separately below.

Table 2-12: Projected Growth in Annual Domestic Production by Boat Type						
	Low Growth Rate	High Growth Rate	Low Change in Net Domestic Production by 2002	High Change in Net Domestic Production by 2002	Low Number of Projected New Major Sources by 2002**, ***	High Number of Projected New Major Sources by 2002**, ***
Outboard	0.0%	1.5%	(387)	17,060	0	6
PWC	3.0%	10.0%	5,590	53,240	0	1
Canoes	0.0%	2.0%	(2,078)	6,117	0	0
Sterndrive	-1.0%	1.0%	(4,310)	4,772	(1)	1
Inboard Cruisers	0.0%	3.0%	(47)	897	0	4
Inboard Runabouts	-1.0%	1.0%	(-343)	157	0	0
Jet Boats*	2.0%	10.0%	8,304	10,674	1	1
Sailboats	1.0%	2.0%	4,596	5,172	3	4
Total			11,325	98,090	3	17

* Projections for jet boats are of domestic *sales* and not domestic production because import and export data are not available.
** Represent the maximum number of new facilities because all growth in sales is assumed to be from new facilities, rather than from expanded production at existing facilities.
*** Calculated assuming that the percent of domestic production produced by major sources remains the same as currently.

2.9.2a Outboards

Domestic sales of outboard boats fell over 40% from 1988-1992. However, in the past five years (1993-1997) both domestic sales and annual domestic production have been relatively constant. Qualitative information on boat sales suggests a decline in the ranking of boats among leisure products and the general trend away from smaller and mid-size boats. Given these trends, a low forecast for domestic sales of zero growth and a high forecast of 1.5% was used. Exports are forecast to remain constant at approximately 8,000 boats per year. The import share is projected to remain relatively constant at 0.8% of domestic sales.

Using the low forecast results in a decline in domestic production of outboards of almost 400 boats. The decline is caused by the slight increase in the import share. Using the high forecast rate results in a total increase in annual domestic production of 17,000 boats by 2002.

2.9.2b PWCs

Over the six years for which data are available for PWCs, net domestic production has grown at an average annual rate of 12.0%. Domestic production of PWCs rose quickly shortly after PWCs entered the recreational boat market and have appeared to level off as this market segment has matured. Sales over the last two years have actually declined. Given these recent trends, a low forecast growth rate for domestic sales of three percent and a high growth rate of 10% was used. Exports are assumed constant at 19,000 boats per year while the import share is forecast to remain at about 40% of domestic sales.

Based on the low forecasted growth rate of three percent, annual domestic PWC production will increase by approximately 5,600 boats by 2002. Based on a high forecast growth rate of 10%, annual domestic PWC production will increase by approximately 53,000 boats by 2002.

2.9.2c Canoes

The canoe market has remained stable over the past 5 years. Zero growth is used as a low projection of domestic sales and two percent growth as a high projection. Exports are projected to remain constant at 18,000 boats per year. The import share has been steadily rising in the sector and it is projected that it will increase to 24% of domestic sales by 2002.

Using the low forecast, a decline in annual domestic production in this sector is projected. Using the high forecast, an increase in domestic production of approximately 6,100 boats per year by 2002 is projected.

2.9.2d Sterndrives

Over the ten year period from 1988-1997, sterndrive production has fallen by over 30% (an average of 3.2% per year). However, most of that decline occurred in the years 1988 to 1991. Since 1994, sterndrive production has been fairly steady at roughly 100,000 boats produced per year. The low forecast for annual domestic sales in this sector is negative one percent and the high forecast growth rate is one percent. Exports in this sector are projected to hold steady at 9,000 boats per year. The import share of domestic sales is also expected to hold steady at 1.3% of domestic sales.

Using the low forecast growth rate leads to a decline in annual domestic production of roughly 4,300 boats. The high forecast growth rate results in an increase in annual domestic production of 4,700 boats.

2.9.2e Inboard Runabouts

Domestic sales of inboard runabouts decreased annually by an average rate of 1.8% per year from 1988 to 1997. Trends in trade data are skewed by the substantial reported increase in exports and imports in 1996 and 1997. As previously mentioned, these increases are not substantiated in the trade literature. We use negative one percent as a low forecast for growth in domestic sales for this sector and one percent as a high estimate. Given the previously mentioned difficulties with the international trade data for this sector we assume that exports will remain constant at the 1995 rate of 1,000 boats per year and that the import share will also remain at the 1995 rate of 18% of domestic sales.

Using the low growth rate, a decline in domestic production of approximately 340 boats in this sector is projected for the year 2002. Based on the high growth rate of one percent, a very slight increase in production of approximately 150 boats is projected for 2002.

2.9.2f Inboard Cruisers

Domestic sales of inboard cruisers fell over 50% from 1988 to 1997 (an average of -5.3% annually). As with the sterndrive market, most of the decline in inboard cruiser production occurred in the years 1988-1991. Recent sales have been steadily increasing. Inboard cruisers are a luxury boat and the recent increase in sales is thought to be a function of the wealth effect created by a strong stock market, as well as the 1993 repeal of the luxury tax on boats valued at over $100,000. Because of the potential volatility in the stock market, zero growth is used as the low forecast. As a high forecast, an increase in sales of inboard cruisers of three percent is assumed. These two growth rates reflect the recent history of increased sales but assumes a leveling off of the growth rate based on potential volatility of stock market returns. Exports in the inboard cruiser segment are assumed constant at 500 boats per year. The import share of domestic sales was approximately 10% for the early part of this decade. In 1997, it fell to 5.6%. A six percent import share for this sector is projected to 2002.

Using the lowt growth rate, a slight decline in production is predicted for this sector. Based on the high growth rate of three percent, an increase in annual production of almost 900 boats by the year 2002 is projected.

2.9.2g Jet Boats

Jet boat sales increased substantially after introduction in the early 1990s and have declined in recent years. No reliable information was available on exports or imports of jet boats. A high growth in domestic sales of 10% is estimated and low growth rate of two percent for this sector.

Using the low two percent growth rate, it is expected that an additional 11,200 jet boats per year will be sold in the U.S. by 2002. Based on the high forecast, there will be an additional 17,100 jet boats sold annually by 2002. Some of these jet boats are expected to be imported and the increase in annual domestic production could be less than the increase in domestic sales.

2.9.2h Sailboats

Data on sailboat production were only available from 1991-1997. Domestic sales of sailboats rose substantially between 1992 and 1994 but have tapered off since. A low forecast of one percent was used, with a high forecast rate of two percent. Exports are projected to remain at about 7,000 boats per year and the import share is projected to remain constant at 24% of domestic sales.

Using a one percent growth rate, it is predicted that a growth of annual production of 4,600 boats by 2002 will occur. Based on the high growth rate of two percent, sailboat production will increase by 5,200 boats over that time frame.

3. Compliance Costs

3.1 Introduction

The NESHAP for the Boat Manufacturing source category regulates emissions of hazardous air pollutants (HAPs) resulting from the boat manufacturing process. Facilities that are considered major sources of HAP emissions in this industry will be required to change their material use and/or production processes to attain a level of emissions control equal to the maximum achievable control technology (MACT) floor. Costs of reducing HAP emissions to the MACT floor are estimated for each of these potentially affected facilities.

The economic impact analysis (EIA) relies on the estimate of the facility-level costs of complying with the regulation to determine how the producers and consumers in the market will react to the regulation (See Chapter 4) . This chapter summarizes the procedure used to estimate facility-level compliance costs. The document entitled, "Final Cost Procedures Documentation Memorandum" (U.S. EPA, 1999) contains a detailed description of how facility-level compliance costs are calculated.

The compliance cost estimation procedure has the following steps:

- Determine which facilities are likely to be required to comply with the regulation. EPA used data from the Toxic Release Inventory (TRI) to determine which boat manufacturing facilities were likely to be required to comply with the regulation. EPA assumed that all facilities in SIC 3732 "Boat Manufacturing and Repair" that are major sources of styrene emissions in TRI will be required to comply with the rule.

- Determine potential emission points, where an emission point is defined as a material that contains HAPs and/or a production process that releases HAPs.

- For each affected facility, determine if current materials and processes meet the MACT standards at each emissions point. If current materials and/or processes do not meet the MACT standard then facilities must switch to materials with a lower HAP content and/or processes that release lower levels of HAPs.

- For each affected facility, determine the total cost of switching from materials with higher HAP content to materials with lower HAP content and the cost of changing production processes to release lower levels of HAPs.

- Transform the total facility-level compliance cost into total fixed costs and variable costs per boat produced. These are the two facility-level cost components used as inputs to the EIA.

Section 3.2 lists the different emissions points and describes how EPA determined if a facility's current materials and/or processes meet the MACT floor for HAP emissions. The costs of switching materials and processes are described in Section 3.3. Section 3.4 describes the methodology for converting total compliance costs into fixed costs and variable costs per boat produced.

3.2 Facility-level Emissions

EPA determined that there were 12 potential emission points for HAPs in the boat manufacturing process. These

12 emissions points fall in two broad categories: production materials that contain HAPs, and production processes that release HAPs.

- Production materials the contain HAPs:
  - Production resin
  - Tooling resin
  - Pigmented gel coat
  - Clear gel coat
  - Basecoat gel coat
  - Tooling gel coat
  - Resin and gel coat application equipment cleaning solvents
  - Resin and gel coat mixing container covers
  - Aluminum wipedown and surface preparation solvents
  - Aluminum boat hull and deck coatings
  - Carpet and fabric adhesives
- Production processes the release HAPs:
  - Resin atomized spray guns

In addition to these 12 emissions points, EPA estimated monitoring, recordkeeping, and reporting (MRR) costs and the cost of testing new production materials to insure that they will meet performance standards.

The facility-level cost of compliance is estimated as the sum of the costs of complying with the MACT floor at each of the potential emissions points. For the purpose of this analysis, facilities that do not meet the MACT floor must switch to materials that contain lower levels of HAPs and/or switch to production processes that release lower levels of HAPS at *every* emission point for which current practices are not sufficient. Because the NESHAP will probably allow emissions averaging among some types of materials and processes some facilities may reduce their cost of complying with the rule by reducing emissions more than required at emissions points where reductions are achieved relatively inexpensively and reducing emissions less than required at emissions points where reductions are relatively costly. The estimated costs of complying with the NESHAP do not consider any potential cost reductions from emissions averaging. It is difficult to determine how particular facilities will implement the variety of options of emissions averaging or whether they will use it to achieve greater operating flexibility at the same regulatory cost. Therefore, the estimated compliance costs are an upper-bound estimate in that we assume that no facilities will use emissions averaging.

EPA conducted a survey of approximately one-third of the major source boat manufacturing facilities. Detailed data on the specific materials and the HAP content of those materials used was obtained for each of the surveyed facilities. The survey also requested information on the amount of material used or the number of processes used for the surveyed facilities. Thus, for approximately one-third of the affected facilities, we could use survey data to determine whether current materials and/or processes meet the MACT floor for HAPs emissions at each emission point. If a facility did not meet the HAP floor at a given emissions point, we used data from the survey to determine the amount of material or the number of production processes that would need to be changed to insure compliance with the rule.

For the remaining two-thirds of the facilities, we did not have data on the type and HAP content of materials currently used nor did we have information on the amount of materials and number of processes used. For the bulk of facilities, we only had data on reported styrene emissions in TRI. For these non-surveyed facilities we estimated both the HAP content of the materials used and the amount of material and number of processes used as discussed below.

- **HAP content:** Because the HAP content of the materials currently used by non-surveyed facilities is unknown, the analysis assumes that all of the non-survey facilities will need to switch to lower HAP materials, or change processes to comply with standards based on the MACT floor at all 12 emissions points. This approach overestimates the costs of compliance for at least some of the non-surveyed facilities.

- **Amount of material/processes used:** EPA used data on the amount of materials and processes from the surveyed facilities and data on total styrene emissions levels from both the surveyed and non-surveyed facilities to impute the amount of materials and the number of processes used by the non-surveyed facilities. For each of the 11 materials-based emissions points, EPA estimated a relationship between total styrene emissions and total material use for the surveyed facilities. This relationship was then applied to the non-surveyed facilities based on the total styrene emissions reported in TRI to obtain an estimate of the amount of materials used by the non-surveyed facilities. For the process-based emission point, EPA used a similar estimation procedure to infer the number of atomized resin spray guns used at non-surveyed facilities.

3.3 Compliance Costs

There are four categories of compliance costs that a facility could potentially incur under the rule:

- Switching production materials,
- Changing production processes;
- Monitoring, recordkeeping and reporting; and
- Testing new production materials.

Eleven of the 12 emissions points listed in Section 3.2 involve potential changes in materials used by an affected facility. The procedure used to estimate the cost of switching to materials with lower HAP content is addressed in Section 3.3.1. One of the emissions points–resin application technology–is a process-based emission point and is addressed separately in Section 3.3.2 below. The estimation of monitoring, recordkeeping, and reporting (MRR) costs is addressed in Section 3.3.3. Materials testing costs are the subject of Section 3.3.4.

3.3.1 Materials Switching Costs

EPA estimated the facility-level materials costs at each emission point by determining what the cost of switching to materials with a lower HAP content would be and then summing the switching costs for all emission points. If a facility's current materials satisfy the MACT floor at a given emission point then the switching cost is zero for that particular emission point.

The cost of switching materials (e.g., resins) were estimated as the difference in list prices between materials with a higher HAP content and the lowest-priced material with a HAP content at or below the MACT floor. This cost difference was calculated separately for materials used at each emission point. The list prices were obtained from material vendors. The analysis uses list prices because actual prices are variable among facilities depending on the amount purchased, often according to proprietary pricing agreements.

For each emissions point, facilities were grouped into three categories based on the amount of information obtained by EPA on materials use and cost:

- Surveyed facilities for which the type of material, HAP content, and list price were known;
- Surveyed facilities for which the type of material and HAP content were known but for which the list price was not available; and
- Non-surveyed facilities.

For the surveyed facilities where the list price of current materials was known EPA calculated the switching cost as the cost of the current material minus the cost of the least-expensive material with a HAP content at or below the MACT floor.

For surveyed facilities where the price of the material currently used is unknown, EPA developed a default cost of switching. The default cost difference is the average cost difference between all materials with a HAP content above the MACT floor and the lowest priced material with a HAP content at or below the floor. For example, a default cost might be calculated as the average cost difference for all materials with a HAP content above 35% and the lowest priced material with a HAP content below 35%. The total amount of material used by surveyed facilities was multiplied by this default cost to obtain the total switching cost.

For non-surveyed facilities, EPA does not know the HAP content of the material currently used. The switching cost for non-surveyed facilities was imputed from the data from surveyed facilities. For each of the surveyed facilities EPA divided the total switching cost by the number of units of material used to obtain an average switching cost per unit of material used. The estimated amount of material used by a non-survey facility was then multiplied by this average switching cost per unit material used to estimate the cost of switching for non-surveyed facilities.

3.3.2 Process Change Costs

The only process change considered by the rule is a change in resin application technology from atomized spray guns to non-atomized flowcoaters. The cost of complying with the requirements for non-atomized resin application has four elements.

- The cost to switch from atomized resin spray guns to non-atomized resin flowcoaters.
- The cost savings from the reduced need for personal protective equipment (PPE) with non-atomized resin application system.
- The cost savings from reduced resin consumption because of the greater transfer efficiency of flowcoaters compared to spray guns.
- The cost savings from the reduced use of floor coverings associated with reduced resin overspray.

EPA estimated the cost of switching to flowcoaters from spray guns as the net annual difference in cost between a facility that continues to use spray guns, and the same facility switching from spray guns to flowcoaters before the spray guns have reached the end of their useful economic life. That is, the costs are estimated for the same plant under two scenarios: (1) the plant operates spray guns in the absence of the rule and (2) the same plant must switch to flowcoaters while the spray guns are still functional.
This net cost difference was estimated for each of the surveyed facilities. EPA used the results from the surveyed facilities to estimate costs for the non-surveyed facilities.

For each surveyed facility EPA knew the number of spray-guns currently in use. EPA assumed that all spray guns are halfway through their economic life at the time the regulation takes effect. The cost analysis covers a 10 year period. Using this time frame, EPA calculated the difference in total capital costs, operating and maintenance costs, net of the costs savings such as reduced PPE costs and reduced floor covering costs for both spray guns and flowcoaters. The difference in these costs is the cost of switching from spray guns to flowcoaters.

The flowcoaters themselves require an initial capital outlay and are slightly more expensive to operate and maintain. However, EPA estimates that the majority of survey facilities will experience overall cost savings when floor covering and resin cost savings are added to the flowcoater cost impacts. If the net cost (capital and OM costs less the cost savings) was negative for a given surveyed facility, the total cost of switching from spray guns to flowcoaters was assumed to be zero. We assumed that if a facility is expected to see an overall cost saving from changing production processes, the facility will make this change voluntarily when the current capital associated with the process depreciates. Thus, the cost savings are not directly attributable to the regulation and should not be used to offset cost impacts for other regulated materials, such as gel coats or adhesives.

For non-surveyed facilities, we assumed the cost impact for switching to flowcoaters was zero because the majority of surveyed facilities had no net cost increase from changing this production process.

3.3.3 Monitoring, Recordkeeping, and Reporting (MRR) Costs

The cost analysis includes an estimate of the additional managerial and clerical hours needed for monitoring, recordkeeping, and reporting (MRR) based on the compliance activities required. EPA estimated that there are 11 manufacturing operations that could have separate MRR costs. Total managerial and clerical hours were calculated separately for each operation.

Surveyed facilities were assigned the average annual MRR cost for all operations currently performed at the facility. The average annual hours was based on the estimated hours required during the first 3 years of compliance. The estimated hours in the first year are higher than those in the second and third years because of hours needed to learn the rule and set up recordkeeping systems (e.g., spreadsheets) for monitoring compliance. Total MRR costs were determined by multiplying the average annual management and clerical hours by the associated labor rate for that category taken from the Bureau of Labor Statistics. Non-surveyed facilities were assigned the average annual MRR cost for all the surveyed facilities.

3.3.4 Materials Testing Costs

EPA included costs for testing the physical properties of materials for each facility that has to switch materials at one or more emission point. The purpose of the tests is to insure that the new materials that meet the MACT floor requirements for HAP content also satisfy the facility's production needs. Tests will likely focus on finding a material with a HAP content at or below the MACT floor that maintains the quality of the final product.

Testing costs were estimated for facilities switching any of their production resins, tooling resins, pigmented gel coats, clear gel coats and/or tooling gel coats to low-HAP materials. No testing costs were calculated for basecoat gel coats because they are "work-off" products made from other surplus gel coats. The analysis assumed that facilities will need to perform three tests per material to find a suitable low-HAP replacement for higher-HAP materials.

Facilities were assigned testing costs for every emissions point where the facility is expected to change the material used. The total testing costs at the facility was then annualized over 10 years. These costs may be over-estimated for some facilities for the following three reasons.

- The facility may rely on performance data provided by the material supplier, rather than doing their own tests.
- The material supplier may test samples prepared by the boat manufacturer and incur the cost of testing.
- If several facilities are operated by the same company, only one series of tests may be needed for materials that are used at all facilities.

3.4 Unit Compliance Costs

The total "engineering" costs sum to $15.4 million per year. The economic model uses this information as inputs to determine the total social cost of the rule (i.e., taking into account the reactions in the boat markets by producers and consumers. There are two compliance costs inputs to the economic analysis presented in Chapter 4:

- Facility-level variable compliance costs per boat produced, and
- Facility-level fixed compliance costs.

The categories of costs described in Sections 3.3.1 to 3.3.3 (i.e., material switching, process changes and MRR costs) are all variable compliance costs, meaning those costs that vary with the level of production at a given facility. The materials testing costs described in Section 3.3.4 are fixed costs, meaning those costs that will be incurred at the same level regardless of the level production at the facility as long as the facility remains in operation.

The sum of the materials switching costs, the process change costs and the MRR costs is the total variable compliance costs for each facility. However, the variable compliance cost per boat produced is the necessary input to the economic model. EPA estimated the number of boats produced at each facility and used these estimates to transform total variable compliance costs into variable costs per boat produced.

For each facility, EPA had an estimate of facility-level sales and information on the type of boat(s) produced at the facility (See Appendix A). The National Marine Manufacturers Association (NMMA) publishes data annually on the average price of a boat by boat type. EPA used the facility-level sales estimates and the average price per boat to estimate the total number of boats produced at each affected facility. For each facility, EPA calculated unit variable compliance costs by dividing the total variable compliance cost by the total number of boats produced.

The testing costs are the only fixed cost of compliance. These costs do not need to be transformed into unit costs for the EIA.

Table 3-1 provides cost information for all facilities for which costs were estimated. The data provided includes, the type of boat(s) produced, total variable costs, variable cost per unit produced, and total fixed costs.

Table 3-1: Compliance Cost Per Facility

Facility ID	Type of Boat	Total Variable Cost	Total Variable Cost per Unit	Total Fixed Cost
1	Outboard	$31,755	$18	$5,126
2	Outboard, Sterndrive, Inboard Cruisers	$228,654	$82	$3,844
5	Outboard, Inboard Runabout, Sterndrive	$116,433	$40	$1,281
6	Outboard, Inboard Runabout, Sterndrive	$48,503	$33	$1,281
7	Outboard, Inboard Runabout, Sterndrive	$27,641	$13	$1,281
8	Outboard, Inboard Runabout, Sterndrive	$73,336	$28	$1,281
9	Outboard, Inboard Runabout, Sterndrive	$46,019	$27	$1,281
10	Outboard, Inboard Runabout, Sterndrive	$127,438	$19	$1,281
11	Outboard, Inboard Runabout, Sterndrive	$66,741	$63	$1,281
12	Sailboats	$31,553	$55	$5,126
13	Outboard, Inboard Runabout	$59,128	$10	$2,563
14	Outboard, Inboard Runabout	$107,709	$108	$5,126
15	Inboard Runabout	$38,836	$126	$2,563
16	Outboard, Sterndrive, Inboard Cruisers	$401,183	$133	$5,126
17	Sterndrive	$155,745	$93	$3,844
18	Sailboats	$36,378	$47	$5,126
19	Outboard, Sterndrive	$77,739	$47	$3,844
20	Outboard	$34,379	$68	$2,563
21	Outboard	$116,318	$24	$3,844
22	Outboard	$72,576	$6	$2,563
23	Jet Boats	$77,906	$18	$3,844
25	Outboard	$323,871	$35	$6,407
26	Inboard Cruisers	$29,939	$93	$2,563
27	Sailboats	$31,549	$28	$3,844
28	Outboard	$109,033	$59	$5,126
29	Sterndrive, Inboard Cruisers	$78,535	$96	$3,844
33	Outboard, Inboard Runabout, Sterndrive, Jet Boats	$32,777	$4	$5,126
34	Outboard	$26,384	$55	$5,126
35	Sailboats	$31,021	$73	$3,844
36	Outboard	$86,285	$10	$5,126
37	Outboard, Sterndrive, Canoe	$147,863	$15	$3,844
38	Inboard Runabout, Inboard Cruisers	$340,591	$705	$5,126
39	Inboard Runabout, Sterndrive, Inboard Cruisers, Jet Boats	$49,232	$51	$3,844
40	Inboard Runabout, Sterndrive, Inboard Cruisers, Jet Boats	$38,467	$21	$2,563
41	Inboard Runabout, Sterndrive, Inboard Cruisers, Jet Boats	$21,116	$18	$2,563
42	Inboard Runabout, Sterndrive, Inboard Cruisers, Jet Boats	$88,830	$45	$3,844
43	Inboard Runabout, Sterndrive, Inboard Cruisers, Jet Boats	$43,264	$18	$2,563
44	Inboard Runabout, Sterndrive, Inboard	$176,150	$953	$1,281

Facility ID	Type of Boat	Total Variable Cost	Total Variable Cost per Unit	Total Fixed Cost
	Cruisers, Jet Boats			
45	Inboard Runabout, Sterndrive, Inboard Cruisers, Jet Boats	$91,088	$197	$3,844
46	Inboard Runabout, Sterndrive, Inboard Cruisers, Jet Boats	$71,586	$33	$3,844
47	Sterndrive, Inboard Cruisers	$16,799	$10	$2,563
48	Sailboats	$220,935	$69	$3,844
49	Outboard	$188,977	$45	$5,126
51	Outboard, Sterndrive, Inboard Cruisers	$241,317	$634	$5,126
52	Outboard, Sterndrive, Inboard Cruisers	$163,846	$165	$2,563
53	Outboard	$117,661	$32	$5,126
54	Outboard, Inboard Runabout, Sterndrive	$122,909	$23	$3,844
101	Inboard Cruisers	$65,048	$689	$5,126
103	Sterndrive	$181,781	$98	$5,126
106	PWC, Jet Boats	$70,375	$2	$2,563
109	Sailboats	$42,589	$38	$6,407
110	Sailboats	$23,993	$76	$5,126
112	Sterndrive	$141,725	$68	$2,563
113	Outboard, Sterndrive	$276,649	$202	$6,407
115	Outboard	$46,380	$37	$6,407
120	Outboard	$37,725	$244	$3,844
121	PWC	$64,995	$1	$5,126
124	Inboard Cruisers	$67,359	$3,187	$5,126
201	Outboard	$71,133	$82	$5,126
202	Outboard	$68,856	$65	$6,407
203	Outboard	$67,594	$96	$6,407
205	Inboard Runabout	$60,686	$181	$5,126
207	Outboard, Inboard Runabout, Sterndrive	$82,891	$35	$5,126
208	Inboard Cruisers	$55,983	$4,236	$5,126
209	Sailboats	$40,854	$140	$5,126
211	Outboard	$49,649	$294	$6,407
213	Outboard	$85,771	$61	$6,407
214	Inboard Runabout, Inboard Cruisers	$78,769	$833	$5,126
218	Inboard Runabout, Sterndrive	$97,438	$64	$6,407
219	Outboard, Inboard Runabout, Sterndrive	$132,144	$49	$6,407
221	Outboard	$47,690	$68	$5,126
222	Outboard	$52,135	$93	$5,126
223	Sailboats	$120,145	$71	$5,126
226	Sterndrive, Jet Boats	$41,247	$110	$5,126
227	Outboard, Inboard Runabout, Jet Boats	$214,446	$21	$6,407
228	Outboard, Inboard Runabout	$96,351	$130	$5,126
230	Outboard, Sterndrive	$117,085	$97	$6,407
231	Outboard	$211,664	$167	$6,407
232	Sterndrive	$348,848	$116	$5,126

Table 3-1: Compliance Cost Per Facility

Facility ID	Type of Boat	Total Variable Cost	Total Variable Cost per Unit	Total Fixed Cost
233	Sterndrive, Inboard Cruisers	$535,375	$343	$5,126
235	Sterndrive	$181,040	$90	$6,407
236	Sterndrive	$40,449	$20	$6,407
238	Outboard, Sterndrive	$144,102	$46	$6,407
239	Sterndrive, Inboard Cruisers	$106,067	$292	$5,126
240	Outboard	$55,787	$8	$6,407
241	Outboard, Sterndrive, Canoe	$178,025	$27	$6,407
242	Sterndrive, Inboard Cruisers	$141,474	$179	$5,126
243	Outboard, Sterndrive	$45,472	$169	$5,126
245	Outboard, Sterndrive, Jet Boats	$46,395	$45	$5,126
247	Outboard	$44,284	$14	$5,126
248	Sterndrive	$39,395	$177	$5,126
249	Outboard, Inboard Runabout	$172,142	$31	$5,126
250	Inboard Runabout	$37,179	$189	$5,126
251	Outboard	$41,802	$48	$6,407
252	Outboard	$145,560	$86	$6,407
253	Inboard Runabout, Sterndrive	$50,624	$163	$5,126
254	Outboard, Sterndrive	$267,339	$178	$0
255	Outboard, Sterndrive, Inboard Cruisers	$179,433	$75	$5,126
257	Outboard	$41,878	$299	$6,407
258	Outboard	$73,043	$104	$5,126
260	Inboard Runabout	$44,182	$58	$5,126
262	Inboard Runabout	$136,837	$102	$5,126
263	Inboard Runabout, Inboard Cruisers	$77,748	$187	$5,126
265	Inboard Runabout, Sterndrive	$36,558	$103	$5,126
266	Sterndrive	$62,324	$45	$6,407
267	Inboard Runabout	$45,062	$2,015	$5,126
270	Sailboats	$107,107	$142	$5,126
271	Sterndrive	$84,762	$119	$5,126
274	Outboard	$46,245	$143	$6,407
275	Outboard, Sterndrive	$56,166	$122	$5,126
276	Outboard	$159,478	$61	$5,126
277	Outboard	$38,086	$309	$6,407
1000	Outboard, Sterndrive	$336,492	$170	$0
2000	Outboard	$11,639	$2	$0
4000	Outboard, Canoe	$6,802	$7	$0
5000	Outboard	$24,919	$3	$0
6000	Outboard	$10,051	$2	$0
7000	Outboard, Sterndrive, Canoe	$11,639	$1	$0
11000	Outboard, Sterndrive, Canoe	$12,499	$3	$0
13000	Outboard	$644,030	$389	$0
3A	Outboard, Sterndrive, Inboard Cruisers	$134,753	$32	$926
3B	Outboard, Sterndrive, Inboard Cruisers	$51,715	$32	$355

Table 3-1: Compliance Cost Per Facility

Facility ID	Type of Boat	Total Variable Cost	Total Variable Cost per Unit	Total Fixed Cost
4A	Outboard, Inboard Runabout, Sterndrive	$62,122	$12	$729
4B	Outboard, Inboard Runabout, Sterndrive	$24,025	$12	$282
4C	Outboard, Inboard Runabout, Sterndrive	$23,065	$12	$271
	Not Included in Economic Model			
116	Ships	$108,955	#N/A	$3,844
119	PWC Components	$34,773	#N/A	$5,126
122	PFC Parts	$125,107	#N/A	$5,126
123	Boat Parts	$39,382	#N/A	$5,126
126	Ships	$102,542	#N/A	$5,126
Total		**$13,251,923**		**$544,613**

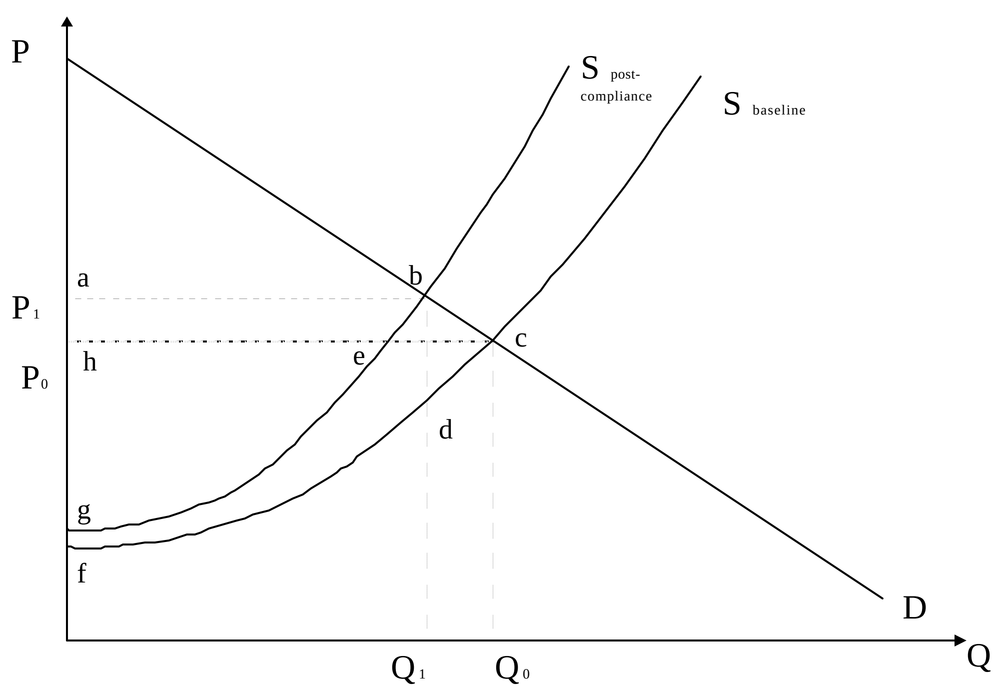
4. Economic Impacts

4.1 Introduction

The compliance costs outlined in Chapter 3 represent the direct impact of the rule on individual boat manufacturing facilities that are major sources of HAP emissions. The analysis presented in this chapter estimates the *net social burden* of the regulation, taking into account market adjustments to the rule. The social burden includes the compliance costs but also takes into account other factors, such as the loss consumers incur when boat prices rise, the loss both consumers and affected producers incur when fewer boats are produced, and increases in profits for unaffected producers who enjoy higher market prices without any additional costs. This social burden or cost is weighed by policymakers against the social gains associated with the regulation, including the value of reduced impacts on human health and the environment, when evaluating regulatory options.

Facility-level compliance costs vary based on characteristics of the boat-producing facilities, such as the amount and type of resin used. Social costs vary based on characteristics of markets in which these facilities participate. At the market level, the imposition of compliance costs on some boat producers adds to the cost of producing a boat, and thus results in an upward shift of the market supply curve. In a perfectly competitive market, the supply curve measures the marginal cost of supplying boats to the market as a function of the quantity supplied. The area under the supply curve from 0 to any number, Q, measures the total cost of supplying Q boats. An upward shift in the supply curve means that it costs more to supply a given quantity of boats. This is what we would expect if some producers have to switch to lower HAP technologies. The demand for boats measures the quantity of boats consumers will purchase as a function of the price of boats, assuming all else is held constant. The demand for boats is unchanged by the regulation. Figure 4-1 below graphically presents the impact of the regulation on the market for boats. Note that the shift in the supply curve results in an increase in price and a decrease in the quantity of boats sold.

Figure 4-1. Market Model



The imposition of compliance costs on boat producers results in three types of cost:

- **Change in Consumer Surplus**: Consumer surplus measures the difference between what consumers are willing to pay and what they actually pay for a product. When the supply curve shifts up and the price of boats increases, consumer surplus changes by a portion of the externalized cost. The change in consumer surplus is represented by the area ***abch*** in Figure 4-1.

- **Change in Producer Surplus**: Producer surplus measures the difference between what it costs suppliers to produce the boats they sell and the revenue they receive from selling these boats – their economic profit. When compliance costs are imposed, some producer surplus is gained if the price received increases, and some producer surplus is lost because the cost of producing boats also increases as producers internalize the cost of pollution. Although unaffected producers enjoy a gain in surplus, the loss from producers who must comply with the regulation outweighs these gains so there is a net loss in producer surplus. The loss of producer surplus is represented by the area ***fceg*** in Figure 4-1.

- **Deadweight loss:** The loss in consumer and producer surplus for units that would have been produced before the regulation but are no longer being produced is called deadweight loss. Notice that the deadweight loss is comprised of some loss in consumer surplus and some loss in producer surplus. The deadweight loss is not an additional type of loss but rather is a component of lost consumer and producer surplus. The deadweight loss is represented as area ***bcd*** in Figure 4-1.

The total social costs of the regulation can be estimated as the sum of the loss in producer and consumer surplus (areas ***abch*** plus ***fceg*** in Figure 4-1) minus whatever surplus is transferred from consumers to producers (area ***abeh*** in Figure 4-1)[3]. Section 4.2 presents the methodology for translating this theoretical framework into actual models for calculating the social cost of the boat manufacturing NESHAP. The results of the social cost analysis are presented in Section 4.3. The social cost analysis contains information on the effects of the regulation on domestic producers and consumers and the effect on international trade.

In addition to the social cost analysis, the EIA addresses other issues of concern to policy makers – in particular, the effects of the rule on employment and on facility closures. Section 4.4 addresses the employment effects of the regulation, and Section 4.5 addresses facility closures.

4.2 Methodology

An important underlying assumption in the framework for calculating the social cost of a regulation as outlined in the previous section is that the market for boats is perfectly competitive. In a perfectly competitive market, homogenous goods are sold at one price. Individual producers cannot affect the price of the product they sell by strategically altering output. Producers are willing to supply boats to the market as long as the market price is greater than or equal to their cost of production. It would be difficult to argue that the overall market for boats is perfectly competitive. Different categories of boats offer very different amenities and sell for a wide range of prices. Yachts and PWCs, for example, cannot be modeled as a homogeneous good selling for a single market

---

[3]The EIA focuses on the social costs to U.S. producers and consumers only. As a result, the social cost is calculated as the change in producer and consumer surplus for U.S. producers and U.S. consumers.

price.

However, analyzing specific boat sub-markets as competitive markets is more reasonable. We developed models for six different segments of the boat market: outboard motor boats; inboard runabouts and sterndrive motorboats; yachts; personal watercraft and jet boats; sailboats; and canoes. While some product differentiation and price differentiation still occurs for these product groups, modeling these more homogeneous markets in a perfectly competitive framework provides a reasonable approximation of likely market adjustments in these markets.

For each market segment, domestic and foreign demand and supply, including the non-regulated portion of domestic supply, was modeled explicitly. These supply and demand models were then used to estimate changes in market price and quantity produced and sold, as well as changes in producer and consumer surplus. The remainder of this section outlines the specific assumptions and calculations required to determine the impact of the regulation on each market segment. Sections 4.2.1 and 4.2.2 discuss domestic and foreign supply, respectively. Sections 4.2.3 and 4.2.4 discuss domestic and foreign demand. Section 4.2.5 provides the equilibrium conditions that solve the model. Finally, Section 4.2.6 discusses the calculation of the social cost of the regulation.

4.2.1 Domestic Supply

Not all boat manufacturing facilities in the industry will be impacted by the rule. As a result, there are two groups of facilities that need to be considered – facilities that will be required to comply with the MACT standards, and facilities that will not incur costs under the MACT standards.

Facilities that are subject to the MACT standards will incur compliance costs which vary by facility. A given facility's supply response to increased costs depends on the facility's cost structure, and is measured by its elasticity of supply. The elasticity of supply measures the percentage change in quantity supplied given a one percent change in price. Firms with a high elasticity of supply will react more to changing market prices, by expanding or contracting output, than firms with a low elasticity of supply. For example, an elasticity of supply of 2 means that if the price of the product increases by one percent the firm will increase the quantity supplied by two percent.

Under the assumption of perfect competition, the change in production at each individual facility can be calculated as[4]:

$$\text{Î}Q_{ij}^{SD} = e_{ij} * (Q_{ij0}/P_{j0}) * (\text{Î}P_j - c_{ij}), \quad \textbf{(1)}$$

where

$\text{Î}Q_{ij}^{SD}$	=	the change in quantity supplied by domestic facility i of product j
e_{ij}	=	the elasticity of supply (% change in quantity supplied resulting from a 1% change in price) for product j at facility i
Q_{ij0}	=	the baseline quantity of product j supplied by facility i
P_{j0}	=	the baseline price of product j

[4]Note that we have not assumed a functional form for the supply curve. Because we are interested in small (marginal) changes around the baseline equilibrium, equation(1)-(2) will hold for any functional form of the market supply curve that is approximately linear in the neighborhood of the equilibrium.

ΔP_j = the change in price of product j
c_{ij} = average compliance cost for facility i for product j.

The same equation can be used to model the change in quantity supplied for facilities that do not incur additional costs under the MACT standards, but for these facilities the compliance cost term (c_{ij}) is zero. This equation shows that the actual change in quantity supplied by each facility is a function of the facility's elasticity of supply, its baseline production level and price, and its compliance costs.

For each facility identified as a major source of styrene emissions in TRI, we estimated the number of boats produced in the baseline (Q_{ij0}). These estimates were calculated by dividing estimated facility-level sales by the average price for the given boat type (as derived in the Industry Profile, Chapter 2). Appendix A of this document describes the facility-level sales estimations in detail.

We also have estimates of the total compliance costs for each facility (C_i) and assume that these costs are incurred equally for all boat types produced at the facility ($c_{ij} = C_i/Q_{i0}$). The average price per boat by boat type is used as an estimate of the baseline market price (P_{j0}). The elasticity of supply at each individual facility is unknown. The base case estimates assume that the elasticity of supply for each facility equals the elasticity of supply for the entire market. Further, in the absence of previous studies of supply responses in the boat manufacturing industry, the market supply elasticity is assumed to be one. This means that when prices change by one percent, market-level quantity supplied changes by one percent as well. This assumes that the facility-level marginal supply response is the same for all facilities in the vicinity of their baseline output. Appendix B presents a sensitivity analysis to determine how changes in the elasticity assumption affect the total impact of the MACT regulation.

Facilities will have different total output responses because their compliance costs vary. Equation (1) shows that if the unit compliance costs are greater than the change in price for a given facility, then the facility's quantity supplied will decrease. If the unit compliance costs are less than the change in price then the facility's quantity supplied will increase.

Data on non-impacted facilities are not available at the facility level. We therefore model non-impacted facilities as a single sector. Given the data on the total number of boats produced domestically in Chapter 2 and estimates of the number of boats produced by affected facilities, we calculate the difference between the total number of domestically produced boats and the number produced by affected facilities to derive the baseline quantity supplied by the non-impacted sector. The compliance cost for the non-impacted sector is zero and the elasticity of supply for this sector is assumed to be one.

4.2.2 Foreign Supply to the U.S. Market

Imports are an important source of competition in certain boat markets and modeling the foreign supply response to changing market conditions in the United States is necessary to correctly identify the impacts of the MACT standards. However, we do not have the data required to determine the distribution of impacts across different foreign producers. As a result, we model foreign supply as a single sector.

The change in foreign supply can be calculated using the following equation:

$$\Delta Q_j^{SF} = e_j * (Q_{j0}^{F}/P_{j0}) * \Delta P_j, \qquad \textbf{(2)}$$

where

ΔQ_j^{SF} = the change in quantity of product j supplied by foreign firms
e_j = the elasticity of foreign supply (% change in quantity supplied resulting from a 1% increase in price) for product j
Q_{j0} = the baseline quantity of product j supplied by foreign firms
P_{j0} = the baseline price of product j
ΔP_j = the change in price of product j

We have data from the International Trade Commission (ITC) on the total number of imports by boat type (See Chapter 2). The foreign supply sector is assumed to supply a baseline quantity equal to total imports of boats. Information on the elasticity of foreign supply was not available, and we therefore assumed that the elasticity of supply is one. Again, we conduct a sensitivity analysis to determine the responsiveness of the model results to the assumption about foreign supply elasticity. This sensitivity analysis is presented in Appendix B.

4.2.3 Domestic Demand

Domestic demand for boats is a function of various factors, such as the price of boats, the income of boat consumers, and the preferences of boat consumers. We assume that all factors other than price are constant in the short-run. Under this assumption, the change in quantity demanded resulting from the regulation can be calculated using the following equation[5]:

$$\Delta Q_j^{DD} = E_j^D * (Q_{j0}/P_{j0}) * \Delta P_j \qquad \textbf{(3)}$$

where
ΔQ_j^{DD} = the change in quantity demanded by domestic consumers of product j
E_j^D = the domestic elasticity of demand (% change in quantity demanded resulting from a 1% increase in price) for product j
Q_{j0} = the baseline quantity of domestic demand for product j
P_{j0} = the baseline price of product j
ΔP_j = the change in price of product j.

The total number of boats sold domestically is the estimated baseline domestic demand (see Chapter 2). The average price of boats by boat type is used as the baseline market price.

The elasticity of demand represents the percentage change in quantity demanded given a one percent increase in price. The degree to which firms can pass on cost increases to consumers is determined by the elasticity of demand. All other things equal, firms that face a more price elastic demand function will be forced to absorb more of the cost of compliance. Unless demand is perfectly elastic, however, some of the compliance costs will be passed on to consumers in the form of higher prices. Because the elasticity of demand is negative (the quantity demanded varies inversely with price), more elastic demand curves have lower (more negative) elasticities.

Elasticity of demand for boats was estimated econometrically in Raboy, 1987. The elasticity of demand for all boats was estimated to be -1.78. However, the elasticity of demand varies by boat type, ranging from -1.4 for auxiliary-powered sailboats over 30 ft to -2.17 for inboard runabouts. The elasticity of demand estimates are

---

[5]As with the market supply curve, the demand equations (3)-(4) are valid for any functional form of the market demand curve that is approximately linear in the neighborhood of the baseline equilibrium for small changes in price and quantity.

given in Table 4-1.

Table 4-1: Elasticity of Demand Estimates by Boat Type	
Outboard boats	-2.02
Inboard runabouts	-2.17
Sterndrive boats	-1.90
Inboard Cruisers	-1.44
Sailboats, non-powered	Elasticity estimate not statistically significant
Sailboats, auxiliary-powered, less than 30 feet	-1.90
Sailboats, auxiliary-powered, over 30 feet	-1.40
All Boats	-1.78
Source: Raboy, David G., 1987. "Results of an Economic Analysis of Proposed Excise Taxes on Boats" mimeo, (Washington, D.C.: Patton, Boggs and Blow). Prepared for the National Marine Manufacturers Association, Chicago, Illinois.	

These elasticity estimates support a grouping of boat types into six boat markets:

- Outboard boats are modeled separately with an initial elasticity of -2.02.

- Inboard runabouts and sterndrive boats have similar average (market) prices and similar elasticities of demand. These boats are widely viewed as substitutes and we model inboard runabouts and sterndrive motor boats as a single market. The best estimate of the elasticity demand for this product is -2.0.

- Inboard Cruisers, or yachts, are modeled as a separate product. The best estimate for the elasticity of demand is -1.44.

- While there appear to be differences in the elasticity of demand for different sizes of sailboats, we do not have baseline price and quantity data for different sizes of sailboats. As a result, all sailboats are modeled as a homogenous product with a best estimate of the elasticity of demand of -1.65.

Elasticity estimates are not available for the PWCs and jet boats market segment or for the canoe market segment. Based on qualitative data on the demand for these products, we expect that they will have relatively high price elasticities. In both market segments we will use an initial elasticity of -2.0.

All six markets are characterized by elastic demand functions (elasticity less than -1). This means for a one percent increase in price, consumers will purchase two percent less in quantity. An increase in price will cause total revenue to decrease in the boat manufacturing industry because the increase in price will not offset the decrease in units sold.

4.2.4 Foreign Demand for U.S.-Produced Boats

The U.S. is a net exporter in most of the boat market segments. Foreign demand for U.S.-produced boats responds to changes in the regulatory environment in the United States according to the following equation:

$$\Delta Q_j^{DF} = E_j^F * (Q_{j0}^F / P_{j0}^F) * \Delta P_j \qquad \textbf{(4)}$$

where

ΔQ_j^{DF}	=	the change in quantity demanded by foreign consumers of product j
E_j^F	=	the foreign elasticity of demand (% change in quantity demanded resulting from a 1% increase in price) for product j
Q_{j0}^F	=	the baseline quantity of foreign demand for product j
P_{j0}^F	=	the baseline price of product j
ΔP_j	=	the change in price of product j.

Data on current exports by boat type presented in Chapter 2) are used as the estimate of baseline foreign quantity demanded (Q_{j0}^F). We assume that the boat market is perfectly competitive both domestically and abroad and that domestic and foreign-produced boats are perfect substitutes. Therefore, the baseline price of domestic boats in the United States is also the baseline price abroad. We use the average price of boats as an estimate of the baseline market price. Data on the price elasticities of foreign demand are not available, and we assume these elasticities are equal to the price elasticities of domestic demand.

4.2.5 Market Equilibrium

In equilibrium, the quantity of boats supplied equals the quantity demanded. Therefore, in changing from the baseline to the post-compliance equilibrium the change in quantity supplied must equal the change in quantity demanded.[6] Using the equations above this can be stated mathematically as:

$$\sum_i \Delta Q_{ij}^{SD} + \Delta Q_j^{SF} = \Delta Q_j^{DD} + \Delta Q_j^{DF} \qquad (5)$$

where that i refers to the ith domestic facility and j refers to the jth product. Foreign supply is the supply of foreign-produced boats to U.S. consumers, and foreign demand is the demand by foreign consumers for U.S.-produced boats. Because there are six products (i.e., six different boat markets), equation (5) is actually a series of six equations in six unknowns (the six ΔP_j's) which can be solved algebraically.

An Excel spreadsheet model is used to solve these equations. Given the change in compliance costs for affected firms, the model iterates the change in price (ΔP_j) until all of the equations are solved. The model provides the following results:

- the change in the market price (ΔP_j),
- the change in the quantity supplied by each of the affected facilities and by the domestic unaffected sector (ΔQ_{ij}^{SD}),
- the change in the quantity supplied by the foreign supply sector (ΔQ_j^{SF}),
- the change in domestic quantity demanded (ΔQ_j^{DD}), and
- the change in foreign quantity demanded (ΔQ_j^{DF}).

---

[6]The analysis does not consider foreign supply to foreign consumers, implicitly assuming that the foreign market for foreign-produced boats does not affect the foreign market for U.S.-produced boats.

4.2.6 Social Cost of the Regulation

The social cost of the regulation is approximated by the net change in producer and consumer surplus in all affected primary, intermediate and final goods markets. In the case of boats, calculating the social cost would involve determining not just the impact of the regulation on the producer and consumer surplus in the final markets for boats, but the impact on the producer and consumer surplus in the markets for different types of inputs as well. We do not have data on the spillover impacts that changes in the final market for boats have on input markets. However, we expect that overall demand for resins will decrease but that the demand for pollution-reducing resins will increase. Boat manufacturing is not the primary source of demand for resin inputs and we expect the net effect of the regulation on input markets to be small. Given that the impact on input markets is small, the social cost of the regulation can be approximated by calculating the change in producer and consumer surplus in the boat markets alone. Figure 4-1 above depicts the change in surplus graphically.

The social cost of the regulation resulting from changes in one of the six boat markets analyzed can be estimated using the following series of equations[7]:

$$SC_j = \Delta PS_j + \Delta CS_j \quad \textbf{(6)}$$

$$\Delta PS_j = \Sigma_i \{ [(Q_{ij1} * (\Delta P_j - c_{ij})) - 0.5 * \Delta Q_{ij} * (\Delta P_j - c_{ij})] - F_{ij} \} \quad \textbf{(7)}$$

$$\Delta CS_j = -(Q_{j1} * \Delta P_j + 0.5 * \Delta Q_j^D * \Delta P_j) \quad \textbf{(8)}$$

SC_j	=	social cost resulting from changes in the jth market,
ΔPS_j	=	change in producer surplus in the jth market,
ΔCS_j	=	change in consumer surplus in the jth market,
Q_{ij1}	=	post-compliance quantity supplied by domestic facility i of product j,
ΔQ_{ij}^S	=	change in quantity supplied by domestic facility i of product j,
Q_{j0}	=	baseline quantity demanded of product j (domestic),
ΔQ_j^D	=	change in quantity demanded of product j (domestic),
ΔP_j	=	change in market price of product j,
c_{ij}	=	variable cost of compliance for domestic facility i for product j,
F_{ij}	=	fixed cost of compliance for domestic facility i for product j.

The change in social cost is calculated separately for each of the six boat markets and then summed to get the total change in social costs.[8] Appendix C provides the derivation of equations (7) and (8).

---

[7]Previously we argued that the supply and demand curves can take on any functional form if we are interested only in small changes around the baseline equilibrium. When calculating the social cost of the regulation we are inferring information about the total area under the supply and demand curves, not just the area around the equilibrium point. Thus, we must assume a functional form for the supply and demand curves. For simplicity, we have assumed linear supply and demand functions.

[8]If compliance costs fall disproportionately more on the producers of some types of boats than on others , it is possible that consumers might substitute away to other types of boats. This would shift demand curves in these markets. We do not have sufficient information to model such shifts in demand which, in any case, are likely to be very small. We therefore assume that the demand curves in these

4.3 Results

Overall, we expect that the regulation will increase the market price and decrease the equilibrium quantity of boats sold. Because facilities incur different compliance costs, the impact of the MACT standards will not be uniform across facilities. Some facilities will incur a larger share of sales losses and some unaffected facilities are expected to see their sales increase. As previously mentioned, the price elasticity of demand in all five boat markets is less than -1, indicating that overall total revenue will decrease as the price of boats increases. All of these distributional effects are captured in the models.

The following sections present the results of the market-based economic impact analysis for each of the six boat markets. A summary table of the predicted effects of the regulation is presented in Section 4.3.7, along with the estimate of the total social cost of the rule.

4.3.1 Outboard Market

The majority of affected facilities (73 of 125) produce outboard boats. A total of $6.7 million will be spent on compliance costs by facilities in this sector[9]. This represents less than one percent of the $1.42 billion dollars in annual sales of outboard boats.

The costs of complying with the MACT standards are expected to increase the price of an outboard boat by $10 and decrease the quantity of outboard boats purchased domestically by 589 boats. This represents a 0.1% increase in price and a 0.3% decrease in domestic sales.

Imports of outboard boats are predicted to increase very slightly (two additional boats) as foreign competitors take advantage of the fact that they do not incur compliance costs. Exports of outboard boats will decrease slightly (25 fewer boats). The net effect on total domestic production is a decrease of 616 units produced. This decrease is a 0.3% reduction from the baseline quantity of domestically produced outboard boats.

The social cost of the regulation on the outboard market is determined by summing the change in producer and consumer surplus. The change in producer surplus represents the increase in revenue on units produced post-compliance, less the total compliance costs paid, less lost profits on units no longer produced. This total for the outboard market is approximately -$4.6 million (i.e., a decrease in profit of $4.6 million). Of this -$4.6 million, -$6.7 million is compliance costs and lost profit on units no longer sold and $2.1 million is increased revenue on units still sold (resulting from higher prices.)

The change in consumer surplus is the welfare loss that results both from the increase in price on outboard boats and from the decrease in consumption of these boats. The total change in consumer surplus is -$2.0 million for the outboard boat market. Thus, the total social cost of the regulation on this market segment is $6.6 million.

The total loss in producer surplus caused by the rule is distributed unevenly among domestic producers.

---

markets do not change.

[9]All compliance cost estimates are provided using post-compliance (market adjusted) output. Thus, the total compliance costs may differ from the total presented in the cost analysis presented in Chapter 3.

Producers with higher compliance costs tend to have larger losses in producer surplus. However, producers with average compliance costs but low sales may also have relatively large losses in surplus because they receive less in revenue increases on the units sold. Non-affected facilities stand to gain from the regulation and some affected facilities may also gain if their compliance costs are less than the amount they receive in increased revenue resulting from the price increase. The average annual facility-level loss of producer surplus for affected facilities is -$66,500 for this industry, but annual losses range from -$610,000 to +$77,900 for affected facilities. In addition, non-affected facilities as a sector are expected to gain $273,600 annually from the rule.

4.3.2 Inboard Runabouts/Sterndrive Market

A total of 74 facilities that produce inboard runabouts or sterndrive boats are considered major sources of HAP emissions. We estimate that these 74 facilities account for 62% of the revenue in this market segment, while unaffected domestic producers account for the remaining 38%. The 74 affected facilities will spend $4.8 million in compliance costs under the rule. This represents less than one percent of the $2.4 billion dollars in baseline annual sales in this sector.

Imposition of compliance costs on a large percentage of the facilities in this market is expected to increase the weighted average price of runabouts/sterndrives by $17 . This is approximately 0.1% of the baseline weighted average price of $22,476. The increase in price is also expected to decrease the quantity of runabout/sterndrive boats purchased domestically by 108 boats (-0.1%). Imports are projected to increase by three boats per year (0.1%), while exports will decrease by 17 boats per year (-0.1%). The net effect on total domestic production is a decrease of 125 units produced. This decrease is 0.1% of the baseline quantity of domestically-produced inboard runabout/sterndrive boats.

The social cost of the regulation on the inboard runabouts/sterndrive market is again determined by summing the change in producer and consumer surplus. Producer surplus in this market segment decreases by approximately $3.0 million. Of this total -$3.0 million, -$4.8 million in compliance costs is partially offset by a $1.9 million increase in revenue from the price increase. Consumer surplus decreases by approximately $1.7 million, resulting in a total social cost of $4.7 million for this market segment.

The total social cost of the rule is not shared equally among affected facilities. The average affected facility has a loss of producer surplus of -$37,500 but the facility level losses range from -$477,300 to +$30,100. In addition, the non-affected facilities as a sector are expected to gain $711,600 from the rule.

4.3.3 Inboard Cruiser/Yacht Market

Twenty-seven facilities that produce inboard cruisers and/or yachts are considered major sources of HAPs. These 27 facilities produce 34% of the total units produced domestically in this market. A total of $0.6 million will be spent on compliance costs by facilities in this sector. These costs are nearly negligible compared to the $1.7 billion dollars in annual sales of inboard cruisers/yachts.

Given the relatively insignificant compliance burden and the large share of boats produced by non-affected facilities, the overall market impacts are minimal. The compliance costs are expected to increase the price of a cruiser/yacht by boats by $35. While this is the largest absolute price increase in any of the six market segments examined, it is less than 0.1% increase over the average baseline price of $264,937. The effect of the price increase on the quantity of cruisers/yachts produced domestically, imported and exported is negligible. The model estimated that there would be one fewer cruiser/yacht produced annually and that there would be no change in imports and exports.

Producer surplus is expected to decrease by $0.4 million while consumer surplus will decrease by $0.2 million. Thus, the total social cost of the regulation on this market segment is $0.6 million. The average affected facility has a loss of producer surplus of -$19,800 but the facility level losses range from -$166,300 to +$2,600. The non-affected facilities as a sector are expected to gain $149,500 from the rule.

4.3.4 Jet Boats/PWC Market

Only 16 facilities that produce jet boats and/or PWCs were identified as major sources of HAPs. However, these 16 facilities account for 71% of all domestically produced boats in this market segment. As stated in Chapter 2, imports of PWCs are significant. Thirty-two percent of all PWCs and jet boats sold in the U.S. are manufactured abroad.

A total of $506,000 will be spent on compliance costs by facilities in this sector. This total is negligible compared to the $1.5 billion dollars in annual sales in this sector. The compliance costs do not increase the price of boats by more than $1, in large part because such a small sector of the market will incur compliance costs.

A total of 28 fewer units will be sold (less than 0.1% reduction). The social cost of the regulation on this market is $0.3 million, of which $0.2 is a decrease in producer surplus and $0.1 is a decrease in consumer surplus.

The average affected jet boat/PWC facility has a loss of producer surplus of -$14,700, but the facility level losses range from -$78,600 to -$1,200. In addition, the non-affected domestic facilities as a sector are expected to gain $174,100 as a result of market adjustments to the rule.

4.3.5 Sailboat Market

There are ten facilities that produce sailboats and are major sources of HAPs. These ten facilities will spend an estimated $0.7 million in compliance costs. As with most of the other market segments, these costs represent a very small fraction of the $448 million dollars in estimated annual sales in this sector.

The compliance costs are expected to increase the price of a sailboat by $11. This is an increase of less than one percent over the baseline price of $22,379. The price increase is accompanied by a decrease in domestic sales of sailboats by 15 boats. Imports of sailboats are expected to rise by roughly three boats, and exports to decline by six boats. In net, 24 fewer sailboats will be produced domestically. This is a decrease of 0.2% from the baseline level of domestic production.

Producer surplus is expected to decrease by $0.6 million, consumer surplus will decrease by $0.1 million, and the total social cost is $0.7 million. The average affected sailboat facility has a loss of producer surplus of -$62,000 but the facility level losses range from -$188,900 to -$22,800. In addition, the non-affected facilities as a sector are expected to gain $32,600 from the rule.

4.3.6 Canoe Market

There are five U.S. facilities that produce canoes and are major sources of HAPs. These five facilities produce only an estimated eight percent of domestic production. While the five facilities will incur $94,000 in compliance costs, these costs have a negligible effect on the overall market. The price of canoes is predicted to increase by less than one dollar. Producer surplus is expected to decrease by $0.1 million while consumer surplus will decrease by less than $0.1 million. Thus, the total social cost of the regulation on this market segment is approximately $0.1 million.

The average affected sailboat facility has a loss of producer surplus of -$18,600, and the facility level losses range from -$46,800 to -$2,200. Non-affected facilities as a sector are expected to gain $23,400 from the rule.

4.3.7 Summary of Economic Impacts

The previous sections describe the impacts of the rule on each of the six boat market segments. These predicted effects are summarized in Table 4-2 below. The table provides estimates of baseline and post-compliance price and quantity as well as estimates of the changes in producer and consumer surplus.

The overall impact of the regulation on each of the boat markets separately are modest. The total cost of the regulation is less than one percent of total revenue in each of the six market segments. Three of the markets, namely inboard cruisers/yachts, jet boats/PWCs and canoes, have nearly negligible market-level impacts. This does not mean that some individual firms within these markets might not be significantly impacted by the regulation, but these effects are offset by gains at other facilities, so that the domestic producers as a group are not significantly impacted.

The total social cost of the regulation can be estimated by summing the change in market surplus for all six boat market segments. The total annual social cost is $13.0 million, of which $8.9 million is lost producer surplus and $4.1 million is lost consumer surplus. Total revenue for all market segments is $6.8 billion. Thus, the total social cost of the rule equals 0.2% of total baseline revenue.

Table 4-2: Summary of Market-Level Economic Impacts of the MACT Standards							
	Outboard	Inboard Runabout/ Sterndrive	Inboard Cruiser/Yacht	Jet Boats/ PWCs	Sailboats	Canoes	Total–All Markets
Baseline Market Conditions							
Baseline Domestic Demand (# of boats)	200,000	98,100	6,300	187,700	14,300	103,600	610,000
Baseline Domestic Production (# of boats)	206,787	107,704	6,469	139,625	13,240	98,814	572,639
Baseline Imports (# of boats)	1,561	3,203	340	67,150	20,041	22,839	115,134
Baseline Exports (# of boats)	8,348	12,807	509	19,075	5,714	18,053	64,533
Baseline Price	$7,107	$22,476	$264,937	$7,036	$15,000	$590	NA
Post-Compliance Market Adjustment							
Change in Domestic Demand (# of boats)	(589)	(108)	(1)	(28)	(15)	(87)	(828)
Percentage Change in Domestic Demand	-0.3%	-0.1%	0.0%	0.0%	-0.1%	-0.1%	-0.1%
Change in Domestic Production (# of boats)	(616)	(125)	(1)	(27)	(24)	(113)	(906)
Percentage Change in Domestic Production	-0.3%	-0.1%	0.0%	0.0%	-0.2%	-0.1%	-0.2%
Change in Imports (# of boats)	2	3	0	7	3	11	26
Percentage Change in Imports	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Change in Exports (# of boats)	(25)	(17)	0	(4)	(6)	(15)	(64)
Percentage Change in Exports	-0.3%	-0.1%	0.0%	0.0%	-0.1%	-0.1%	-0.1%
Change in Price	$10	$17	$35	$1	$11	$0	NA
Percentage Change in Price	0.1%	0.1%	0.0%	0.0%	0.1%	0.1%	NA
Post-Compliance Welfare Measures							
Change in Producer Surplus (Millions $)	($4.6)	($3.0)	($0.4)	($0.2)	($0.6)	($0.1)	($8.9)
Change in Consumer Surplus (Millions $)	($2.0)	($1.7)	($0.2)	($0.1)	($0.1)	$0.0	($4.1)
Total Social Cost(Millions $)	($6.6)	($4.7)	($0.6)	($0.3)	($0.7)	($0.1)	($13.0)

4.4 Facility Closures and Employment Effects

The social costs of the regulation measure the amount the regulation costs society as a whole. In addition to assessing the total social burden, EPA is interested in how the costs are distributed. This section investigates distributional issues by examining facility closures and changes in employment that are expected as a result of the regulation.

4.4.1 Facility Closures

While the social costs of the regulation are relatively modest, this does not mean that individual facilities will not experience more substantial impacts. One of the primary limitations of the methodology used to estimate social costs is that it assumes that each facility has the same elasticity of supply in the neighborhood of the baseline equilibrium. This implies that, given small price changes, each facility will reduce production at the same rate. This does not mean that each facility reduces production by the same amount, because a facility's change in production depends not only on its elasticity of supply but also on its baseline level of production and its compliance costs (as shown in equation (1)), both of which may vary from one facility to another. However, it does imply that all firms will reduce production in a smooth and uniform fashion. As a result, the small price changes predicted by the model do not result in any predicted facility closures. All facilities that incur compliance costs simply reduce production by some amount. Facilities with higher compliance costs reduce production more, but never to zero.

In reality, different facilities have different baseline cost structures and will respond to increased compliance costs and price changes differently. In the absence of information on facility production costs, we had to make assumptions about producers' supply responses. We examine the impact of altering these assumptions in the sensitivity analysis presented in Appendix B.

In lieu of determining facility-level closures based on information on facility-level profits and compliance costs, we use the market level information on total predicted change in quantity to infer the number of facilities that would shut down if the quantity decrease was born entirely by one (or more) facility. For example, if the market analysis predicts that 1,000 fewer boats are produced and the average facility produces 500 boats, then the impact is equivalent to two facility closures.

Table 4-3 presents the total predicted reduction in domestic production, average output per facility, and predicted boat facility closures for each of the six boat market segments. Note that the predicted reduction in quantity is not equivalent to even one facility closure in all six markets. While this does not mean that no facilities will close after implementation of the rule, it does indicate that the rule itself has modest total impacts and that any facility closures will likely reflect poor relative baseline profitability rather than resulting solely from the compliance burden.

Table 4-3: Estimated Equivalent Facility Closures by Market Segment			
	Predicted Reduction in Output	Average Number of Units Produced Per Facility	Equivalent Number of Facility Closures
Outboard	616	2,471	0.25
Inboard Runabout/Sterndrive	125	678	0.18
Inboard Cruiser/Yacht	1	82	0.01
Jet Boat/PWC	27	6,154	0.00
Sailboat	24	1,030	0.02
Canoe	113	1,590	0.07

4.4.2 Employment Effects

We estimated the employment effects of the MACT standard by using information on the ratio of facility production to facility employment. For each of the affected facilities, we calculated the ratio of facility-level employment to facility-level output. The average baseline production/employment ratio was multiplied by the predicted change in production from the market-level analysis to estimate the total change in employment for each market segment. The total change in employment is then calculated as the sum of the predicted changes in all six market segments. These results are presented in Table 4-4 below. The total predicted change in employment is 48 employees. Total employment in this industry is 51,500 (U.S. Department of Commerce, 1992). Thus the regulation-induced reduction in employment is less than one tenth of one percent from the baseline. Note that this approach assumes that employment is directly proportional to production. Thus, as production falls we predict employment will fall. This is not necessarily the case, particularly for small output changes. The employment changes presented in Table 4-4 should be considered upper bound estimates.

Table 4-4: Estimated Change in Employment by Boat Market Segment			
	Predicted Reduction in Output	Production to Employment Ratio	Equivalent Reduction in Employment
Outboard	616	26	24
Inboard Runabout/Sterndrive	125	7	17
Inboard Cruiser/Yacht	1	1	1
Jet Boat/PWC	27	26	1
Sailboat	24	5	5
Canoe	113	400	0
Total	906	NA	48

5. Firm-Level Analysis

5.1 Introduction

The Regulatory Flexibility Act (RFA) and the Small Business Regulatory Enforcement Fairness Act (SBREFA) require EPA to prepare a regulatory flexibility analysis for any notice-and-comment rule it issues, unless the agency certifies that the rule "will not, if promulgated, have a significant economic impact on a substantial number of small entities." A regulatory flexibility analysis includes:

- the number of small entities potentially affected,
- information on the compliance costs of the rule,
- identification of any federal rules that may duplicate, overlap or conflict with the rule, and
- an analysis of any significant regulatory alternatives which accomplish the same objectives and which minimize any significant economic impact of the rule on small entities.

In addition, SBREFA requires the agency to perform a variety of other tasks to ensure that small entity issues are being addressed if small business impacts are thought to be of sufficient concern. These additional requirements include: performing small entity outreach, convening small business advocacy review panels, issuing compliance guides for small entities, and allowing for Congressional review of the regulation. EPA has prepared guidelines for implementing the SBREFA and RFA requirements and this chapter was developed in accordance with those guidelines (EPA, 1997).

The NESHAP for the Boat Manufacturing Source Category is a notice-and-comment rulemaking subject to SBREFA and RFA. This chapter evaluates impacts on affected firms in the industry, where an affected firm is the ultimate legal entity owning an affected facility.

Evaluating impacts on boat manufacturing firms requires three types of information:

- The number of small and large firms.
- The regulatory costs incurred by small and large firms (calculated as the sum of costs for all facilities owned by a firm).
- A criteria for determining the significance of impacts.

The number of small firms is discussed in Section 2.2 of the Industry Profile -- Chapter 2. For convenience, these data are summarized in Section 5.2. Section 5.3 discusses criteria for identifying significant impacts. The impact of the rule on small and large firms is analyzed in Section 5.4 based on compliance cost-to-revenue ratios. Section 5.5 presents the conclusions of the analysis and discusses whether the rule presents a "significant economic impact on a substantial number of small entities."

5.2 Number of Small Firms

The Small Business Administration (SBA) provides small business thresholds by 4-digit SIC code. Boat Manufacturing is included in SIC 3732–Boat Manufacturing and Repair. The SBA defines "small" for this SIC as firms with less than 500 employees. EPA found no compelling reason to use an alternative definition of a "small" firm based on financial profiles or production profiles of boat manufacturing facilities and firms. This analysis therefore examines the impacts of the rule on firms with fewer than 500 employees and compares these to the impacts on firms with more than 500 employees.

As described in Section 2.2, the Statistics of U.S. Businesses (SUSB) was used to determine the total number of firms engaged in boat manufacture and repair. However, not every firm will be affected by the regulation. Firms will be required to comply with the rule if they are major sources of hazardous air pollutants (HAPs). The number of potentially affected firms was determined using data on facility-level styrene emissions from the Toxic Release Inventory (TRI). Firms owning at least one facility that is a major source of styrene based on the 1997 TRI data are assumed to be affected by the regulation. There are a total of 78 boat manufacturing firms that own at least one facility classified as a major source of styrene.

Data from Dun and Bradstreet were used to determine firm-level employment for all affected firms. Of the 78 affected firms, 66 are classified as small firms. Table 5-1 below shows the distribution of boat manufacturing firms by employment size for both affected and unaffected firms. Note that while there are a large number of small boat manufacturing firms, only 2.9% of these firms will be affected by the regulation. Alternatively, there are only 21 large boat manufacturing firms, but most (71.4%) of these firms own facilities that are major sources of styrene and that will be affected by the rule.

Table 5-1: Estimated Number of Boat Manufacturing Firms by Employment Size

	Total Number of Firms	Number of Affected Firms	Affected Firms as a Percent of Total Firms
Small Firms–SIC 3732	2,590	66	2.5%
Less Small Firms Specializing in Boat Repair	283	0	0.0%
Total Small Boat Manufacturing Firms (est.)	2,307	66	2.9%
Large Firms–SIC 3732	21	15	71.4%
Total Boat Manufacturing Firms (est.)	2,328	78	3.4%

5.3 Criteria for Assessing Impacts

Several different measures of “impact” could be used to determine whether there is a “significant economic impact on a substantial number of small entities”. EPA’s SBREFA guidance suggests three different measures for determining the economic impact of a regulation on small firms[10]. These three measures are:

- Annualized compliance costs as a percentage of sales (“Sales Test”),
- Debt-financed capital compliance costs relative to current cash flow (“Cash Flow Test”), and
- Annualized compliance costs as a percentage of before-tax profits (“Profit Test”).

[10]U.S. Environmental Protection Agency, *EPA Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act.*, February 5, 1997.

Current EPA guidelines recommend using the sales test for analyzing impacts on small firms (EPA, 1997). The sales test is also the most appropriate test to use given the nature of compliance costs and the data available for the boat manufacturing industry[11].

For the sales test, the EPA guidelines suggest using one percent and three percent as thresholds for evaluating impacts (EPA, 1997). We examined industry profit margins to determine the reasonableness of the thresholds suggested by the EPA guidelines. Dun and Bradstreet (D&B) "Industry Norms and Business Ratios" were used to determine the financial characteristics of boat manufacturers[12]. D&B provides data on percentage return on sales, calculated as net profit after taxes divided by total annual sales. This is an estimate of typical profit margins in the industry. These ratios are generated using data from 103 boat manufacturing firms. The median return on sales for the boat building and repair industry (SIC 3732) in 1997 was 3.1%. The upper quartile of the distribution have profit margins in excess of 6.6% while the lowest quartile have profit margins below 0.9%. We classify firms as experiencing a significant impact if before-tax compliance costs as a percentage of sales equals the baseline after-tax profits as a percentage of sales[13]. Therefore, it appears that three percent is an appropriate upper threshold for measuring economic impacts for this industry, and that one percent can be considered a moderate impact on firms in this industry.

Based on its guidelines, EPA can certify that the rule does not have a "significant economic impact on a substantial number of small entities" if compliance cost-to-sales ratios are less than one percent for all entities. EPA can also certify the rule if fewer than 100 entities are affected regardless of the level of impact. If more than 100 entities are affected and some entities experience compliance costs in excess of one percent of sales, EPA may still certify the rule by presenting supporting evidence to the Small Business Advisory Committee. If the rule is not certified as not having a "significant economic impact on a substantial number of small entities,"

---

[11]While profits is the most appropriate basis for assessing impacts in theory, this approach requires detailed information on firm-level profits. Profit information is typically only available for publically owned firms. However, most of the small firms affected by this rule are privately owned and do not provide this information. We therefore rely on the sales test and note that firms with similar compliance cost-to-sales ratios may experience different levels of impact depending on their baseline costs and profitability. The cash flow test is most appropriate when capital costs are a substantial portion of the total compliance costs. As described in Chapter 2, the compliance costs for boat manufacturing are largely materials costs. Thus, the cash flow test is less relevant in this case.

[12]*D&B Industry Norms and Key Business Ratios* 1998-1999. Other sources of financial ratio data include Leo Troy's *Almanac of Business and Industrial Financial Ratios* and RMA's *Annual Statement Studies*. In both of these sources, data were available for the combined ship and boat building and repair industries. While the rule will apply to a very small segment of the shipbuilding industry, the focus of this analysis is on boat manufacturing facilities. In both publications, reported profit ratios for the combined industries were slightly lower than those reported in Dun and Bradstreet for boat manufacturers.

[13]There is no simple relationship between before-tax costs as a percent of revenues and impacts on profitability. Compliance costs are a tax-deductible expense. Therefore, costs equal to three percent of profits would not result in zero profits for a firm that was earning a three percent profit on sales in the baseline. The precise impact on after-tax profit rates would depend on the firm's marginal tax rate. For example, with a 29% marginal tax rate, before tax compliance costs equal to three percent of sales would reduce after-tax profits from three percent to just below one percent of sales. In addition, to the extent that some of the compliance costs are recovered in price increases, the impact on after-tax profits would be less severe.

EPA must prepare a regulatory flexibility analysis that considers all other significant regulatory alternatives which accomplish the same objectives and which minimize any significant economic impact of the rule on small entities.

As a caveat, we note that while the boat manufacturing NESHAP may not present a "significant economic impact on a substantial number of small entities" this conclusion is made using industry level financial thresholds. On average, firms in this industry earn three percent profits, but the lower quartile of firms earn profits of less than one percent. To the extent that some of the small firms that are major sources of HAPs are in this lower quartile, cost-to-sales ratios of one percent or less may be significant for individual firms. Without more detailed firm-level profitability in the baseline, it is not possible to reach more precise conclusions about the impacts of the rule on small firms.

5.4 Impact of the Rule on Small Firms

Compliance costs (as are reported in Chapter 3) were estimated at the facility level and then summed for all facilities owned by the same firm to obtain firm-level compliance costs. Firm-level sales were taken from Dun and Bradstreet and other publically available data sources, including companies' web pages and SEC filings. These data were combined to calculate cost-to-sales ratios for each firm.

Table 5-2 presents the number of firms (both small and large) that have compliance cost-to-sales ratios above the one percent or three percent threshold. Nineteen small firms (30%) were found to incur compliance costs in excess of one percent of sales. Of these 19 firms, only one firm has costs in excess of three percent of sales. The following sections first discuss the 18 firms with compliance costs between one and three percent of sales, and then discuss the one firm with costs exceeding three percent of sales in more detail.

5.4.1 Small Firms With Compliance Costs Between One and Three Percent of Sales

The majority of the 18 firms with ratios between one and three percent have impacts very near or equal to one percent. Specifically, three firms have compliance costs equal to one percent of their sales. An additional 10 firms incur costs between 1.1% and 1.5% of sales. Only three firms have compliance costs over two percent of sales.

The 18 small firms with compliance costs between one and three percent of sales share the following features:

- **Firms manufacture a single type of boat**. All but three firms make only a single type of boat. The majority of firms with compliance costs in excess of one percent of sales (11 in total) manufacture outboard boats. Facilities owned by these firms incur average compliance costs of $81,000 per year – slightly lower than the $91,000 per facility average cost for the market segment as a whole. However, the 11 firms own facilities that are smaller than the average for the entire market segment, with average baseline revenues of $4.4 million compared to the average of $17.6 million for all outboard manufacturing facilities. They therefore receive less total increase in revenue from the predicted $10 per boat price increase than the average facility (an average of $6,000 each versus a $26,000 average increase for the segment as a whole). The predominance of outboard boat manufacturers among the 18 small firms probably reflects the fact that outboard boat production involves primarily hull manufacture, with relatively few add- on features. Add-on features such as engines (for inboards and jet boats) or furniture (for yachts) add value to the boat but are not associated with compliance costs under the rule.

- **Firms own a single facility**. Eleven of the 18 firms are single-facility firms. Of the remaining seven firms, five may be single facility firms but the parent-company employment was not available from Dun and Bradstreet to confirm this. Only two of the 18 firms are known to be multiple facility firms.

It is also worth noting that while only four of the 78 firms affected by the rule manufacture boat parts or serve as job shops, three of these four firms have compliance costs in excess of one percent of sales.

Table 5-2: Compliance Cost to Sales Ratios by Firm Employment Size								
	Total Firms	Total Affected Firms	Number of Firms With Costs in Excess of 1% of Sales	Percent of Affected Firms	Percent of Total Firms	Number of Firms With Costs in Excess of 3% of Sales	Percent of Affected Firms	Percent of Total Firms
Small Firms	2,307	63	19	30.2%	0.8%	1	1.6%	0.0%
Large Firms	21	15	0	0.0%	0.0%	0	0.0%	< 0.1%
Total	2,328	78	19	24.4%	0.8%	1	1.3%	< 0.1%

Note: Numbers shown are not exclusive. Firms with compliance costs in excess of three percent of sales are also listed as having costs in excess of one percent of sales.

5.4.2 Firms With Compliance Costs Greater Than Three Percent of Sales

The one firm with costs exceeding three percent of sales is a single-facility firm that makes both outboard boats and other fiberglass products such as bathtubs and spas. Survey data on total resin consumption were available for this firm. Data from the survey do not indicate what percentage of the firm's resin usage is associated with the manufacture of boats. The estimated annualized costs based on total reported resin use are $41,569. This cost may be overstated if substantial portions of the resin use is not associated with boat manufacturing.

Sales for this firm of $1.1 million were obtained from Dun and Bradstreet. The estimated compliance cost-to-sales ratio of 3.7% suggests that this firm may experience significant economic impacts if the firm has baseline profits similar to the industry average for boat manufacturers. A more detailed analysis of the potential impact on this facility could not be performed because the facility is privately owned and we have no information on firm-level costs or profits. It is possible that this facility will elect to stop manufacturing boats and switch to exclusively manufacturing bathtubs and spas as a result of the regulation. This might occur if the bulk of resin use is from boat manufacturing and if revenue from bathtub/spa manufacture is sufficient to maintain operations[14].

5.5 Conversion to North American Industrial Classification System

This section is to inform the reader of the changes, if any, that occur to the results of the economic impact and small entity analyses prepared in November of 1999 for the proposal of the Boat Manufacturing NESHAP when the data for the analyses are based on a new system of classifying industries, the North American Industry Classification System (NAICS). As of October 1, 2000, the Agency converted to the NAICS system for data collection on regulated industries. Prior to this date and in our analysis of the rule, we used the Standard Industry Classification (SIC) system.

[14]EPA is currently developing MACT standards to control emissions from other manufacturers using reinforced plastics, including bathtub and spa manufacturers. If this sources is subject to the reinforced plastics MACT, they may incur additional compliance costs associated with that rule.

The Bureau of Census provides a comparison of the two industry classification systems on their website of the Census of Manufacturers (www.census.gov). According to the Bureau's data, the SIC 3731 that was formerly used for Shipbuilding and Repair is now represented by NAICS code 336611. Under the SIC code in 1997, there were 700 establishments and the value of shipments (total revenues) for the industry were $10.6 billion. Small businesses were defined as firms with employment of 1000 or less. Under NAICS 336611, the data matches exactly with the SIC code data. Therefore, there can be a direct comparison between the SIC and the NAICS for the shipbuilding industry. Because the final rule will not change any of the costs or economic impacts, the conclusions for the shipbuilding industry contained in the Economic Impact Analysis at proposal will still apply for the final rule. Also for shipbuilding, the definition of a small business is the same as that of the SIC code, therefore, there is <u>no change</u> in the results of the small entity analysis if it is completed using the NAICS-based size standards.

For boat building and repair, the SIC code 3732 is converted into two NAICS codes. Boat building is included under NAICS 336612 and boat repair is listed under NAICS 811490. However, the boat repair industry is only one component of NAICS 811490. This NAICS code also includes all personal and household goods repair and maintenance, such as: garment repair and alteration; watch, clock, and jewelry repair; and welding repair. For comparison to the former SIC system, the Census provides a breakout of the establishments and value of shipments for each component of NAICS 811490 - personal and household goods repair and maintenance. According to the Census, in 1997 the SIC 3732 had 2,782 establishments earning $6.4 billion. The conversion to the NAICS codes for 1997 is as follows:

Industry	NAICS	No. Establishments	Value of Shipments
Boat Building	336612	1,043	$5.6 billion
Boat Repair*	811490	1,739	$0.8 billion
Combined Total:		2,782	$6.4 billion

*Boat Repair is one of several components to NAICS 811490. The data provided here includes only the portion of this NAICS code attributed to boat repair.

This indicates that when the relevant portions of the two NAICS codes are combined, the data matches exactly with that used for SIC 3732 in our analysis at proposal of the rule and contained in this report. The small business size standard under the NAICS code 336612 is 500 employees of less, which again matches the definition under the SIC system. For NAICS 811490, the definition of a small business is any firm with revenues of $5.0 million or less. Although the definition for NAICS 811490 differs from that which was used under the SIC system, the regulation does not affect any small businesses in the boat repair industry. Thus, again we conclude that the conversion to the NAICS system of data for boat building and repair will result in <u>no change</u> in the conclusions of our analysis at proposal.

5.6 Conclusions

Nineteen small firms that are major sources of HAP emissions, and hence affected by the regulation, are expected to have compliance costs in excess of one percent of their total sales. This represents 30.2% of all affected small firms, but only 0.8 percent of the estimated total number of small boat manufacturers. Only one firm is expected to experience costs in excess of three percent of sales. There is uncertainty regarding the compliance costs estimates for this firm, which stems from the fact that the firm manufactures bathtubs and spas as well as boats, and no information was available on the percent of emissions that can be attributed to bathtub/spa manufacture versus boat manufacture.

Table 3-1 in Chapter 3 shows that capital costs represent only four percent of total compliance costs for all affected firms (before taking production level adjustments into account.) Most compliance costs are materials costs and are largely variable with production levels. This suggests that, in general, smaller producers will not incur disproportionate costs due high fixed compliance expenditures. Some particular small producers may be at a disadvantage because they emit more HAPs per boat produced than other producers, or otherwise are farther from compliance with the requirements in the baseline than other small producers or their larger competitors.

The analysis in this chapter has focused on negative economic impacts. However, less than three percent of the estimated 2,307 small firms in the industry[15] are affected by the rule and the unaffected small firms stand to gain a competitive advantage from the regulation. These numerous unaffected small firms will experience an increase in revenue as prices rise but will not incur any compliance cost themselves. Given the small percentage of small firms expected to incur compliance costs in excess of one percent of sales and given the large number of small firms that are not major sources and that could gain a competitive advantage from the regulation, it does not appear as if the NESHAP presents a “significant economic impact on a substantial number of small entities” at the industry level.

[15]Only 66 of the 2,307 estimated small boat manufacturing firms are major sources of HAPs.

References

Boating Industry. 1996. "The Boating Business, 1995 Annual Industry Review." January.

Boating Industry. 1998. "The Boating Business, 1997 Annual Industry Review." January

DeFranco, Liz. 1996. "Sailboat Production Rose Moderately in 1995." *Boating Industry,* v59, n4, 1996.

DeFranco, Liz and Richard Porter. 1996. "Marine Retailing: A Look into the Future," *Boating Industry,* v59, n4, pg43.

Dun and Bradstreet. 1998. *Industry Norms and Key Business Ratios.*

Encyclopedia of American Industries. 1998. Gale Research Group, Editors, Heil. S and Peck, T.

ITC. 1998. U.S. Domestic Exports and U.S. Imports for Consumption.

Kurowski, Jeff. 1996. "Freedonia Forecasts Industry Sales, PWC Market", *Boating Industry*, v59, n7.

Manufacturing USA, Fifth Edition, 1996.

National Marine Manufacturers Association. 1995 *Boating Industry 1995*. Chicago, IL.

National Marine Manufacturers Association. 1996. *Boating Industry 1996*. Chicago, IL.

National Marine Manufacturers Association. 1997. *Boating Industry 1997*. Chicago, IL.

Raboy, Dr. David G. 1987. "Results of an Economic Analysis of Proposed Excise Taxes on Boats", mimeo, Washington D.C.: Patton, Boggs and Blow, prepared for the National Marine Manufacturers Association, Chicago, IL.

SRI International. 1996. *Chemical Economics Handbook*, Unsaturated Polyester Resins, April, page 580.1201 F.

The Sailing Company of Miller Sports Group LLC. 1998. *1998 Annual Sailing Business Report*.

U.S. Department of Commerce. 1993. International Trade Administration. *U.S. Industrial Outlook, 1993,* Washington, DC.

U.S. Department of Commerce. 1994. International Trade Administration. *U.S. Industrial Outlook, 1994,* Washington, DC.

U.S. Department of Commerce. 1998. International Trade Administration, *U.S. Industry and Trade Outlook 1998*, Washington, DC.

U.S. Department of Commerce. 1992. Bureau of the Census. *1992 Census of Manufactures, Industry Series,* MC92-I-37C (including "Ship and Boat Building".)

U.S. Department of Commerce. 1996a. Bureau of the Census. *1996 Annual Survey of Manufacturers*.

U.S. Department of Commerce. 1996b. Bureau of the Census. *County Business Patterns, 1996*.

U.S. Department of Commerce. 1996c. Bureau of the Census. *Statistical Abstract of the U.S. 1996*.

U.S. Department of Commerce. 1996d. Bureau of the Census. *Statistics of U.S. Businesses*, U.S. Totals for All Industries, 1996.

U.S. Environmental Protection Agency. 1999. Final Cost Procedures Documentation Memorandum. June 10, 1999.

U.S. Environmental Protection Agency. 1997a. <u>Profile of the U.S. Shipbuilding and Repair Industry</u>. Office of Compliance Sector Notebook Project. EPA 310-R-97-008, September.

U.S. Environmental Protection Agency. 1997b. *EPA Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act.* February 5, 1997.

U.S. Small Business Administration. 1999. *Small Business Size Standards Matched to SIC Codes*. Downloaded from SBA website.

Appendix A: Facility-level Sales Estimates

A.1 Introduction

The economic impact analysis requires as inputs the number of boats produced by type, the price of each boat type, and sales for each facility. Depending on what information was available for each affected facility, we used available data to derive missing data at the facility level (e.g., using price and quantity produced to calculate sales or price and sales to calculate number of boats produced.) In all cases, we classified facilities by type of boat produced and used data on the average price per boat for different types of boat as the estimate of price. To the extent that the boats produced by a particular facility are sold at higher or lower prices than the average price reported for the relevant boat market, facility-level sales will be under- or overstated (or the number of boats produced will be under- or overstated) by this estimation approach.

Firm-level sales are available for most of the boat manufacturing firms from Dun and Bradstreet (D&B). This appendix details the assumptions and calculations that were used to estimate sales at the facility level. The process included classifying facilities by boat type and estimating facility-level sales. Section A.2 describes the data and estimation procedures used. Section A.3 documents our decision criteria for choosing a sales estimate when more than one estimate was available for a facility.

A.2 Methods of estimating facility-level sales

Facility-level sales are available for some facilities in D&B, but even when these numbers are available, they are not always reliable. For example, firm-level sales are reported for many facilities, or the sum of facility-level sales within one firm is significantly different from firm sales. As a result, we do not rely on facility-level sales from D&B. Instead a variety of different data sources were used to estimate facility-level sales. This section first describes the sources of data used and then explains the three different estimation procedures employed.

A.2.1 Sources of data

The following data sources were employed in the estimation of facility-level sales and classification of facilities by type of boat produced. None of the data sources contained information on all the boat manufacturing facilities of interest. Therefore, of the three estimation methods used, only one or two were available for most facilities due to data limitations.

- Survey of selected boat manufacturing facilities: The survey provides information on the number of boats produced, the average size of boats produced and the number of employees at each facility. Survey data are available for 47 percent of facilities.

- Firm web pages: Web pages, when available, can provide information on the type of boats (outboard, inboard cruiser, jet boat etc.) produced at each facility. Internet information was available for approximately 110 facilities.

- Firm Security and Exchange Commission (SEC) filings: Publicly traded firms are required to file with the SEC. These filings can include information on the type of boats produced and firm revenue. SEC filings were available for seven firms.

- National Marine Manufacturers' Association. (NMMA) "Boating 1997": Provides information on the average price of boats by boat type (outboard, inboard runabouts, etc.)

- Dun and Bradstreet: At the firm level, D&B provides information on sales and employment.

Employment figures are available at both the facility- and firm level. As mentioned above, facility-level sales are available, but are believed to be unreliable.

- Census of Manufacturers, 1992: The Census of Manufactures provides information on total value of shipments and total employment by facility employment-size range at the four digit SIC code level. The data for SIC 3732 "Boat Manufacturing and Repair" were used in this analysis.

- Annual Survey of Manufacturers, 1996: The Annual Survey of Manufacturers provides value of shipments and total employment information on a more frequent basis than the Census of Manufacturers. However, the Annual Survey does not provide these figures by different employment ranges. Again, data for SIC 3732 "Boat Manufacturing and Repair" were used.

A.2.2 Three estimations of facility-level sales

This section describes three different approaches that were used to estimate sales at the facility level. Where more than one method could be used for a particular facility, the estimates were compared and a single estimate was selected using decision criteria described in the next section. It should be noted that all of the methods used are subject to uncertainty, and the estimate selected for any single facility may be either over- or understated. The use of multiple methods wherever possible should prevent significant errors in the estimates, however.

(a) Using the number, type and price of boats sold

The survey provided data on the number of boats produced for 47 percent of the affected facilities. Web sites and SEC filings were used to determine the type of boat manufactured at each facility. If the facility produced only one type of boat, then the estimate of facility sales was simply the number of boats multiplied by the average price for that boat type[16].

The calculations were more complex if information from the survey, web-pages, or SEC filings indicated that the facility or firm made more than one type of boat. Unfortunately we do not have information on the number of boats of different types produced at each facility. Instead we have the total number of boats produced and qualitative information on the types of boats produced. In order to complete the calculation we needed to determine the average price of all boats produced at the facility. A simple average of the prices of all boats manufactured was believed to be misleading because it assumes that facilities produce the same number of different types of boats. Instead of using a simple average, we used industry level sales data to calculate a weighted average price. The price of each type of boat produced at the facility is weighted by the ratio of the number of boats of that type produced industry-wide to the total number of boats produced of all types. Instead of assuming that each facility divides production evenly between the boat types it produces, this method assumes that each facility produces different boats in the same ratio as the industry as a whole. The weighted average price was then multiplied by the total number of boats produced to obtain an estimate of facility sales.

The average price of boats was taken from the 1997 NMMA report and no updating of these dollar values was necessary.

(b) Using firm level sales and the ratio of facility-to-firm employment from D&B

As previously mentioned, D&B provides data on sales and employment at the firm level and data on employment

[16]Price information from the NMMA reflects the average retail price of boats sold. Boat manufacturers receive the wholesale price, and using the retail price may therefore overstate total sales for the facility to an unknown extent.

at the facility level. The second estimation method assumes that, within each firm, facility sales are proportional to facility employment. Using this assumption, facility-level sales can be calculated as firm-level sales multiplied by the ratio of facility employment to firm employment. This method is most accurate when the firm is relatively homogenous. If the firm manufactures a wide variety of products, then the assumption that sales are proportional to employement is more suspect.

The D&B data are updated at least once every two years for each firm. As a result, the dollar values are assumed to be current and no updating of these numbers was performed.

(c) Using value of shipments and the ratio of facility employment to total employment by range from the Census of Manufacturers (employment data from D&B)

The third estimate of facility-level sales relies on information from the Census of Manufacturers. The Census of Manufacturers is conducted every five years and establishment (facility) data are reported at the four-digit SIC code level. Data for SIC 3732 "Boat Manufacturing and Repair" were used for this analysis. Data on the value of shipments and total employment are reported by establishment employment range. For example, data are available for facilities with employment ranging from 100-500 employees.

The most recent Census of Manufacturers was conducted in 1992, making the value of shipments data incompatible with the more recent D&B data. The Annual Survey of Manufacturers was last conducted in 1996 and provides value of shipment and employment data for the boat manufacturing SIC code, but not by establishment employment range. We updated the 1992 values by multiplying total value of shipments from the 1996 Annual Survey of Manufacturers by the ratio of employment range value of shipments to total value of shipments from the 1992 Census. This calculation implicitly assumes that the percentage of the total value of shipments and total employment attributed to each employment range did not change between 1992 and 1996.

Facility-level sales are extrapolated from the updated value of shipments and employment numbers by employment range. Each facility was first assigned to an employment range based on the facility employment data from D&B. For example, a facility with 150 employees is assigned to the employment range "100-500 employees." The total value of shipments for that employment range is then multiplied by the ratio of facility employment to the total number of employees for all establishment in the employment range, to estimate facility sales.

As with the D&B estimate described above, this method makes an assumption about the proportionality of sales to employment. In this estimation, we assume that sales are proportional to employment within an employment size range. This may not be true if facilities in the same employment class produce different types of boats or conduct different activities (e.g., boat repair versus boat manufacturing).

3. Selecting facility level sales

Not every facility had enough data to calculate facility sales using all three methods. Where only one method was feasible, that estimate of sales was used. However, data were available to estimate sales using at least two of the methods for many facilities. Specific decision rules were used to choose systematically among sales estimates for facilities with multiple estimates. In developing these decision criteria we were concerned with being as consistent as possible across facilities. The decision rules are given below.

- Where facility employment equals firm employment in D&B: In this case, we assumed that the firm owns only the one facility. For these facilities, we used the D&B firm-level sales as the facility-level sales value as well.

- Where facility employment does not equal firm employment and both D&B and Census estimates are available: We always chose the D&B estimate if there was one available, recognizing the diversity of SIC codes and the fact that the D&B data are at least reported at the firm level rather than the SIC/employee size category level.

- Where D&B employment data are available but not sales data: The average per-facility value of shipments was taken from the Census for the relevant facility employment-size category.

- Where no facility employment estimate is available: An estimate based on the number of boats produced reported in the survey and the average price of the relevant boat type was used.

D&B data were not used for five of the affected companies. Three out of the five had no D&B information on sales and employment. For two of these companies, sales estimates were obtained from different sources including a phone call to the facility and *Manufacturing USA* (Fifth Edition, 1996). For the third company no sales estimate could be obtained and we assumed sales at this company were equal to the average sales for all affected small businesses. D&B data were not used for the other two companies because a more accurate ultimate sales estimate could be obtained elsewhere. These two companies are large and have many divisions that do not specialize in boat manufacturing. For these companies, a 10-K filing from the SEC and/or website information was used to obtain sales and employment data for their marine segment only.

As a check on the reasonableness of our sales estimates, we used the survey data to calculate an "implied" average price of boats produced at each facility by dividing the facility sales estimate by the number of boats produced. These implied prices are generally higher than the average retail price of boats reported by the NMMA. There are several potential explanations for this discrepancy, including:

- Major sources may produce higher-end boats than the average facility in the same employment size category;

- The assumption of a consistent relationship between employment and number of boats produced may be inaccurate; and

- The assumed mix of boats at each facility may be inaccurate.

As a second check on the reasonableness of the facility sales estimates, we summed sales for all facilities in the same firm and compared these values to firm-level sales in D&B. The sum of estimated facility sales exceeded firm-level sales for only one facility. In addition, we compared the total sales at all facilities to total sales for the boat manufacturing industry. The total sales for all facilities in the analysis is approximately half of the total sales for the boat manufacturing industry as a whole.

Appendix B: Sensitivity Analysis

B.1 Overview

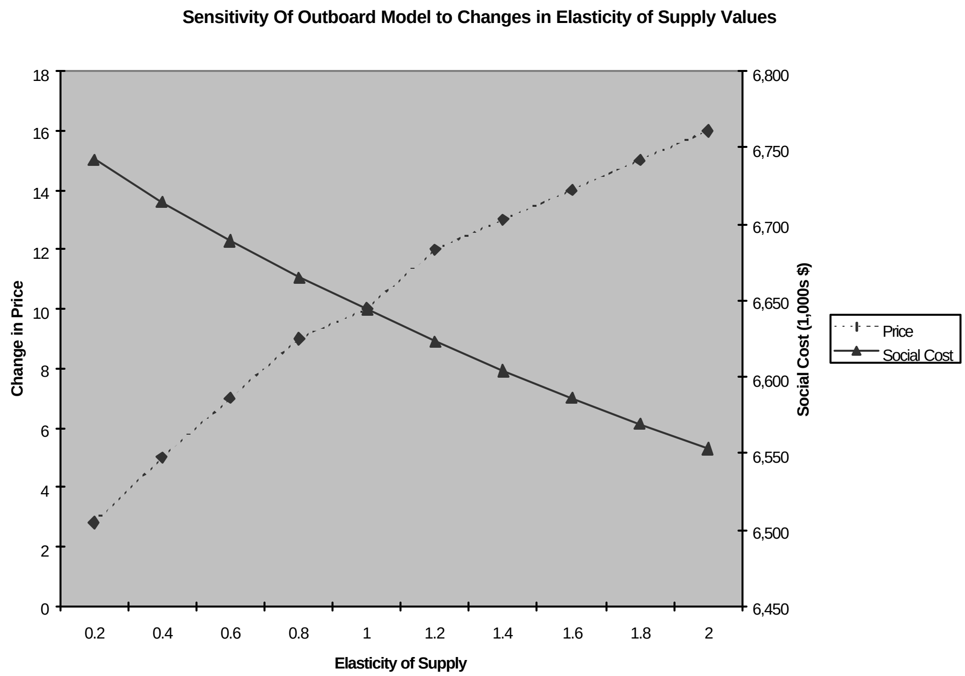
One of the key assumptions made in the Economic Impact Analysis (EIA) results presented in Chapter 4 is that the market elasticity of supply (both foreign and domestic) is equal to one for all six boat markets. In addition the facility-level elasticity of supply is assumed to be the same for all firms and equal to the market elasticity of supply. We tested the sensitivity of the model results to changes in the assumed market-level supply elasticity. In order to test the sensitivity of market-level results to changes in the elasticity of supply, we held all other inputs to the model constant. We examined how two key indicators for each market–the change in price and the total social costs–vary over the range of elasticity of supply values between zero and two. This appendix describes the results of those tests for each of the six boat market segments.

In all six boat markets the change in equilibrium price varies positively with the elasticity of supply. For a given demand function and a given average compliance cost, the upward shift of a supply function induced by these compliance costs will result in a greater increase in the equilibrium price the greater the price elasticity of supply. In four of the six boat markets the total social cost decreases as the price elasticity of supply increases. In two markets, jet boats/PWCs and sailboats, the total social cost increases as the price elasticity of supply increases. Although the greater increase in price creates greater losses in consumer surplus, most of these losses in consumer surplus are simply transfers to boat producers. Consumers pay a higher price, but producers receive a higher price. Thus these losses in consumer surplus are largely offset by equal gains in producer surplus. In the jet boats/PWCs and sailboats markets, however, import competition is substantial. When the price elasticity of supply rises and the increase in equilibrium price rises, a larger share of these gains goes to foreign producers while the compliance costs are borne solely by domestic producers. Because gains to foreign producers are not included in the calculation of social costs, the total social cost rises with the elasticity of supply in these two markets.

In the analysis presented in Chapter 4 we assumed an elasticity of supply equal to one in all markets, which resulted in an estimate of total social cost for the regulation of $13.0 million. If we assume that the elasticity of supply takes the value between zero and two that maximizes the total social cost in each market, the total social costs of the rule is $13.3 million. This cost is 0.2 percent of the $6.8 billion in total revenue for all market segments, and is only 2.3 percent higher than the total social cost estimated in the base case.

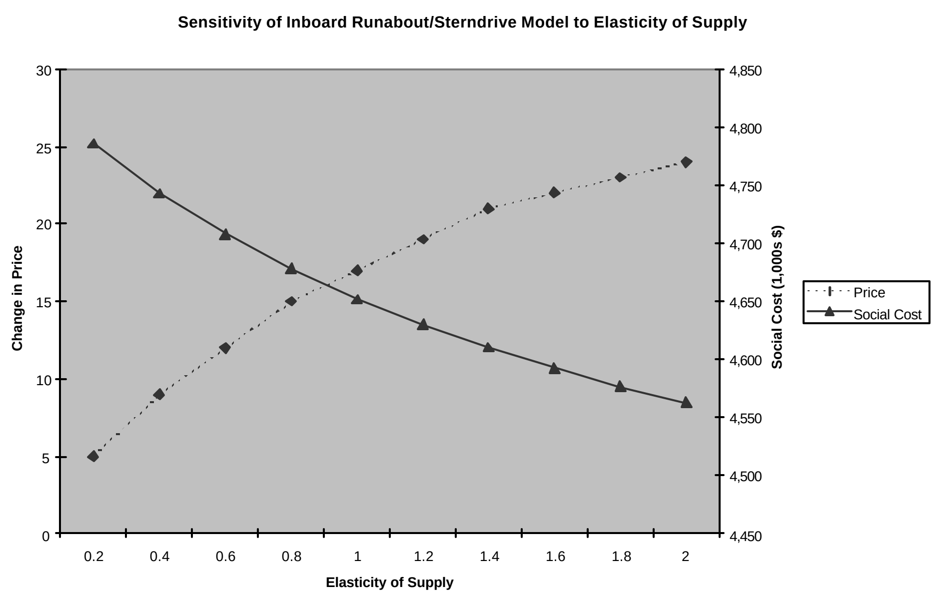
B2. Outboard Market

With a facility-level elasticity of supply equal to one for all domestic facilities and foreign suppliers, the predicted change in price for outboards was $10. The total estimated social costs of the regulation in this market was $6.64 million. The change in price increases as the elasticity of supply increases. Over the range of elasticities between zero and two, the expected change in price ranges from $3 to $16. The social costs decreases as the supply elasticity increases. The total social costs ranges from $6.74 to $6.55 million.



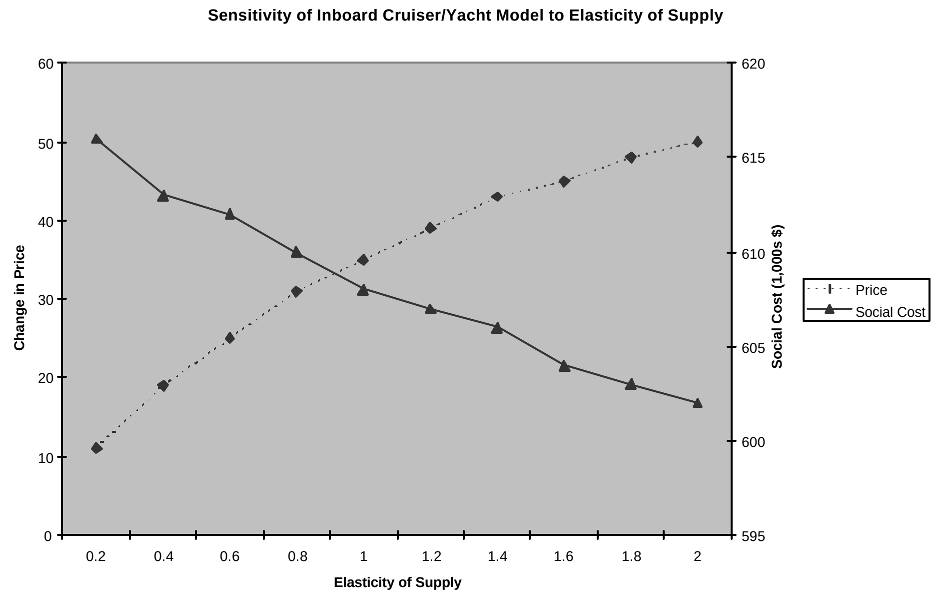
B3. Inboard Runabout/Sterndrive Market

With a facility-level elasticity of supply equal to one for all domestic facilities and foreign suppliers, the predicted change in price for inboard runabouts/sterndrives was $17. The total estimated social costs of the regulation in this market was $4.65 million. Over the range of elasticities between zero and two, the expected change in price ranges from $5 to $24. Over the same range in elasticities, the total social costs ranges from $4.79 to $4.56 million.



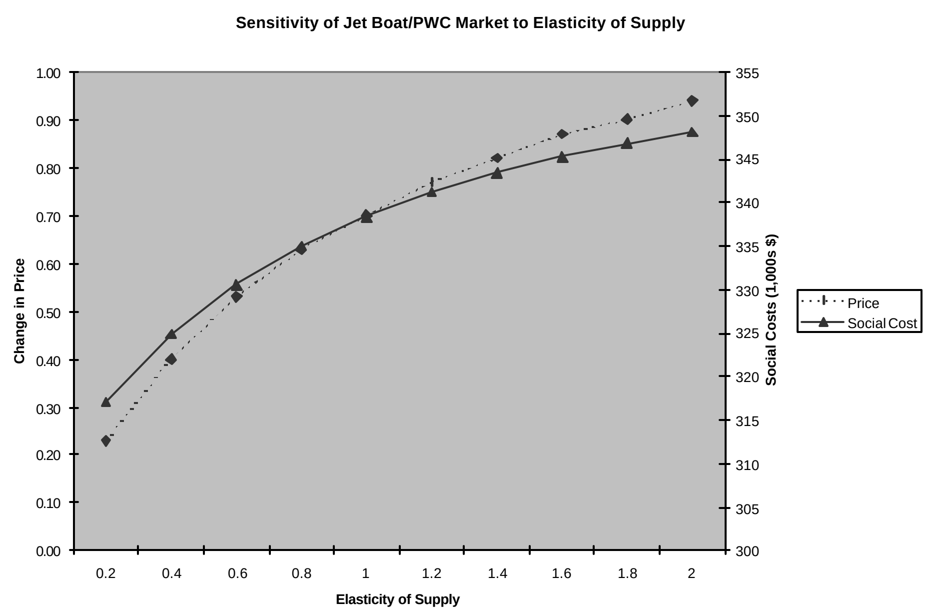
B4. Inboard Cruiser/Yachts Model

With a facility-level elasticity of supply equal to one the predicted change in price for inboard cruisers/yachts was $35 and the total estimated social costs is $608,000. Over the range of elasticities between zero and two, the expected change in price ranges from $11 to $50. The total social costs ranges from $616,000 to $602,000.



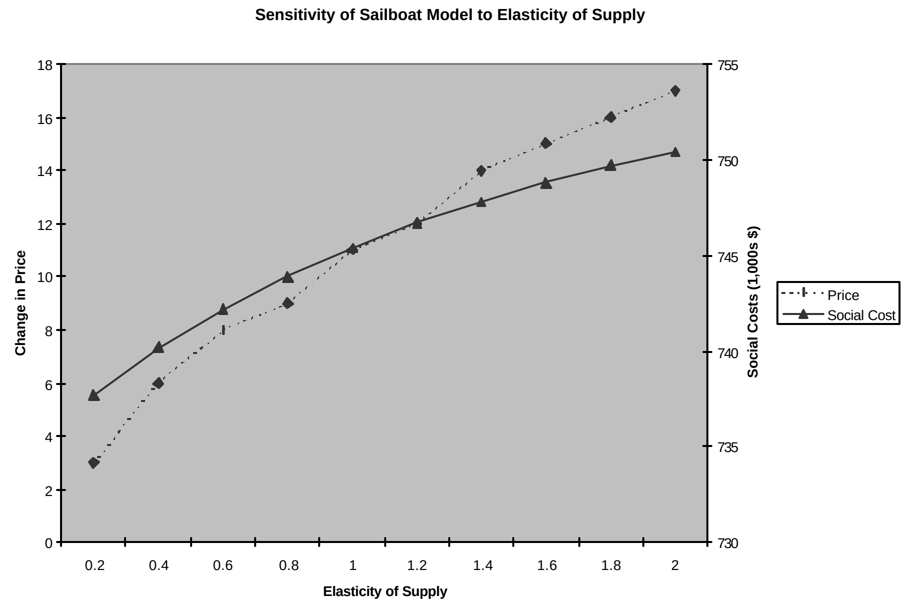
B5. Jet Boats/PWC Model

In the baseline scenario, with elasticity of supply equal to one for all domestic facilities and foreign suppliers, the predicted change in price for jet boats/PWCs was $0.70. The total estimated social costs of the regulation in this market was $338,000. Over the range of elasticities between zero and two, the expected change in price ranges from $0.23 to $0.94. The social costs also increases as the supply elasticity increases, ranging from $317,000 to $348,000.



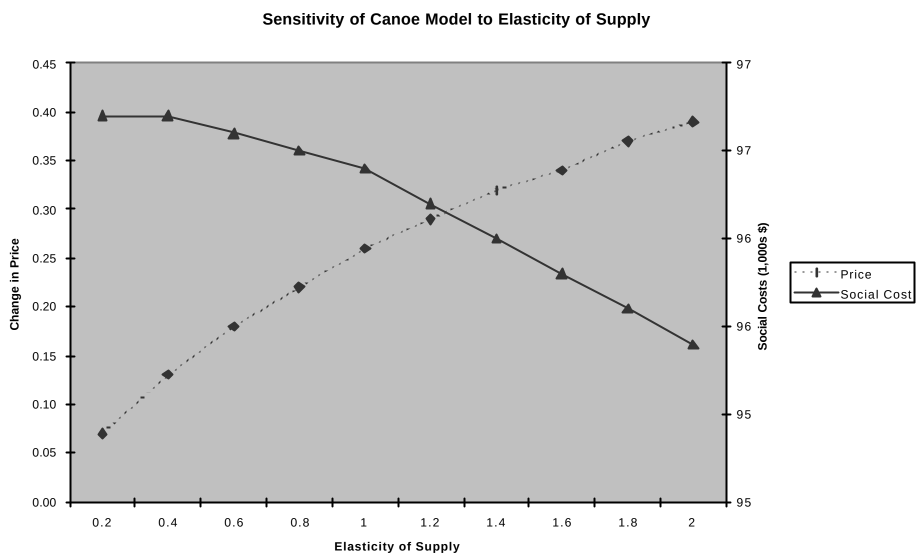
B6. Sailboat Model

The baseline predicted change in price for sailboats was $11and the total estimated social costs of the regulation in this market was $745,000. Over the range of elasticities between zero and two, the expected change in price ranges from $3 to $17. The total social costs ranges from $738,000 to $750,000.



B.7 Canoe Model

The predicted change in price for canoes was $0.26 and the total estimated social costs was $96,000. Over the range of elasticities between zero and two, the expected change in price ranges from $0.07 to $0.39. The total social costs ranges from $97,000 to $95,000, over the same elasticity range.



Appendix C: Social Cost Equations

The change in social costs is estimated as the sum of the changes in producer and consumer surplus for domestic consumers and domestic producers only. The equations for estimating the change in producer and consumer surplus given linear demand curves (equations (7) and (8) in Chapter 4) are as follows:

$$\Delta PS = \Sigma_i \{ [(Q_{i1} * (\Delta P - c_i)) - 0.5 * \Delta Q_i * (\Delta P - c_i)] - F_i \} \quad \textbf{(7)}$$

$$\Delta CS = -(Q_1 * \Delta P + 0.5 * \Delta Q^D * \Delta P), \quad \textbf{(8)}$$

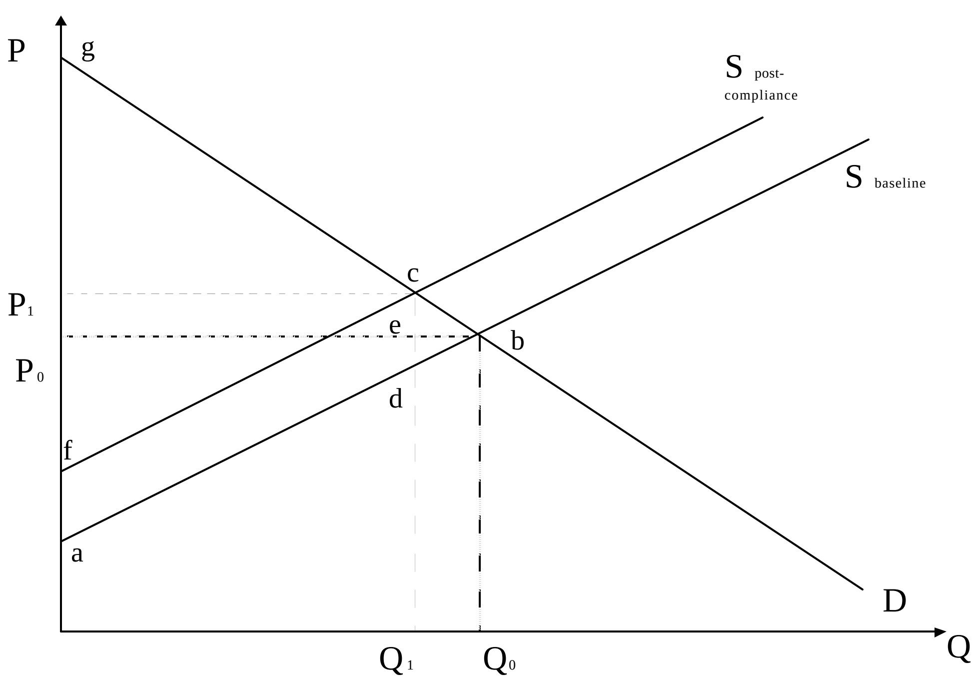
where

SC	=	social cost resulting from changes in the market,
ΔPS	=	change in producer surplus,
ΔCS	=	change in consumer surplus,
Q_{i1}	=	post-compliance quantity supplied by domestic facility i,
ΔQ_i^S	=	change in quantity supplied by domestic facility i,
Q_0	=	baseline quantity demanded of (domestic),
ΔQ^D	=	change in quantity demanded of (domestic),
ΔP	=	change in market price,
c_i	=	variable cost of compliance for domestic facility i,
F_i	=	fixed cost of compliance for domestic facility i.

This appendix provides the derivation of these equations. For simplicity we focus on calculating the change in surplus for a single product and therefore drop the j subscripts that are associated with the six boat types.

Figure C-1 provides a graphical representation of the changes in surplus and is used for reference in the sections that follow.

Figure C-1



C.1 Change in Producer Surplus

Producer surplus measures the difference between what it costs suppliers to produce the boats they sell and the revenue they receive from selling these boats – their economic profit. The pre-compliance producer surplus is represented by the area $\boldsymbol{abP_0}$ in Figure C-1, while the post-compliance producer surplus is represented by the area $\boldsymbol{fcP_1}$.

The change in producer surplus consists of three distinct parts:

- **Incremental increase in revenue on units produced post–compliance**. Graphically this is the area $\boldsymbol{P_1P_0ec}$ in Figure C-1. Mathematically this area can be estimated using the following equation:

$$\Sigma\, Q_{i1} * (P_1 - P_0) \quad \text{or}$$

$$\boldsymbol{\Sigma\, Q_{i1} * \Delta P}$$

- **Compliance costs paid on units produced post-compliance**. This value is represented as the area $\boldsymbol{adcf}$ in Figure C-1 plus the fixed costs of compliance which are not shown in the graph. Mathematically this area can be estimated using the equation:

$$\boldsymbol{- \Sigma\, (Q_{i1} * c_i) - F_i}$$

- **Lost profit on units no longer produced**. Graphically the area $\boldsymbol{dbe}$ in Figure C-1 represents the profit producers lose because the units Q_0 minus Q_1 are no longer produced. Note that the line segment $\boldsymbol{dc}$ equals the average compliance costs (c_i) while the line segment $\boldsymbol{ce}$ represents the change in price (ΔP). Thus, the height of the triangle we are interested in is given by the line segment $\boldsymbol{de}$ which can be calculated as $\Delta P - c_i$. Mathematically the lost profit can be estimated as:

$$\boldsymbol{\Sigma\;\; 0.5 * \Delta Q * (\Delta P - c_i)}$$

Adding all of these components together results in equation (7):

$$\boldsymbol{\Delta PS = \Sigma_i \{\, [(Q_{i1}*(\Delta P\text{-}c_i)) - 0.5*\Delta Q_i*(\Delta P\text{-}c_i)] - F_i \,\}}$$

C.2 Change in Consumer Surplus

Consumer surplus measures the difference between what consumers are willing to pay and what they actually pay for a product. The pre-compliance consumer surplus is represented by the area $\boldsymbol{gbP_0}$, while the post-compliance consumer surplus is represented by the area $\boldsymbol{gcP_1}$. The change in consumer surplus is therefore represented by the area $\boldsymbol{P_1P_0bc}$. This change has two components.

- **Transfer of surplus from consumers to producers**. The area $\boldsymbol{P_1P_0ec}$ is lost consumer surplus but is also a gain in producer surplus (See Section C.1 above). This area can be estimated mathematically using the following equation:

$$- \Sigma\, Q_{i1} * (P_1 - P_0) \quad \text{or}$$

$$\boldsymbol{- \Sigma\, Q_{i1} * \Delta P}$$

- **Lost surplus on units no longer consumed**. The triangle ***ceb*** represents lost consumer surplus on units that were consumed pre-compliance but are no longer consumed post-compliance. Mathematically the area of this triangle can be estimated as:

$$-0.5 * \Delta P * \Delta Q$$

Adding the two components of the change in consumer surplus yields equation (8):

$$\Delta CS = -(Q_1 * \Delta P + 0.5 * \Delta Q^D * \Delta P).$$