United States
Environmental Protection
Agency

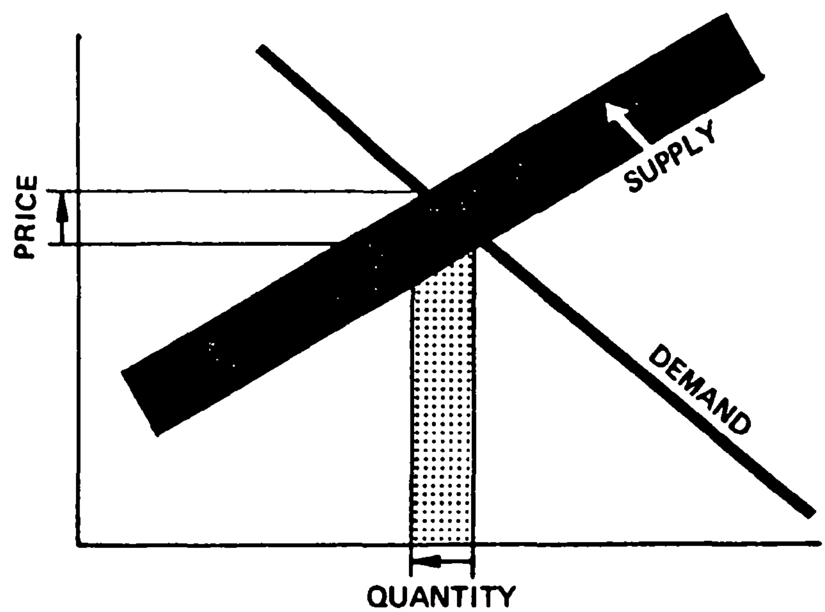
Office of Water Regulations
and Standards
Washington, DC 20460

EPA 440/2-85-028
September 1985

Water

EPA

ECONOMIC IMPACT ANALYSIS OF EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR THE METAL MOLDING AND CASTING (FOUNDRY) INDUSTRY



ECONOMIC IMPACT ANALYSIS OF EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR THE METAL MOLDING AND CASTING (FOUNDRY) INDUSTRY

September 1985

Submitted to:

Economic Analysis Branch
Analysis and Evaluation Division
Office of Water Regulation and Standards
Environmental Protection Agency
401 M Street, South West
Washington, D.C. 20460

Submitted by:

Policy Planning & Evaluation, Inc.
8301 Greensboro Drive, Suite 460
McLean, VA 22102

Contract No. 68-01-6731

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

A. PURPOSE

This report presents the results of the economic impact study developed for the effluent guidelines, limitations, and standards applicable to the metal molding and casting (foundry) industry. These regulations are based on Best Practicable Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES) which are being issued under authority of Sections 301, 304, 306, and 307 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977. The primary economic impact variables assessed in this report include the costs of the effluent regulations and the potential for these regulations to cause plant closures, the increase in foundry costs as a percentage of sales, and impacts on small businesses.

B. INDUSTRY COVERAGE

For purposes of this study, the foundry industry consists of plants that cast one of the following metals:

Ferrous Metals	Nonferrous Metals
Gray Iron	Aluminum
Malleable Iron	Copper-base
Ductile Iron	Zinc
Steel	Magnesium

The analysis in this study differentiates between jobber operations and captive operations. A plant is considered to be a captive operation if more than 50 percent of its output is consumed by its parent company. Conversely, a plant selling 50 percent or more of its output to outside customers is considered to be a jobber. Publicly available data show that most foundries produce castings of a single metal.

C. METHODOLOGY

EPA anticipates that all direct dischargers will have complied with this regulation by 1986, and that all indirect dischargers will have complied by 1988. In estimating impacts, however, EPA has assumed a common basis of compliance in 1986. (Because of increasing levels of castings shipments, this assumption may tend to overstate the impacts on indirect dischargers.) EPA then reviewed the characteristics of each metal subcategory over the 1978 to 1984 time frame. From this historical base, estimates of the population of plants and the number of employees per plant were made. In addition, a variety of sources were used to estimate plant financial characteristics, including shipments and financial ratios. Finally, the likely plant-specific responses to the imposition of compliance costs were assessed. Supplemental analyses were used to link the conditions in the foundry industry to other effects such as community and balance of trade impacts.

1. Description of Industry Characteristics

The first step in the analysis is to develop a description of the basic industry operations and financial characteristics. For the purposes of this report, the operating characteristics included:

- the number of foundries casting each metal type;
- the distribution of foundries by the number of employees in each plant; and
- the value of shipments.

Data were collected for the period 1960 through 1984. From this information, EPA judged that the population of foundries in 1984 represents a reasonable estimate of the population that will exist in 1986. Principal support for this judgment is the projected rise in castings shipments countered by long-term trends of consolidation.

Assessing the basic financial characteristics of the industry required data from the Small Business Administration's (SBA's) FINSTAT database, the Census Bureau's Annual Survey of Manufactures, and corporate annual reports. The financial information is condensed into the following financial ratios:

- return on sales;
- sales to net worth;
- debt to net worth;
- net fixed assets to net worth;
- gross fixed assets to net worth; and
- depreciation to gross fixed assets.

Estimates of average shipments in 1978 were taken from EPA's survey of 438 wet foundries over the 1978-1983 time period. The average 1978 shipments were revised downward by the ratio of the industry shipments decline between 1978 and 1982. In making this adjustment, EPA is compromising between the shipments data supplied by firms in its database and average plant shipments reported in other sources, and is accounting for the economic downturn that occurred in the industry during the early 1980s.

These estimates of sales, combined with estimates of financial ratios, are used to establish the overall financial statement of model firms in the industry. These statements form the basis for determining the impacts of compliance costs on model foundries, which are then projected to the industry as a whole.

2. Establishing the Affected Population

EPA estimated the affected population in three steps. First, EPA used the 1978 directory of foundries published by Penton

Publications to prepare a list of potentially affected foundries. Second, EPA surveyed a sample of the industry to determine the types of discharging processes, the nature and amounts of effluent discharged, and plant operating characteristics typical of the industry. Two results of this survey were a revised estimate of the number of foundries in each of the ferrous subcategories and an estimate of the proportion of wet plants in each metal and size category. The third step was to develop a count of the number of foundries in 1984 by tracing openings and closings from the 1983 directory of foundries issued by Penton Publications.

Because of the large discrepancies between the categorization of ferrous foundries in the Penton directory and the results of EPA's survey, EPA has not tried to extrapolate the foundry population to 1986. Because the foundry population has shown steady declines over the past 20 years, EPA does not anticipate any noticeable growth in the number of potentially affected foundries. At the same time, however, EPA expects the recent and anticipated increases in foundry shipments to prevent significant numbers of closures between 1984 and 1986.

3. Costs of Compliance

The water treatment control systems, costs, and effluent limitations and pretreatment standards recommended for the foundry industry are presented in the Development Document for Effluent Limitation Guidelines and Standards for the Metal Molding and Casting (Foundry) Point Source Category. The Development Document contains detailed descriptions of the technologies recommended and the development of their costs, as developed by EPA's technical staff. For this economic analysis, EPA has made four modifications to the treatment costs presented in the Development Document. First, EPA reduced the treatment costs to coincide with the production figures used in the economic analysis. Second, EPA has considered savings attributable to the cotreatment of several discharging processes at a single plant. Third, EPA has combined the operating and maintenance costs with annualized capital costs in estimating the increases in plant production costs. Fourth, EPA has considered possible increases in compliance costs by the 30 percent of plants found to commingle large volumes of noncontact cooling water with small volumes of regulated waste streams.

4. Plant Closure Analysis

The pro forma financial statements developed for foundries in each size category are formed from metal type-employment size level financial ratios and plant-level value of shipments. Financial ratios in 1986 are taken to be a composite of financial ratios for the 1975 to 1984 time period. Plant level shipments data are estimated based on average yield and production data from EPA's collection of 438 data collection portfolios (DCP's) from discharging foundries. The values estimated from the DCP's have been adjusted downwards to capture reductions in shipments during the recession in 1978-1982 and to make the values more consistent with average sales data from other sources.

The values of financial ratios for 1978 are used with projected plant-level shipments to construct model 1985 financial statements. Compliance costs are then imposed on the model plant financial statements. The following three closure tests and the plant closure criterion are used to assess the impacts of these costs. Where estimated postcompliance ratios exceed the boundaries chosen (threshold values), the affected foundries are considered potential closures. The selection of ratios and the threshold values were based on an extensive literature search and on data from actual foundries. The tests are applicable to both jobbers and captives.

a. Return on Assets Test

This is a profitability test; it measures a foundry's efficiency at generating income from its asset base. It is defined as net income after taxes divided by total book assets. A threshold of 2.5 percent is used based on Beaver's work (1966) and a recent examination of data for failed foundries as well as for foundries still solvent.

b. Total Debt to Total Assets Test

For this solvency test, total debt is considered to be any liability that is not owner's equity. Beaver's cut-off for debt to assets ranged from 50 percent to 57 percent. Due to recent structural changes in the economy, it is not uncommon for foundries to carry upwards of 60 percent to 65 percent debt. Based on a review of foundries that have actually filed for bankruptcy, a threshold of 70 percent is used.

c. Beaver's Ratio

Beaver's ratio, defined as cash flow to total debt, is another solvency test. Cash flow is measured as net income after taxes plus depreciation. Total debt is assumed the same as in the debt to assets test. A threshold of 8 percent has been chosen.

d. Plant Closure Criterion

Foundry closure estimates are based primarily on the quantitative estimates of after-compliance profitability and the ability to raise capital developed in the above tests. A foundry failing any two of the three tests is considered a potential closure for the purposes of this analysis.

The identification of potential closures in this analysis should be interpreted as an indication of the extent of plant impact rather than as a prediction of certain closure. The decision to close a foundry also involves consideration of other, highly uncertain and unquantifiable factors. However, the Agency's review of recently bankrupt metals companies, financial literature, Dun & Bradstreet composite ratios, and case-study foundries all tend to support the method chosen.

5. Other Economic Impacts

Besides potential foundry closures, other economic impacts are also analyzed and presented. These include effects on employment, communities, production, foreign trade, and small businesses.

a. Employment Impacts

In developing the model plants, changes in average plant employment for each employment size category of each metal were considered. Estimated employment impacts are based on the number of forecast closures and the average number of employees per closed plant.

b. Potential Price Impacts

To estimate potential price impacts, it was assumed that foundries could pass along the entire cost of the regulation to customers. Thus, the potential price impact is the ratio of the annual cost of the regulation to annual revenues of foundries incurring costs. (It should be noted that the assumption used for estimating closures was that no price pass-through would be possible, and foundries would bear the entire cost of the regulations.)

c. Production Impacts

To estimate potential production impacts, it was assumed that production capacity is proportional to sales. Thus, the proportion of sales accounted for by the model foundries forecast to fail is assumed to equal the proportion of foundry production capacity lost. It is likely, however, that production lost by closed foundries will be made up by expanded production at remaining foundries.

d. Balance of Trade Impacts

To estimate potential impacts on the balance of trade, imports and exports of castings both as castings and as components of products in end markets were considered. Of principal concern were both the trends in the balance of trade and the importance of imports and exports to the overall domestic castings market.

e. Community Effects

To estimate potential community effects, it was assumed that the plants that close are distributed nationally in the same manner as the total foundry population. This is necessary because the analysis uses model foundries. There is no way to determine either which actual foundries may correspond to the model foundries, or where, geographically, the specific impacts may occur.

f. Small Business Impacts

To measure the impacts on small businesses, both model compliance costs and financial data were gathered for plants of different sizes. After classifying the foundries by metal type and size (number of employees), foundries with 50 employees or less were identified as small businesses for this analysis. In establishing small business cut-offs for the final rule, EPA will relate production per plant to the employee size groups in this analysis.

D. INDUSTRY CHARACTERISTICS

EPA has determined that there were approximately 3,850 foundries in the U.S. in 1984. Of these, 1,059 generated process waste waters, including 499 indirect dischargers, 301 direct dischargers, and 259 zero dischargers. Only indirect and direct dischargers will incur capital and annual costs as a result of this regulation. Therefore, only these dischargers are analyzed in this report. As a basic industry, foundries are found throughout the country, with some concentration in the industrial areas of the East (New York, New Jersey, Pennsylvania, Massachusetts), the Midwest (Illinois, Indiana, Missouri, Ohio), the South (Texas), and the West (California).

Castings are critical components for various durable goods industries. In fact, 90 percent of all durable goods contain some castings. The castings industry was hit hard by the 1982 recession with capacity utilization and employment suffering their worst declines in many years.

Historical data indicate that the foundry industry picked up sharply after the recession, showing increases in shipments ranging from 14 to 43 percent (depending on metal cast) between 1982 and 1984. Shipments growth for ferrous castings is expected to be 2 percent through the rest of the decade, while growth of shipments of nonferrous castings is expected to be 5 percent per year through the end of the decade (Department of Commerce, Bureau of Industrial Economics).

Competition among metal types is strong in certain markets. The automotive industry is moving towards the use of lightweight castings as it strives to increase mileage ratings. Ferrous foundries must attempt to satisfy the need for these special castings in the face of competition from aluminum and zinc foundries. New markets must be found for all foundries that feel the effects of product substitution.

E. BASIS FOR COMPLIANCE COSTS

Listed below are brief descriptions of the various treatment levels being considered as possible bases for the regulation. A complete description of these technologies can be found in the Development Document for Effluent Limitations Guidelines and Standards for the Metal Molding and Casting (Foundry) Industry.

1. Option 1: Recycle and Simple Settling

Option 1 comprises high rate recycle achieved by settling (including surface skimming for free oil removed in certain segments) and recycle to the process (including pH adjustment as required to maintain water chemistry balance between scaling and corrosion), and including cooling towers for some segments, followed by settling of the blowdown stream prior to discharge. Option 1 costs include the costs for the grinding scrubber operations of aluminum, copper, ductile iron, gray iron, malleable iron, magnesium, and steel plants. Treatment for grinding scrubber operations is similar to Option 1, but requires complete recycle with no blowdown, and thus no blowdown treatment. Option 1 costs were not developed for the aluminum and zinc die casting segments or for the ferrous dust collection and wet sand reclamation segments because the treatment systems would be inadequate for the treatment of wastes from these segments.

2. Option 2: Recycle, Lime Addition, and Settling

Option 2 is designed as an "add-on" to the Option 1 facility and consists of the addition of flocculation with lime and polymer to facilitate metals precipitation and solids settling for blowdown treatment. This option also includes emulsion breaking for the aluminum and zinc die casting segments and chemical oxidation of organic matter for these two segments and for ferrous dust collection and wet sand reclamation.

3. Option 3: Recycle, Lime Addition, Settling, and Filtration

Option 3 adds filtration of the effluent from the Option 2 facility through cartridge filters, multimedia filters, and pressure filters, depending on the size of the systems.

4. Option 4: Recycle, Lime Addition, Settling, Filtration, and Carbon Adsorption

Option 4 adds carbon adsorption treatment of the effluent from the Option 3 facility. Option 4 costs were determined only for those segments where the Option 3 effluent contained toxic organic chemicals at a level that could be reduced by this method of treatment.

F. FINDINGS

This section provides a brief summary of the potential economic impacts.

1. Selection of Options

Table 1 shows the selected options for the foundry effluent guidelines. The options chosen are based on EPA's estimates of economic impacts and other factors. Effluent guidelines have been chosen for all metals except the magnesium subcategory, which is not being regulated.

Effluent guidelines for BPT (Best Practicable Control Technology Currently Achievable) are set based on removal using Option 2 technology (partial recycle of process water followed by lime addition and settling). For steel and aluminum, removals under BAT (Best Available Technology Economically Achievable), PSES (Pretreatment Standards for

TABLE 1

SELECTED OPTIONS FOR EFFLUENT GUIDELINES

	BPT	BAT	PSES	NSPS	PSNS
Gray Iron	2	3	3[a]	3	3[a]
Ductile Iron	2	3	3	3	3
Malleable Iron	2	3[b]	3[b]	3[b]	3[b]
Steel	2	2	2	2	2
Aluminum	2	2	2	2	2
Copper-Base	2	3	3	3	3
Zinc	2	3	3	3	3
Magnesium	n.r.[c]	n.r.	n.r.	n.r.	n.r.

Option 1: Recycle and simple settle
Option 2: Recycle, lime addition, and settling
Option 3: Recycle, lime addition, settling and filtration
Option 4: Recycle, lime addition, settling, filtration, and carbon adsorption

BPT: Best practicable control technolgy currently available
BAT: Best available technology economically achievable
NSPS: New source performance standards
PSES: Pretreatment standards for existing sources
PSNS: Pretreatment standards for new sources

[a]For plants with fewer than 50 employees, PSES and PSNS are set at Option 2.

[b]For plants with fewer than 100 employees, BAT, PSES, NSPS, and PSNS are set at Option 2.

[c]n.r. means not regulated.

Existing Sources), NSPS (New Source Performance Standards) and PSNS (Pretreatment Standards for New Sources) have been set equal to BPT.

In general, standards for gray iron, ductile iron, malleable iron, copper-based metals, and zinc have been set at the more stringent Option 3 treatment (partial recycle of process water followed by lime addition, settling and filtration). However, EPA has established lower levels of stringency for small gray and malleable iron foundries. For malleable iron foundries with fewer than 100 employees, BAT, PSES, NSPS, and PSNS are set equal to BPT. For gray iron foundries with fewer than 50 employees, PSES and PSNS have also been set equal to BPT.

2. Potential Plant Closure and Employment Loss Impacts

EPA has used the potential loss of employment and closure of plants as the primary measure of economic impacts. Precompliance financial statements were established using the model financial ratios presented in Chapter II. Estimated compliance costs, in 1983 dollars, were imposed on the model financial statements to estimate postcompliance financial conditions. Where the model postcompliance financial statements failed two of three tests, the number of firms estimated to have those financial statements has been forecast to fail.[1]

As shown in Tables 2 through 5, overall impacts under each of the four options are expected to be low. Under Option 1, only four foundries (two casting gray iron and two casting magnesium) are projected to close. The associated job loss of 100 employees represents 0.07 percent of the 149,287 employees of discharging foundries. Under Option 4, a total of 24 foundries are judged potential closures. The associated job loss of 724 employees represents 0.50 percent of the employment of discharging foundries.

In complying with the regulations, the estimated 800 discharging foundries would incur capital costs ranging from $43.2 million under Option 1 to $102.4 million under Option 4.[2] Total annual costs, including operating costs, interest, and depreciation, would range from $16.0 million under Option 1 to $47 million under Option 4. Aggregate impacts at all four levels are:

---

[1]As a conservative measure, impacts are estimated assuming all foundries incur costs to segregate noncontact cooling water. This was done because EPA was not able to determine the specific foundries that would incur these costs. Actually, only 30 percent are expected to incur the incremental cost.

[2]All costs in this chapter are in 1983 dollars.

TABLE 2

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
Total										
Gray Iron	91	145	4,662	8,758	1,640	3,113	2	0	2	54
Ductile Iron	27	25	3,036	1,167	1,058	413	0	0	0	0
Malleable Iron	21	29	573	1,064	205	373	0	0	0	0
Steel	43	64	1,706	2,350	614	861	0	0	0	0
Total Ferrous	182	263	9,978	13,339	3,517	4,759	2	0	2	54
Aluminum	45	131	2,524	3,627	949	1,400	0	0	0	0
Copper-base	63	54	7,946	4,355	3,369	1,650	0	0	0	0
Zinc	9	49	151	1,175	73	460	0	0	0	0
Magnesium	2	2	47	57	22	20	1	1	2	46
Total Nonferrous	119	236	10,669	9,214	4,413	3,530	1	1	2	46
Grand Total	301	499	20,647	22,553	7,930	8,290	3	1	4	100
Jobber										
Gray Iron	65	10	3,274	6,145	1,154	2,167	1	0	1	27
Ductile Iron	23	21	2,497	1,087	864	386	0	0	0	0
Malleable Iron	15	23	431	878	153	308	0	0	0	0
Steel	35	53	1,423	1,871	513	685	0	0	0	0
Total Ferrous	138	207	7,624	9,982	2,684	3,547	1	0	1	27
Aluminum	37	107	2,213	2,876	824	1,114	0	0	0	0
Copper-base	42	38	4,803	3,094	2,002	1,177	0	0	0	0
Zinc	7	38	105	834	52	334	0	0	0	0
Magnesium	2	2	47	57	22	20	1	1	2	46
Total Nonferrous	88	185	7,168	6,861	2,900	2,645	1	1	2	46
Grand Total	227	392	14,792	16,843	5,584	6,192	2	1	3	73
Captive										
Gray Iron	26	35	1,389	2,613	486	945	1	0	1	27
Ductile Iron	4	4	539	80	193	27	0	0	0	0
Malleable Iron	6	6	143	186	51	64	0	0	0	0
Steel	8	11	283	478	102	176	0	0	0	0
Total Ferrous	44	56	2,354	3,358	832	1,213	1	0	1	27
Aluminum	8	24	311	751	125	286	0	0	0	0
Copper-base	21	16	3,143	1,261	1,367	473	0	0	0	0
Zinc	2	11	47	341	21	126	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0
Total Nonferrous	31	51	3,501	2,353	1,513	886	0	0	0	0
Grand Total	76	107	5,855	5,711	2,345	2,099	1	0	1	27

TABLE 3

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
Total										
Gray Iron	91	145	13,899	19,772	6,091	8,522	3	2	5	135
Ductile Iron	27	25	6,546	2,475	2,836	1,061	0	0	0	0
Malleable Iron	21	29	2,387	2,432	1,109	1,072	0	0	0	0
Steel	43	64	4,377	5,409	1,849	2,370	0	0	0	0
Total Ferrous	182	263	27,209	30,088	11,885	13,025	3	2	5	135
Aluminum	45	131	3,040	6,005	1,337	3,230	0	0	0	0
Copper-base	63	54	8,208	4,607	3,607	1,871	0	0	0	0
Zinc	9	49	197	1,700	123	880	0	0	0	0
Magnesium	2	2	59	65	26	23	1	1	2	46
Total Nonferrous	119	236	11,504	12,377	5,093	6,004	1	1	2	46
Grand Total	301	499	38,713	42,466	16,979	19,029	4	3	7	181
Jobber										
Gray Iron	65	110	9,421	13,980	4,125	5,987	2	2	4	108
Ductile Iron	23	21	5,484	2,171	2,367	935	0	0	0	0
Malleable Iron	15	23	1,774	1,986	822	876	0	0	0	0
Steel	35	53	3,712	4,393	1,592	1,920	0	0	0	0
Total Ferrous	138	207	20,391	22,531	8,907	9,718	2	2	4	108
Aluminum	37	107	2,628	4,833	1,135	2,624	0	0	0	0
Copper-base	42	38	4,988	3,281	2,165	1,340	0	0	0	0
Zinc	7	38	138	1,243	89	665	0	0	0	0
Magnesium	2	2	59	65	26	23	1	1	2	46
Total Nonferrous	88	185	7,812	9,422	3,414	4,651	1	1	2	46
Grand Total	227	392	28,203	31,953	12,321	14,369	3	3	6	154
Captive										
Gray Iron	26	35	4,478	5,792	1,966	2,535	1	0	1	27
Ductile Iron	4	4	1,062	304	468	127	0	0	0	0
Malleable Iron	6	6	613	446	288	196	0	0	0	0
Steel	8	11	665	1,015	257	450	0	0	0	0
Total Ferrous	44	56	6,818	7,558	2,979	3,307	1	0	1	27
Aluminum	8	24	412	1,172	202	606	0	0	0	0
Copper-base	21	16	3,220	1,326	1,443	531	0	0	0	0
Zinc	2	11	59	457	34	215	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0
Total Nonferrous	31	51	3,692	2,956	1,679	1,353	0	0	0	0
Grand Total	76	107	10,510	10,514	4,658	4,660	1	0	1	27

TABLE 4

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
Total										
Gray Iron	91	145	15,702	22,152	7,099	9,892	3	6	9	243
Ductile Iron	27	25	7,450	2,799	3,341	1,245	0	1	1	27
Malleable Iron	21	29	2,641	2,736	1,259	1,245	1	0	1	71
Steel	43	64	4,854	5,900	2,144	2,691	0	0	0	0
Total Ferrous	182	263	30,647	33,587	13,843	15,073	4	7	11	341
Aluminum	45	131	3,353	6,440	1,599	3,652	0	0	0	0
Copper-base	63	54	9,012	4,944	4,173	2,112	0	0	0	0
Zinc	9	49	242	1,828	163	1,012	0	0	0	0
Magnesium	2	2	63	68	30	26	1	1	2	46
Total Nonferrous	119	236	12,669	13,280	5,964	6,801	1	1	2	46
Grand Total	301	499	43,316	46,867	19,806	21,875	5	8	13	387
Jobber										
Gray Iron	65	110	10,674	15,686	4,823	6,964	2	5	7	189
Ductile Iron	23	21	6,237	2,460	2,789	1,100	0	1	1	27
Malleable Iron	15	23	1,962	2,228	932	1,015	1	0	1	71
Steel	35	53	4,096	4,798	1,829	2,185	0	0	0	0
Total Ferrous	138	207	22,969	25,172	10,372	11,265	3	6	9	287
Aluminum	37	107	2,893	5,183	1,357	2,965	0	0	0	0
Copper-base	42	38	5,493	3,526	2,515	1,514	0	0	0	0
Zinc	7	38	170	1,338	117	765	0	0	0	0
Magnesium	2	2	63	68	30	26	1	1	2	46
Total Nonferrous	88	185	8,619	10,114	4,020	5,270	1	1	2	46
Grand Total	227	392	31,588	35,295	14,390	16,535	4	7	11	333
Captive										
Gray Iron	26	35	5,028	6,466	2,277	2,927	1	1	2	54
Ductile Iron	4	4	1,213	339	552	145	0	0	0	0
Malleable Iron	6	6	680	508	327	230	0	0	0	0
Steel	8	11	758	1,102	315	506	0	0	0	0
Total Ferrous	44	56	7,678	8,415	3,471	3,809	1	1	2	54
Aluminum	8	24	460	1,257	242	687	0	0	0	0
Copper-base	21	16	3,519	1,418	1,658	598	0	0	0	0
Zinc	2	11	72	490	45	247	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0
Total Nonferrous	31	51	4,051	3,165	1,945	1,532	0	0	0	0
Grand Total	76	107	11,729	11,580	5,416	5,341	1	1	2	54

TABLE 5

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
Total										
Gray Iron	91	145	17,816	25,041	7,945	11,450	5	13	18	486
Ductile Iron	27	25	8,171	3,111	3,621	1,434	0	1	1	27
Malleable Iron	21	29	2,931	2,994	1,376	1,398	1	1	2	142
Steel	43	64	5,455	6,381	2,352	2,891	0	0	0	0
Total Ferrous	182	263	34,373	37,526	15,295	17,172	6	15	21	655
Aluminum	45	131	4,086	8,052	1,929	4,452	0	0	0	0
Copper-base	63	54	9,583	5,700	4,460	2,487	0	0	0	0
Zinc	9	49	416	2,468	243	1,335	0	0	0	0
Magnesium	2	2	81	68	40	26	2	1	3	69
Total Nonferrous	119	239	14,166	16,289	6,673	8,299	2	1	3	69
Grand Total	301	499	48,538	53,815	21,968	25,471	8	16	24	724
Jobber										
Gray Iron	65	110	12,129	17,766	5,424	8,135	4	11	15	405
Ductile Iron	23	21	6,846	2,737	3,028	1,272	0	1	1	27
Malleable Iron	15	23	2,176	2,435	1,018	1,133	1	1	2	142
Steel	35	53	4,572	5,209	1,993	2,355	0	0	0	0
Total Ferrous	138	207	25,723	28,148	11,464	12,894	5	13	18	574
Aluminum	37	107	3,522	6,519	1,640	3,629	0	0	0	0
Copper-base	42	38	5,895	4,084	2,716	1,792	0	0	0	0
Zinc	7	38	299	1,826	176	1,012	0	0	0	0
Magnesium	2	2	81	68	40	26	2	1	3	69
Total Nonferrous	88	185	9,797	12,497	4,573	6,459	2	1	3	69
Grand Total	227	392	35,520	40,645	16,036	19,353	7	14	21	643
Captive										
Gray Iron	26	35	5,686	7,274	2,522	3,315	1	2	3	81
Ductile Iron	4	4	1,325	374	592	162	0	0	0	0
Malleable Iron	6	6	755	558	358	265	0	0	0	0
Steel	8	11	883	1,171	359	536	0	0	0	0
Total Ferrous	44	56	8,649	9,378	3,831	4,278	1	2	3	81
Aluminum	8	24	563	1,534	289	822	0	0	0	0
Copper-base	21	16	3,688	1,616	1,744	695	0	0	0	0
Zinc	2	11	117	643	67	323	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0
Total Nonferrous	31	51	4,368	3,792	2,100	1,840	0	0	0	0
Grand Total	76	107	13,017	13,170	5,931	6,118	1	2	3	81

Option	Potential Number of Closures	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)	Potential Job Loss
1	4	43,200	16,220	100
2	7	81,179	36,008	181
3	13	90,183	41,681	387
4	24	102,353	47,439	724

The potential industry impacts are concentrated in four segments: gray iron, ductile iron, malleable iron, and magnesium. Projected closures of gray iron foundries ranged from two under Option 1 to 18 under Option 4. One ductile iron foundry is judged a potential closure under Options 3 and 4. One malleable iron foundry may close under Option 3 while two may close under Option 4. The magnesium subcategory has the highest potential impacts, with two potential closures at Options 1 through 3 and three potential closures under Option 4. These closures represent 50 and 75 percent, respectively, of the magnesium foundries incurring costs.

3. Impacts of the Selected Options

Under the selected options (Table 1), six plants are projected to close. Three of these are small directly discharging gray iron foundries, two are small indirectly discharging gray iron foundries, and one is a small indirectly discharging ductile iron foundry. These six plants represent about 1 percent of the 796 foundries directly affected by this regulation. Approximately 162 jobs will be lost as a result of the six plant closures.

Total capital costs for discharging plants as a result of this regulation are estimated to be $90.4 million. Total annualized costs (including depreciation and interest) are estimated at $41.2 million (1985 dollars). Of these total amounts, BPT regulations (which are being promulgated for direct dischargers in all subcategories except magnesium) account for $39.7 million in investment and $17.4 million in annual costs. The BAT requirements that exceed BPT requirements (which affect the gray iron, ductile iron, malleable iron, zinc, and copper subcategories) amount to an additional $3.9 million in capital costs and $2.3 million in annualized costs. BAT limitations for steel, zinc, and aluminum foundries are based on BPT technology; therefore, no incremental BAT compliance costs are incurred in these subcategories.

Pretreatment standards are being promulgated for indirect dischargers in all subcategories except magnesium. Capital costs to comply with PSES are estimated at $46.7 million and annualized costs are $21.5 million (1985 dollars).

New source standards (NSPS and PSNS) are based on the same technology levels as BAT and PSES, respectively. There are no incremental costs and therefore no barriers to entry attributable to the new source standards.

The costs associated with the selected options are summarized below (in 1985 dollars):

Limitations	Capital Costs (millions)	Annualized Costs (millions)
BPT	$39.7	$17.4
BAT	3.9	2.3
PSES	46.7	21.5
	$90.4	$41.2

4. Price Impacts

The closure analysis was predicated on the inability of foundries incurring costs as a result of the regulation to pass along the costs to customers. Specifically, discharging foundries compete with both nondischarging domestic foundries (dry or zero dischargers) and with foreign foundries, neither of which incur costs as a result of these regulations. Nevertheless, an estimation is made of the potential price impacts that would result if the entire cost of compliance could be passed through by regulated foundries. The potential price impacts, measured as annual costs as a percent of total foundry sales, were less than 1 percent for 25 of the 32 metal/size categories. For complete recovery of investment costs, the affected foundries would require an average price pass-through of less than 0.5 percent for most metal segments at the selected options:

Metal	Cost/Sales (%)
Gray Iron	0.49
Ductile Iron	0.51
Malleable Iron	0.30
Steel	0.12
Aluminum	0.12
Copper-base	0.28
Zinc	0.13

5. Potential Production Loss Due to the Regulation

EPA expects that production losses caused by this regulation will be minor. Under the selected options only six foundries (five gray iron and one ductile iron) are expected to close. Those six closures could lead to a loss of about 14,000 tons per year of production, or about 0.2 percent of combined gray and ductile iron production (Table 6). Production losses of this size can be easily made up by the remaining foundries in the industry.

TABLE 6

POTENTIAL PRODUCTION IMPACTS FOR SELECTED OPTIONS

	Gray Iron	Ductile Iron
Foundries Closed	5	1
Annual Sales per Foundry ($ thousands)	947	1,053
Sales Lost ($ thousands)	4,735	1,053
Sales by Dischargers in Size Category ($ thousands)	76,708	14,742
% of Category Sales Lost	6.17	7.14
Sales by Dischargers ($ millions)	4,482	1,231
% of Sales Lost	0.11	0.09
Tons Shipped per Foundry	2,402	2,038
Tons Lost	12,010	2,038
1982 Shipments of Metals (thousand tons)	6,393	1,822
% of Metal Shipments Lost	0.19	0.11

6. Potential Balance of Trade Impacts

This regulation is expected to have no significant impact on the U.S. balance of trade. This conclusion is based on three factors:

- Imports have a minor share in the U.S. market.
- Potential price increases of affected foundries are minor.
- Most U.S. foundries incur no cost increase at all.

As shown in the EIA, foreign imports have a very small share of the U.S. market. Although some specific casting types have had strong competition from imports, foreign castings overall account for only 2.6 percent of the total castings market. International Trade Commission figures also show that exports of U.S. castings have grown at the same time that imports have grown. Based on the data, it appears that factors such as transportation costs, service and responsiveness are strong enough to outweigh the price advantage of some foreign castings.

The second factor precluding large balance of trade effects is the small potential effect on prices. For almost all affected segments, price increases are less than 0.5 percent of costs. For comparison, it should be noted that the value of the dollar fell 11 percent between February and August, 1985, leading to an equivalent increase in the cost of imported castings. Relative to such fluctuations in the cost of imports, the cost increase to affected foundries is minimal.

The third factor reflects the small number of affected foundries relative to the U.S. foundry population as a whole. Although 800 foundries discharge process waters and thus incur costs, more than 3,000 foundries do not. The competitiveness of the 3,000 foundries not incurring costs will not be affected by this regulation.

To summarize, only a fraction of foundries incur cost increases, which are minor relative to recent changes in the value of the U.S. dollar. As a result, EPA concludes that potential balance of trade impacts are minor.

7. Community Effects

Because of the use of model plant analysis to determine impacts, no way exists to determine which specific foundries will close rather than comply with the regulations. In the absence of precise community location of the affected foundries, the analysis assumes that the distribution of closures will be the same as for foundries in general. Foundries are located in four regions composed of various states, as defined in the Census of Manufactures.

The analysis of community effects has been confined to an illustrative distribution of the closures among the four regions. Closed foundries are assumed to have the same distribution as all foundries casting the metal. Half of the seven plant closures at the selected options might occur in the North Central region, with the remainder distributed evenly in each of the other regions.

Because of the small number of closures spread over the four regions and the low total employment loss, significant adverse impacts in any one community are not expected.

8. Small Business Impacts

For this analysis, EPA has generally taken a small foundry to be one employing fewer than 50 employees. Based on their generally larger size, EPA has used a size cut-off of 100 employees for malleable iron foundries.

At the selected options, six foundries may close rather than comply. Of these, five are small (10-49 employee) gray iron foundries, while one is a small (10-49 employee) ductile iron foundry. These closures represent 3 percent of the 250 directly and indirectly discharging foundries. In setting standards, EPA has mitigated small business impacts by exempting magnesium foundries from the regulation (all of these are small plants) and by setting less stringent standards for small gray and malleable iron foundries. These less stringent requirements result in approximately seven fewer plant closures.

CHAPTER I

INTRODUCTION

I. INTRODUCTION

This study assesses the economic impacts likely to result from the effluent guidelines, limitations, and standards applicable to the foundry industry. These regulations are based on Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES) which are being issued under authority of Sections 301, 304, 306, and 307 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977. The primary economic impact variables assessed in this study include the costs of the effluent regulations and the potential for these regulations to cause plant closures, price changes, job losses, changes in industry profitability, structure and competition, shifts in the balance of foreign trade, new source impacts, and impacts on small businesses. However, this study includes new cost information developed since proposal. The basis for the costs estimates is presented elsewhere in the Development Document for Effluent Limitations Guidelines and Standards for the Metal Molding and Casting (Foundries) Point Source Category.

This report is organized as follows:

- Chapter II presents the structure of the industry. No extrapolation is made to baseline conditions in Chapter II. Instead, the basic, historical production and financial information used in the analysis is presented.

- Chapter III presents the methodology. The emphasis in this chapter has been on an overview of the analytical techniques used. More detailed discussions of the justification for and implications of certain methodological parameters, and actual calculations are given in the Appendices and in Chapter VIII, Limitations of the Analysis.

- Chapter IV summarizes the effluent control and guideline costs used as the basis for the analysis. These costs reflect EPA's most recent cost estimates, based on extensive studies of the EPA's survey data base. Costs have been developed in 1983 dollars.

- Chapter V presents the analysis of economic impacts. This chapter contains the estimated closures by metal type and employment size, and ancillary analyses of community effects, production impacts, potential price impacts and balance of trade impacts.

- Chapter VI presents the regulatory flexibility analysis. In accordance with the Regulatory Flexibility Act, this study has analyzed the impacts on small business. For this study, a delineation of size based on number of employees has been used. This chapter also describes the alternatives chosen by EPA to mitigate impacts on small plants.

- Chapter VII presents estimates of the effects of these standards on new sources (plants opening subsequent to promulgation of the rules).

- Chapter VIII presents the limitations of the analysis. Particular attention has been given to reconciling data from different sources.

In addition to the body of the report, two appendices have been provided. Appendix A contains a detailed discussion of the literature on financial statement analysis, the basis for the financial tests chosen for this study, and the basis for the threshold values chosen.

CHAPTER II

STRUCTURE OF THE INDUSTRY

II. STRUCTURE OF THE INDUSTRY

This chapter presents the historical basis for the economic analysis presented in this report, including information on foundry technology and markets, historical trends in foundry shipments, and the financial performance of foundries. In most cases, the information is presented in terms of how it is used in the analysis, which is explained in Chapter III.

A. TECHNOLOGY

The unique feature of the foundry industry is the pouring or injection of molten metal into a mold. The cavity of the mold represents, within close tolerances, the final dimensions of the product. One of the major advantages of this process is that intricate metal shapes, which are not easily made by other methods of fabrication, can be produced. A second advantage is the potential to rapidly develop a finished product from a new design.

The Department of Commerce categorizes industries into Standard Industrial Classifications, with major groupings at the 2-, 3-, 4- and 5-digit levels. For this analysis, EPA has categorized foundries by the major metal cast. In most cases this corresponds to Standard Industrial Classifications (SIC) codes at the 4-digit level:

- gray iron (SIC 3321, except 33211 and 33212)
- ductile iron (SIC 33211 and 33212)
- malleable iron (SIC 3322)
- steel (SIC 3324 and 3325)
- aluminum (SIC 3361)
- copper and copper-based alloys (SIC 3362)
- zinc and zinc-based alloys (SIC 33691)
- magnesium and magnesium-based alloys (SIC 33692)

These categorizations recognize that metals have sufficiently different characteristics that most foundries choose to cast only one metal. Data from the Census of Manufactures show that foundries typically receive 80 to 95 percent of their total revenues from castings of their primary metal, and that plants whose principal business is casting account for 80 to 90 percent of all castings (See Table II-1).

B. TRENDS IN INDUSTRY SHIPMENTS

Individual metals have physical properties that make them particularly well-suited to different purposes. Thus, while castings shipments generally reflect overall trends in the economy, shipments of individual metals show varying trends.

As seen in Table II-2, foundry shipments dropped sharply during the recession of 1982. Relative to 1978, the year of EPA's survey of the industry, the quantity of shipments declined between 30 percent (for

TABLE II-1

SPECIALIZATION AND COVERAGE RATIOS FOR THE METAL MOLDING AND CASTING INDUSTRY

Metal	Ratio	1972	1977	1982
Gray and Ductile Iron	Specialization (%)[a]	94	96	94
	Coverage (%)[b]	87	88	91
Malleable Iron	Specialization (%)	87	86	83
	Coverage (%)	91	93	76
Steel[c]	Specialization (%)	89	87	91
	Coverage (%)	88	91	90
Aluminum	Specialization (%)	84	87	87
	Coverage (%)	89	92	92
Copper, Brass, and Bronze	Specialization (%)	84	85	88
	Coverage (%)	81	74	85
Nonferrous Metals, NEC	Specialization (%)	83	85	85
	Coverage (%)	79	77	77

SOURCE: 1982 Census of Manufactures, Preliminary Report Industry Series.

[a] The specialization ratio is the ratio of primary product shipments (products in the primary 4-digit industry) to total product shipments for establishments classified in the industry.

[b] The coverage ratio is the ratio of primary products shipped by establishments classified in the industry to total shipments of such products by all manufacturing establishments, wherever classified.

[c] Based on steel, not elsewhere classified (SIC 3325).

TABLE II-2

QUANTITY OF SHIPMENTS

Year	Gray Iron (millions of tons)	Ductile Iron (millions of tons)	Malleable Iron (millions of tons)	Steel NEC (millions of tons)	Aluminum (billions of pounds)	Copper-Base (billions of pounds)	Zinc (billions of pounds)	Magnesium (billions of pounds)
1972	13.467	1.835	0.961	1.584	1.916	0.920	0.938	0.050
1973	14.801	2.246	1.031	1.894	2.113	0.966	1.080	0.054
1974	13.458	2.203	0.912	2.091	1.857	0.857	0.843	0.058
1975	10.547	1.823	0.729	1.974	1.455	0.700	0.712	0.038
1976	11.923	2.245	0.848	1.767	1.971	0.682	0.869	0.053
1977	12.371	2.736	0.829	1.677	2.153	0.702	0.789	0.058
1978	13.140	2.984	0.790	1.857	2.287	0.743	0.760	0.051
1979	12.512	2.890	0.715	2.039	2.303	0.793	0.665	0.028
1980	9.399	2.400	0.450	1.879	1.690	0.592	0.486	0.025
1981	9.610	2.191	0.422	1.743	1.820	0.581	0.471	0.023
1982	6.393	1.822	0.284	1.017	1.605	0.456	0.405	0.018
1983	7.180	2.067	0.291	0.729	1.822	0.552	0.516	0.024
1984	8.014	2.607	0.360	0.956	1.830	0.625	0.565	0.024[a]

SOURCE: U.S. Bureau of the Census, Current Industrial Reports.

[a]Estimated. Bureau of the Census estimates approximately 2-1/2 to 5 percent increase in magnesium castings from 1983 to 1984.

aluminum) and 65 percent (for magnesium). As shown in Table II-3, however, increases in castings prices have meant that the decline in castings value has not been as sharp.

Gray iron castings are used in applications requiring high strength without necessarily having maximum workability and resistance to impact. The largest market for gray iron castings is in automotive markets, but they are also used for piping, molds for steel ingots, construction, and other uses. Shipments of gray iron castings reached their peak in 1973, as trends to smaller and lighter cars have reduced automotive consumption since then. Gray iron castings suffered fairly sharp drops in shipments between 1978 and 1982, losing 51 percent of the tonnage shipped. Between 1982 and 1984, gray iron castings shipments increased 25 percent, to about 60 percent of 1978 values.

Ductile iron is a variant of gray iron with improved workability and resistance to fracture. It is used in similar markets, particularly pressure pipe and fittings and automotive applications. Ductile iron is also used in many of the applications formerly served by malleable iron, and has taken over some of those markets because of lower cost. Shipments of ductile iron castings reached their peak in 1978. In 1982 ductile iron shipments slipped to 61 percent of 1978 shipments. By 1984, shipments of ductile iron castings had reached 87 percent of 1978 values.

Malleable iron castings are produced by annealing a brittle "white iron" to transform the carbon content to agglomerations of graphite. The resulting material has relatively high strength and workability, properties that led to its wide use in automotive markets. The market share of malleable iron has declined considerably because of displacement by ductile iron, while automotive use of all iron castings has declined because of increased automobile imports and trends to smaller, lighter cars. Since 1972, malleable iron shipments reached a peak volume in 1973. Malleable iron shipments suffered severely in 1982, reaching only 37 percent of the 1978 value. By 1984, shipments had risen 26 percent, to 46 percent of 1978 values.

Steel castings are preferred because of their high strength, weldability, strength and resistance to impacts. On average, steel castings have the highest price per ton of all ferrous castings. The major markets for steel castings are for heavy capital goods and railroads. Because of the difference in markets, steel castings shipments increased between 1978 and 1980, while shipments of other castings declined. Steel casting shipments reached their lowest point in 1983, at only 39 percent of shipments in 1978. In 1984, steel castings shipments recovered to just over half the value of 1978.

Aluminum is easily cast and machinable, with good thermal and electrical conductivity properties. Because of aluminum's light weight, aluminum castings are widely used in transportation markets, such as motor vehicles and aerospace. Shipments of aluminum castings rose fairly steadily through the 1970's, reaching their peak in 1979. Aluminum castings suffered the smallest decline of any metal,

TABLE II-3

VALUE OF SHIPMENTS

(billions of dollars)

	Gray Iron	Ductile Iron	Malleable Iron	Steel	Aluminum	Copper-Base	Zinc	Magnesium
1972	3.428	0.605	0.485	1.288	1.172	0.463	0.402	0.041
1973	4.281	0.809	0.534	1.505	1.398	0.535	0.505	0.050
1974	5.085	0.981	0.627	2.066	1.745	0.620	0.417	0.056
1975	4.849	1.230	0.561	2.486	1.536	0.494	0.308	0.045
1976	5.498	1.454	0.640	2.480	1.963	0.566	0.405	0.053
1977	6.212	1.623	0.670	2.640	2.294	0.616	0.610	0.083
1978	6.971	1.873	0.680	3.047	2.614	0.690	0.606	a
1979	7.184	1.967	0.708	3.754	3.160	0.862	0.658	0.125
1980	6.142	1.697	0.494	4.047	3.135	0.879	0.556	0.139
1981	6.757	1.816	0.508	3.953	3.326	0.888	0.572	0.118
1982	6.288	1.655	0.371	2.973	2.811	0.715	0.563	0.092

SOURCE: U.S. Bureau of the Census, Annual Survey of Manufactures.

[a]Data not reported by Census because of statistical problems.

maintaining more than 70 percent of 1978 values. By 1984, aluminum castings reached 80 percent of 1978 values.

Copper-base castings, including brass and bronze, are commonly used in the water-handling and plumbing markets. As a result, copper castings production generally fluctuates with the domestic housing market. After reaching a peak in 1973, copper casting shipments first slumped through the mid-1970's, then rose until 1979. At the low point of the 1981 to 1983 recession, shipments of copper-based castings were 61 percent of 1978 values. By 1984, shipments recovered 37 percent, to 84 percent of 1984 values.

Historically, most demand for zinc castings has been in the automotive industry. Through the 1970's zinc lost some of that market to aluminum castings and molded plastics because of price and weight considerations. Zinc casting shipments reached a peak in 1973, dropped through 1975, recovered in 1976, and dropped steadily through 1982. Shipment values in 1982 were 53 percent of those in 1978. By 1984, zinc shipments had recovered to 74 percent of 1978 values.

Magnesium is the smallest of the eight major cast metals both in dollars and tonnage. Magnesium castings command a premium price because of their production costs and very light weight. In 1980, only 120 foundries cast magnesium, a factor that would contribute to its scarcity and price. Magnesium tonnage declined sharply from peaks in 1977. Shipments in 1978 were only 35 percent of 1978 values. By 1984, shipments rose to approximately 47 percent of 1978 values.

C. NUMBER OF FOUNDRIES AFFECTED BY THE REGULATION

Because of the large size of the foundry industry, EPA did not conduct an industry-wide survey to determine the specific foundries that would be affected by this regulation. Instead, EPA has combined publicly available data with the results of its own section 308 survey (including follow-up efforts) to estimate the number of affected foundries.

In summary, EPA used the 1978 directory of the foundry industry developed by Penton Publications as the starting point for a detailed survey. EPA then sent out questionnaires to 1,147 plants, receiving a total of 919 responses. Since 1978, the year of the survey, EPA has received information about an additional 347 plants.

On reviewing the information from these 1,266 plants, EPA found that many foundries were misclassified as to principal metal or size in the Penton directory. Misclassifications of metal type were particularly severe in the ferrous metal subcategories, where foundries reported that their castings included higher fractions of ductile and malleable iron, and lower amounts of gray iron and steel. Therefore, EPA relied heavily on its survey data to allocate the total foundry count into subcategories.

TABLE II-4

FOUNDRY POPULATION OPERATING IN 1984

Metal	Fewer than 10 Employees	10 to 49 Employees	50 to 99 Employees	100 to 249 Employees	250 or more Employees	Total
Gray Iron	81	360	167	169	101	878
Ductile Iron	7	66	22	43	25	163
Malleable Iron	5	23	43	54	22	147
Steel	36	108	91	67	36	338
Total Ferrous	129	557	323	333	184	1,526
Aluminum	476	575	142	114	44	1,351
Copper-base	232	324	77	27	6	666
Zinc	86	116	41	34	10	287
Magnesium	6	10	4	0	3	23
Total Nonferrous	800	1,025	264	175	63	2,327
Grand Total	929	1,582	587	508	247	3,853

SOURCE: Penton Publications and EPA surveys. Data from Penton Publications were used for the count of foundries in each nonferrous metal and for the aggregate cost of ferrous foundries. Proportions of ferrous foundries in each specific metal were determined from EPA survey data.

TABLE II-5

PROJECTED NUMBER OF ACTIVE WET PLANTS IN INDUSTRY (1984)

Metal	Employee Group	Discharge Modes: Direct	Indirect	Zero Discharge	Total
Gray Iron	Fewer than 10	0	2	2	4
	10 to 49	14	38	29	81
	50 to 99	14	27	24	65
	100 to 249	32	48	38	118
	250 or more	31	30	14	75
	Overall	91	145	107	343
Ductile Iron	Fewer than 10	0	0	0	0
	10 to 49	0	9	5	14
	50 to 99	0	3	5	8
	100 to 249	16	11	3	30
	250 or more	11	2	6	19
	Overall	27	25	19	71
Malleable Iron	Fewer than 10	0	0	0	0
	10 to 49	0	0	0	0
	50 to 99	3	5	8	16
	100 to 249	11	22	5	38
	250 or more	7	2	6	15
	Overall	21	29	19	69
Steel	Fewer than 10	2	0	0	2
	10 to 49	0	10	9	19
	50 to 99	11	21	5	37
	100 to 249	19	19	10	48
	250 or more	11	14	3	28
	Overall	43	64	27	134
Aluminum	Fewer than 10	7	0	6	13
	10 to 49	9	61	33	103
	50 to 99	6	20	7	33
	100 to 249	14	41	7	62
	250 or more	9	9	3	21
	Overall	45	131	56	232

(continued)

TABLE II-5 (Continued)

Metal	Employee Group	Discharge Modes			Total
		Direct	Indirect	Zero Discharge	
Copper	Fewer than 10	16	11	0	27
	10 to 49	20	28	4	52
	50 to 99	16	5	8	29
	100 to 249	6	6	3	15
	250 or more	5	4	1	10
	Overall	63	54	16	133
Zinc	Fewer than 10	0	2	1	3
	10 to 49	0	17	6	23
	50 to 99	0	13	2	15
	100 to 249	7	13	2	22
	250 or more	2	4	1	7
	Overall	9	49	12	70
Magnesium	Fewer than 10	0	0	1	1
	10 to 49	2	2	0	4
	50 to 99	0	0	2	2
	100 to 249	0	0	0	0
	250 or more	0	0	0	0
	Overall	2	2	3	7
TOTALS OF ALL METALS		301	499	259	1,059

SOURCE: EPA

TABLE II-6

CALCULATION OF AVERAGE SALES PER FOUNDRY

Metal/Size	Production[a] Short Tons per Day	Production[a] Short Tons per Year[b]	Yield (%)[a]	Tons Shipped per Year	1983 Average Price (thousand dollars per short ton)	1983 Average Sales per Foundry (thousand dollars per short ton)	Ratio of Shipments 1982-78 (Steel 1983-78)	Revised Sales per Foundry	Number of Dischargers[c]	Sales by Dischargers (thousand dollars)
Gray Iron										
Fewer than 10	20	5,200	0.66	3,432	0.810	2,781	0.486530	1,353	4	5,411
10 to 49	14	3,640	0.66	2,402	0.810	1,946	0.486530	947	81	76,708
50 to 99	38	9,880	0.66	6,521	0.810	5,283	0.486530	2,570	65	167,080
100 to 249	161	41,860	0.66	27,628	0.810	22,384	0.486530	10,891	118	1,285,095
250 or more	581	151,060	0.66	99,700	0.810	80,778	0.486530	39,301	75	2,947,575
Total									343	4,481,869
Ductile Iron										
Fewer than 10	20	5,200	0.56	2,912	0.846	2,464	0.610590	1,504	0	0
10 to 49	14	3,640	0.56	2,038	0.846	1,725	0.610590	1,053	14	14,742
50 to 99	38	9,880	0.56	5,533	0.846	4,681	0.610590	2,858	8	22,865
100 to 249	161	41,860	0.56	23,442	0.846	19,832	0.610590	12,109	30	363,278
250 or more	581	151,060	0.56	84,594	0.846	71,568	0.610590	43,699	19	830,275
Total									71	1,231,159
Malleable Iron										
Fewer than 10	20	5,200	0.48	2,496	1.666	4,160	0.359494	1,495	0	0
10 to 49	14	3,640	0.48	1,747	1.666	2,912	0.359494	1,047	0	0
50 to 99	38	9,880	0.48	4,742	1.666	7,903	0.359494	2,841	16	45,458
100 to 249	161	41,860	0.48	20,093	1.666	33,484	0.359494	12,037	38	457,417
250 or more	581	151,060	0.48	72,509	1.666	120,834	0.359494	43,439	15	651,583
Total									69	1,154,458
Steel										
Fewer than 10	20	5,200	0.59	3,068	2.719	8,342	0.392569	3,275	2	6,550
10 to 49	14	3,640	0.59	2,148	2.719	5,840	0.392569	2,292	19	43,557
50 to 99	38	9,880	0.59	5,829	2.719	15,850	0.392569	6,222	37	230,227
100 to 249	161	41,860	0.59	24,697	2.719	67,156	0.392569	26,363	48	1,265,432
250 or more	581	151,060	0.59	89,125	2.719	242,344	0.392569	95,137	28	2,663,825
Total									134	4,209,591

(Continued)

TABLE II-6 (Continued)

CALCULATION OF AVERAGE SALES PER FOUNDRY

Metal/Size	Production[a]		Yield (%)[a]	Tons Shipped per Year	1983 Average Price (thousand dollars per short ton)	1983 Average Sales per Foundry (thousand dollars per short ton)	Ratio of Shipments 1982-78 (Steel 1983-78)	Revised Sales per Foundry	Number of Dischargers[c]	Sales by Dischargers (thousand dollars)
	Short Tons per Day	Short Tons per Year[b]								
Aluminum										
Fewer than 10	12	3,120	0.71	2,215	4.074	9,024	0.701990	6,335	13	82,356
10 to 49	6	1,560	0.71	1,108	4.074	4,512	0.701990	3,168	103	326,257
50 to 99	32	8,320	0.71	5,907	4.074	24,065	0.701990	16,894	33	557,487
100 to 249	65	16,900	0.71	11,999	4.074	48,882	0.701990	34,315	62	2,127,532
250 or more	134	34,840	0.71	24,736	4.074	100,773	0.701990	70,742	21	1,485,577
Total									232	4,579,208
Copper-base										
Fewer than 10	8	2,080	0.69	1,435	1.786	2,563	0.612874	1,571	27	42,416
10 to 49	110	28,600	0.69	19,734	1.786	35,245	0.612874	21,601	52	1,123,250
50 to 99	72	18,720	0.69	12,917	1.786	23,070	0.612874	14,139	29	410,025
100 to 249	258	67,080	0.69	46,285	1.786	82,666	0.612874	50,664	15	759,961
250 or more	153	39,780	0.69	27,448	1.786	49,023	0.612874	30,045	10	300,450
Total									133	2,636,102
Zinc										
Fewer than 10	0.9	234	0.83	194	3.570	693	0.533279	370	5	1,849
10 to 49	7	1,820	0.83	1,511	3.570	5,393	0.533279	2,876	23	66,145
50 to 99	15	3,900	0.83	3,237	3.570	11,556	0.533279	6,163	15	92,439
100 to 249	82	21,320	0.83	17,696	3.570	63,173	0.533279	33,689	22	741,158
250 or more	25	6,500	0.83	5,395	3.570	19,260	0.533279	10,271	7	71,897
Total									72	973,489
Magnesium										
Fewer than 10	0.2	52	0.62	32	6.342	204	0.357499	73	1	73
10 to 49	0.8	208	0.62	129	6.342	818	0.357499	292	4	1,170
50 to 99	10	2,600	0.62	1,612	6.342	10,224	0.357499	3,655	2	7,310
100 to 249	0	0	0.62	0	6.342	0	0.357499	0	0	0
250 or more	0	0	0.62	0	6.342	0	0.357499	0	0	0
Total									7	8,553
Grand Total										19,274,428

[a]Based on data collected by EPA between 1978-1984.

[b]Based on 260 operating days per year.

[c]Includes direct, indirect and zero dischargers.

TABLE II-7

FINANCIAL RATIOS FOR GRAY IRON FOUNDRIES[a]

(includes Ductile Iron)

	Upper Quartile	Median	Lower Quartile
Employee Size: Fewer than 10			
Return on Sales (%)	13.58	8.53	4.70
Sales to Net Worth (times)	1.61	2.60	5.15
Debt to Net Worth (%)	9.59	51.73	188.78
Net Fixed Assets to Net Worth (%)	25.93	37.51	89.19
Employee Size: 10 to 49			
Return on Sales (%)	7.18	4.32	2.61
Sales to Net Worth (times)	1.96	3.01	4.39
Debt to Net Worth (%)	27.63	67.92	136.42
Net Fixed Assets to Net Worth (%)	6.24	36.50	71.62
Employee Size: 50 to 99			
Return on Sales (%)	6.41	4.10	2.64
Sales to Net Worth (times)	2.27	3.32	4.99
Debt to Net Worth (%)	32.04	82.47	184.13
Net Fixed Assets to Net Worth (%)	23.15	56.62	93.59
Employee Size: 100 to 249			
Return on Sales (%)	5.23	3.82	1.42
Sales to Net Worth (times)	2.30	3.26	4.37
Debt to Net Worth (%)	41.11	68.98	122.24
Net Fixed Assets to Net Worth (%)	42.31	59.27	74.34
Employee Size: 250 or more			
Return on Sales (%)	5.57	3.86	2.40
Sales to Net Worth (times)	2.17	2.66	3.13
Debt to Net Worth (%)	64.92	82.47	121.84
Net Fixed Assets to Net Worth (%)	52.25	86.30	109.52
All			
Depreciation to Gross Fixed Assets	6.9941	6.9941	6.9941
Gross Fixed Assets to Net Fixed Assets (times)	2	2	2

[a]Development of the quartiles and quartile financial ratios is explained in Chapter III.

SOURCES:

1. For ratios that vary by size: Review of FINSTAT.
2. Depreciation to Gross Fixed Assets: Annual Survey of Manufactures, 1978.
3. Gross Fixed Assets to Net Fixed Assets: EPA estimates.

TABLE II-8

FINANCIAL RATIOS FOR MALLEABLE IRON FOUNDRIES[a]

	Upper Quartile	Median	Lower Quartile
Employee Size: Fewer than 10			
Return on Sales (%)			
Sales to Net Worth (times)		No discharging foundries.	
Debt to Net Worth (%)			
Net Fixed Assets to Net Worth (%)			
Employee Size: 10 to 49			
Return on Sales (%)	8.87	6.62	.64
Sales to Net Worth (times)	1.26	1.94	4.08
Debt to Net Worth (%)	25.11	44.69	124.99
Net Fixed Assets to Net Worth (%)	0.0	7.99	49.49
Employee Size: 50 to 99[b]			
Return on Sales (%)	7.38	3.10	2.31
Sales to Net Worth (times)	1.04	2.66	17.74
Debt to Net Worth (%)	68.98	108.54	1,185.96
Net Fixed Assets to Net Worth (%)	26.81	68.50	504.26
Employee Size: 100 to 249[b]			
Return on Sales (%)	7.38	3.10	2.31
Sales to Net Worth (times)	1.04	2.66	17.74
Debt to Net Worth (%)	68.98	108.54	1,185.96
Net Fixed Assets to Net Worth (%)	26.81	68.50	504.26
Employee Size: 250 or more			
Return on Sales (%)	7.01	4.42	1.04
Sales to Net Worth (times)	2.18	2.67	4.04
Debt to Net Worth (%)	32.60	55.69	103.18
Net Fixed Assets to Net Worth (%)	38.95	57.26	70.01
All			
Depreciation to Gross Fixed Assets	6.3805	6.3805	6.3805
Gross Fixed Assets to Net Fixed Assets (times)	2	2	2

[a]Development of the quartiles and quartile financial ratios is explained in Chapter III.

[b]Financial data for the 50 to 99 and 100 to 249 employment size groups were merged because of insufficient sample size.

SOURCES:
1. For ratios that vary by size: Review of FINSTAT.
2. Depreciation to Gross Fixed Assets: Annual Survey of Manufactures, 1978.
3. Gross Fixed Assets to Net Fixed Assets: EPA estimates.

TABLE II-9

FINANCIAL RATIOS FOR STEEL FOUNDRIES[a]

	Upper Quartile	Median	Lower Quartile
Employee Size: Fewer than 10			
Return on Sales (%)	14.00	7.07	4.67
Sales to Net Worth (times)	1.01	2.64	3.41
Debt to Net Worth (%)	11.53	36.17	121.20
Net Fixed Assets to Net Worth (%)	4.72	38.13	124.76
Employee Size: 10 to 49			
Return on Sales (%)	11.55	8.00	6.45
Sales to Net Worth (times)	2.10	3.11	4.24
Debt to Net Worth (%)	55.60	113.71	201.99
Net Fixed Assets to Net Worth (%)	0.0	7.39	66.04
Employee Size: 50 to 99			
Return on Sales (%)	3.83	2.55	1.90
Sales to Net Worth (times)	2.47	3.55	5.49
Debt to Net Worth (%)	33.21	76.65	139.27
Net Fixed Assets to Net Worth (%)	26.82	29.56	63.98
Employee Size: 100 to 249			
Return on Sales (%)	8.71	4.67	1.04
Sales to Net Worth (times)	2.52	2.97	4.65
Debt to Net Worth (%)	72.52	115.52	186.83
Net Fixed Assets to Net Worth (%)	0.0	43.98	97.75
Employee Size: 250 or more			
Return on Sales (%)	6.98	4.64	2.68
Sales to Net Worth (times)	2.68	3.33	4.36
Debt to Net Worth (%)	77.66	114.32	213.47
Net Fixed Assets to Net Worth (%)	59.36	73.49	104.07
All			
Depreciation to Gross Fixed Assets	7.4435	7.4435	7.4435
Gross Fixed Assets to Net Fixed Assets (times)	2	2	2

[a]Development of the quartiles and quartile financial ratios is explained in Chapter III.

SOURCES:

1. For ratios that vary by size: Review of FINSTAT.
2. Depreciation to Gross Fixed Assets: Annual Survey of Manufactures, 1978.
3. Gross Fixed Assets to Net Fixed Assets: EPA estimates.

TABLE II-11

FINANCIAL RATIOS FOR COPPER FOUNDRIES[a]

	Upper Quartile	Median	Lower Quartile
Employee Size: Fewer than 10			
Return on Sales (%)	23.73	7.08	2.81
Sales to Net Worth (times)	1.62	3.14	5.54
Debt to Net Worth (%)	10.34	34.26	84.45
Net Fixed Assets to Net Worth (%)	5.68	34.01	73.39
Employee Size: 10 to 49			
Return on Sales (%)	8.24	5.44	3.51
Sales to Net Worth (times)	2.19	3.59	5.51
Debt to Net Worth (%)	21.91	67.60	143.31
Net Fixed Assets to Net Worth (%)	12.84	32.20	62.15
Employee Size: 50 to 99			
Return on Sales (%)	11.58	8.24	3.61
Sales to Net Worth (times)	2.07	2.33	4.09
Debt to Net Worth (%)	33.38	71.51	148.05
Net Fixed Assets to Net Worth (%)	18.63	24.96	56.97
Employee Size: 100 to 249			
Return on Sales (%)	3.36	2.75	2.08
Sales to Net Worth (times)	3.76	3.84	3.98
Debt to Net Worth (%)	52.12	72.66	158.25
Net Fixed Assets to Net Worth (%)	33.54	37.51	40.79
Employee Size: 250 or more			
Return on Sales (%)	6.11	5.24	4.36
Sales to Net Worth (times)	2.41	3.03	3.48
Debt to Net Worth (%)	118.97	133.43	156.40
Net Fixed Assets to Net Worth (%)	52.25	73.14	93.40
All			
Depreciation to Gross Fixed Assets	6.2122	6.2122	6.2122
Gross Fixed Assets to Net Fixed Assets (times)	2	2	2

[a]Development of the quartiles and quartile financial ratios is explained in Chapter III.

SOURCES:
1. For ratios that vary by size: Review of FINSTAT.
2. Depreciation to Gross Fixed Assets: Annual Survey of Manufactures, 1978.
3. Gross Fixed Assets to Net Fixed Assets: EPA estimates.

TABLE II-12

FINANCIAL RATIOS FOR NONFERROUS, NEC FOUNDRIES[a]

(includes Magnesium and Zinc)

	Upper Quartile	Median	Lower Quartile
Employee Size: Fewer than 10			
Return on Sales (%)	17.51	11.86	4.43
Sales to Net Worth (times)	1.59	2.52	6.14
Debt to Net Worth (%)	9.09	40.13	104.28
Net Fixed Assets to Net Worth (%)	3.54	30.94	60.24
Employee Size: 10 to 49			
Return on Sales (%)	7.87	4.72	2.58
Sales to Net Worth (times)	2.50	3.30	5.43
Debt to Net Worth (%)	47.98	83.26	141.92
Net Fixed Assets to Net Worth (%)	16.46	35.84	59.52
Employee Size: 50 to 99			
Return on Sales (%)	4.84	3.59	2.45
Sales to Net Worth (times)	3.17	4.36	6.05
Debt to Net Worth (%)	60.74	154.32	192.55
Net Fixed Assets to Net Worth (%)	28.60	47.42	70.62
Employee Size: 100 to 249			
Return on Sales (%)	5.23	2.80	2.29
Sales to Net Worth (times)	3.13	4.03	4.83
Debt to Net Worth (%)	57.62	122.08	146.83
Net Fixed Assets to Net Worth (%)	22.20	51.12	76.09
Employee Size: 250 or more			
Return on Sales (%)	5.37	4.59	3.25
Sales to Net Worth (times)	2.80	3.46	4.26
Debt to Net Worth (%)	88.51	137.94	207.18
Net Fixed Assets to Net Worth (%)	75.12	98.92	107.71
All			
Depreciation to Gross Fixed Assets	6.8369	6.8369	6.8369
Gross Fixed Assets to Net Fixed Assets (times)	2	2	2

[a]Development of the quartiles and quartile financial ratios is explained in Chapter III.

SOURCES:
1. For ratios that vary by size: Review of FINSTAT.
2. Depreciation to Gross Fixed Assets: Annual Survey of Manufactures, 1978.
3. Gross Fixed Assets to Net Fixed Assets: EPA estimates.

TABLE II-13

SEPARATION OF FERROUS EMPLOYMENT-SIZE SEGMENTS BETWEEN JOBBER AND CAPTIVE FOUNDRIES

Employment Size Segment	Proportions	
	Jobber	Captive
Gray Iron		
Fewer than 10	78%	22%
10 to 49	83	17
50 to 99	78	22
100 to 249	78	22
250 or more	61	39
Total	78	22
Ductile Iron		
Fewer than 10	50	50
10 to 49	63	37
50 to 99	89	11
100 to 249	89	11
250 or more	80	20
Total	77	23
Malleable Iron		
Fewer than 10	67	33
10 to 49	100	0
50 to 99	77	23
100 to 249	77	23
250 or more	77	23
Total	77	23
Steel		
Fewer than 10	63	37
10 to 49	86	14
50 to 99	84	16
100 to 249	84	16
250 or more	80	20
Total	82%	18%

TABLE II-14

SEPARATION OF NONFERROUS EMPLOYMENT-SIZE SEGMENTS BETWEEN JOBBER AND CAPTIVE FOUNDRIES

Employment Size Segment	Proportions	
	Jobber	Captive
Aluminum		
Fewer than 10	80%	20%
10 to 49	83	17
50 to 99	84	16
100 to 249	84	16
250 or more	74	26
Total	82	18
Copper Base		
Fewer than 10	80	20
10 to 49	79	21
50 to 99	56	44
100 to 249	56	44
250 or more	29	71
Total	76	24
Zinc		
Fewer than 10	52	48
10 to 49	77	23
50 to 99	83	17
100 to 249	83	17
250 or more	60	40
Total	70	30
Magnesium		
Fewer than 10	0	100
10 to 49	71	29
50 to 99	100	0
100 to 249	100	0
250 or more	--	--
Total	78%	22%

SOURCE: EPA Surveys.

regarded as captive foundries. The jobber/captive separation was based on data from the 1978 308 survey and its 1981 telephone update. To determine the number of jobber and captive foundries for each employment segment of each metal, the proportion of jobber and captive foundries was applied to the numbers of foundries in each segment. Table II-13 shows the proportion of jobber and captive foundries for the ferrous metals, while Table II-14 presents comparable information for the nonferrous metals.

In computing the economic impacts, captive foundries were treated as though the financial decisions were made on a plant-by-plant basis and subject to the same financial tests as jobbers. The Agency has concluded, in accordance with current financial theory and in line with comments received by many parties on previous foundry analyses, that parent corporations treat their operations in different industries as separate companies, subject to the normal financial structure and restrictions of those industries. The Agency recognizes that this may undervalue any benefits of conglomeration, such as centralized accounting and scheduling, lower corporate borrowing costs, etc.

F. ANALYSIS OF IMPORTS AND EXPORTS

Domestic industries operate increasingly in a competitive world market. Foreign competition is important to this analysis in two major ways. If foreign imports are a significant fraction of domestic consumption, then the ability of domestic foundries to pass along any cost increases may be greatly constrained. Also, if domestic producers perceive significant pressure from importers of castings, then there may be impacts on profits as domestic foundries seek to keep prices low. Recently, the U.S. International Trade Commission (ITC) reviewed foreign trade in the castings market. The investigation, made at the request of the U.S. Trade Representative, was intended to determine whether imported castings were restraining the performance of the foundry industry.

Overall, imports and exports represent a very small fraction of the domestic casting market. According to ITC data, exports rose from 2.4 percent of domestic shipments in 1979 to 4.2 percent of domestic shipments in 1982, declining to 3.9 percent of shipments in 1983. Imported castings rose from 1.0 percent of domestic shipments in 1979 to 2.6 percent in 1983. These numbers show imports and exports to be a small fraction of the total domestic market, but also show that imports have been making progressive inroads. They also show that net exports as a percentage of U.S. markets are still quite close to 1979 levels.

Year	Total Shipments (million $)	Exports (million $)	Imports (million $)	Percent Exports	Percent Imports
1979	21551	508	210	2.4	1.0
1980	20560	749	253	3.6	1.2
1981	22197	805	358	3.6	1.6
1982	16349	684	387	4.2	2.3
1983	15873	614	424	3.9	2.6

Source: U.S. International Trade Commission, 1984, p. 39

The foundry industry experiences competition not only directly from raw castings, but indirectly from imported end products that contain castings. To evaluate the potential impact, EPA examined the castings content and the import/export patterns of 39 end markets. The end markets represented 47 percent of total castings demand in 1977, and an estimated 54 percent in 1982. Table II-15 shows the end markets used for the analysis, while Table II-16 shows the results. Assuming that average castings content in each of the end markets remained constant between 1977 and 1982, it is apparent that net exports (value of exports minus value of imports) grew in both nominal and constant dollars between 1972 and 1982. Also, net exports grew in nominal dollars between 1977 and 1982, although they remained nearly constant in constant 1972 dollars.

Although overall levels of imports are low, the ITC found that import penetration has been severe in some individual product lines. Imports as a fraction of consumption were found to range from 10 percent to 37 percent for some categories of castings. Import penetration has been and is expected to continue to be most significant in the area of standardized, simple-to-manufacture, price-sensitive castings, such as iron construction castings, fittings, and valves, where foreign competitors can take advantage of the large U.S. market, lower labor cost, and other price-related advantages. The International Trade Commission found that average prices on imported products range from 15 percent to 28 percent lower than comparable prices on domestically produced products. Respondents to the ITC investigation claim various responses to the foreign competition: lowered prices, suppressed price increases, and cost reduction efforts. Some producers reported reduced production and curtailed expansion plans.

In the long run, the ability of U.S. foundries to compete with foreign sources hinges on three factors: (1) the maintenance of existing servicing and other marketing advantages, (2) the restriction of price increases through productivity gains, and (3) the value of the U.S. dollar relative to other currencies. The first two of these factors are largely within the control of U.S. producers; the third is not. Of these three factors, the value of the U.S. dollar is probably preeminent. Between 1980 and February 1985 the value of the dollar rose

TABLE II-15

LIST OF END MARKETS USED FOR EXPORT ANALYSIS

SIC	Industry	SIC	Industry
3441	Fabricated Structural Metal	3554	Paper Industries Machinery
3444	Sheet Metal Work	3555	Printing Trades Machinery
3448	Prefabricated Metal Buildings	3561	Pumps and Pumping Equipment
3465	Automotive Stampings	3562	Ball and Roller Bearings
3494	Valves and Pipe Fittings	3563	Air and Gas Compressors
3511	Turbines and Generator Sets	3564	Blowers and Fans
3523	Farm Machinery and Equipment	3567	Industrial Furnaces and Ovens
3524	Lawn and Garden Equipment	3573	Electronic Computing Equipment
3531	Construction Machinery	3579 } 3572 }	Office Machines & Typewriters
3532	Mining Machinery		
3533	Oil Field Machinery	3585	Air Conditioning
3534	Elevators and Moving Stairs	3711	Motor Vehicles and Car Bodies
3535	Conveyors and Conveying Equipment	3714	Motor Vehicle Parts and Accessories
3536	Hoists, Overhead Cranes, Monorails	3715	Truck Trailers
		3721	Aircraft
3537	Industrial Trucks and Tractors	3724	Aircraft Engines and Parts
3541	Machine Tools-Metal Cutting	3728	Aircraft Equipment, NEC
3542	Machine Tools-Metal Forming	3769	Space Vehicles and Equipment
3544	Special Dies, Tools, Etc.	3811	Engineering and Scientific Instruments
3546	Power Hand Tools		
3551	Food Products Machinery	3825	Electricity-Measuring Instruments
3552	Textile Machinery		

TABLE II-16

RESULTS OF IMPORT/EXPORT ANALYSIS

(values in million dollars)

	1972	1977	1982
Iron			
Value of materials consumed in end markets	2,680.9	4,488.3	4,750.6
Value as included in net exports, nominal $	75.1	228.5	300.7
Value as included in net exports, 1972 $	75.1	129.1	116.1
Steel			
Value of materials consumed in end markets	591.0	1,338.9	1,771.6
Value as included in net exports, nominal $	65.3	202.0	307.3
Value as included in net exports, 1972 $	65.3	114.1	118.6
Aluminum			
Value of materials consumed in end markets	629.3	1,153.6	1,355.9
Value as included in net exports, nominal $	21.4	65.1	91.2
Value as included in net exports, 1972 $	21.4	37.2	37.2
Copper			
Value of materials consumed in end markets	88.1	145.1	193.9
Value as included in net exports, nominal $	5.5	12.7	12.5
Value as included in net exports, 1972 $	5.5	7.3	5.0

SOURCE: Bureau of Census, Census of Manufactures; U.S. Industrial Outlook.

Note: Net exports = (value of exports) - (value of imports).

53 percent against foreign currencies. Between February 1985 and August 1985, the dollar fell about 11 percent. Swings of this magnitude outweigh probable gains in productivity. Nevertheless, continued gains in productivity and maintenance of marketing-related advantages will be essential for U.S. foundries to retain their current market share.

In summary, imports have had a real effect in some specific casting markets, while the threat of imports may be restricting price increases for a wide range of castings. As yet, however, the overall importation of castings is very small, less than three percent of the total U.S. castings shipments. Overall, the principal source of competition to the 800 discharging foundries that are projected to incur costs is still the 3,053 dry or non-discharging, wet foundries that will not incur costs because of this rulemaking.

CHAPTER III

METHODOLOGY

III. METHODOLOGY

A. OVERVIEW

This chapter shows how EPA dealt with three crucial issues in the development of the economic impact analysis:

- how to estimate the number of affected plants
- how to estimate compliance costs
- how to estimate impacts.

Although these issues are vital in the development of any effluent guideline, they took on a special prominance for this industry. The foundry industry is broad and diverse. In 1981, there were almost 4,000 foundries employing more than 300,000 people. Many of the plants are independently owned (jobbers), for which there are few reliable data sources. These data have been supplemented by publicly-available composites such as U.S. Bureau of the Census reports and with privately-generated databases such as Dun & Bradstreet financial profiles. By combining these data sources, EPA has obtained a comprehensive financial database for the industry using the best available data sources. EPA has further categorized the industry by conducting surveys of the industry, with data collected between 1978 and 1984.

Nine foundry processes have the potential to generate process waters, with no foundry in the survey database having more than seven in-plant processes. Because of the large number of plants, and the small number of individual discharging processes, EPA has determined economic impacts by developing "model" plants. Each model plant has average sales and compliance costs, but one of several sets of financial ratios.

The remainder of this chapter is arranged in the following steps:

- estimation of the number of affected plants,
- estimation of compliance costs,
- development of model plants,
- estimation of impacts.

This chapter does not provide detailed results, but rather shows the methodology used.

B. ESTIMATION OF THE NUMBER OF AFFECTED PLANTS

A critical element of this analysis is estimating the number of plants subject to the regulation. That estimate is used to determine the aggregate national cost of the regulation, the number of plants potentially suffering economic distress, and the significance of the impacts in terms of the overall industry.

1. Baseline Year for Compliance

The first step is to establish the baseline year for compliance. Over the past 15 years, the foundry industry has been marked by a gradual decline in the foundry population. The deep recession of 1982 induced additional closures, while economic growth since then has led to some plant openings.

Although indirect dischargers need not comply until 1988, EPA has assumed that all foundries, both direct and indirect, will have complied with the guidelines by 1986. Use of 1986 as the baseline year assumes that foundries may require up to a year to arrange financing for design, construction, and installation of pollution control equipment. EPA has not forecast conditions to 1988 because of the difficulty in projecting beyond a year or two. If conditions continue to improve as they have since 1982, impacts forecast for indirect dischargers may be mitigated.

2. Use of Publicly Available Censuses

Although there are several sources of data on the number of foundries, the two prominent ones are the U.S. Bureau of the Census Census of Manufactures and Penton Publications Metal Casting Industry Directory. The Census of Manufactures is more complete than the Penton directory, in that it includes data on sales, production, and employment. However, the Census of Manufactures has two deficiencies:

- The most recent complete Census of Manufactures available for this analysis represents data from 1977;
- It excludes data for many foundries that are part of larger operations in other SIC codes.

The most recent Penton directory represents data from 1983. EPA was able to update the number of plant openings and closings through 1984 through telephone conversations with Penton Publications. EPA believes these data represent the most complete and current count of the foundry industry.

EPA is using the 1984 count of foundries obtained from Penton as the population potentially affected by the regulation. EPA believes that the 1986 foundry population will approximate the 1984 population.

If plants in EPA's database have closed since 1984 because of general economic conditions, the impacts caused by the regulation may be overstated. If new plants have opened since 1984, EPA feels it likely that they will either be in a stronger position to absorb regulatory costs, or will have incorporated effluent controls into the plant design in anticipation of the regulation. EPA believes it extremely unlikely that a foundry opening after 1984 would close because of costs associated with this regulation.

3. Incorporation of EPA Survey Data

Neither the Bureau of the Census nor Penton Publications distinquish between foundries that generate process waters and those that do not. As documented in the technical record, EPA conducted a survey of the foundry industry in 1978[1]. The data collected were specifically oriented, among other things, towards obtaining an estimate of the number of discharging foundries, the types of discharging processes, and the type and amount of pollutant discharged. In response to comments, EPA has expanded and verified the survey.

Results of the survey and additional data gathering have been used in the estimation of the number of affected plants in two ways. First, the 308-based distribution of plants casting ferrous metals (which did not agree with data from Penton) has been used to estimate the number of plants in each ferrous subcategory. The disagreement was particularly large in the malleable iron and ductile iron subcategories. In 1978, Penton estimated that there were 56 malleable iron foundries. However, between 1978 and 1984, EPA obtained data from 63 foundries principally casting malleable iron. Based on the 308-based ratio of malleable iron plants to the total count of ferrous plants, EPA estimates that a total of 147 foundries currently cast malleable iron. Penton also reported a plant count of 83 ductile iron foundries in 1978. However, EPA's survey results showed that many foundries not listed as ductile iron foundries by Penton cast ductile iron as their principal metal. Based on EPA's data, ductile iron foundries represent 11 percent of all ferrous foundries, leading to an overall estimate of 163 ductile iron foundries.

Second, EPA used its survey data to estimate the number of foundries generating and discharging process waste waters. EPA noted substantial differences between metals in the casting processes used, the extent of wastewater generation, and the fraction of plants discharging process waste waters. Details of this analysis may be found in the technical record supporting this regulation.

4. Comparison to Analyses Previously Developed For This Industry

In previous analyses supporting this regulation, EPA projected the foundry population at promulgation from a basis in the 1978 or 1981 Penton directories. At proposal, (EPA, Economic Analysis of Proposed Effluent Limitations and Standards for the Foundry Industry, 1982) EPA projected the industry population by using historical rates for the creation and closing of foundries. In subsequent analyses (EPA, Economic Analysis of Proposed Effluent Limitations and Standards for the Metal Molding and Casting (Foundry) Industry, Supplemental Analysis,

---

[1]The survey was conducted under the authority of Section 308 of the Clean Water Act, and is thus referred to as the "308 survey." Its product was a group of more than 1,200 Data Collection Portfolios (dcp's).

downward to reflect decreased industry shipments between 1978 and 1982. Second, EPA has developed costs for the various combinations of discharging processes that occur commonly in the foundry industry. Third, EPA has combined the one-time capital costs and the operating costs into a single equivalent annual cost. Fourth, the capital costs have been increased to account for those foundries that commingle process water and noncontact cooling water. A detailed study of 20 plants showed that 6 (or 30 percent) would benefit from installing separate piping to carry noncontact cooling water. These 30 percent incur increases in capital costs ranging from 14.8 percent at Option 1 to 7.4 percent at Option 4. Estimates of potential closures due to compliance are based on an assumption that all foundries incur costs to segregate noncontact cooling water. This is a conservative assumption that reflects EPA's inability to specify those foundries in the affected population that will have to install a segregation system. However, the compliance cost estimates presented in this report accurately reflect the proportion actually incurring the additional cost (30 percent).

1. Adjustment of Costs for Revised Production Estimates

Since EPA's survey in 1978, the foundry industry suffered a severe recession in 1982. EPA recognizes that the decline has reduced average foundry shipments, and has adjusted its per plant revenue estimates accordingly (see discussion below). The adjustments are based on estimated production declines in the industry from 1978 through the recession in 1982. (For one segment, steel, production continued to decline through 1983.) Production declines for individual metals range from 30 to 65 percent. Use of these production decline factors also serves to bring estimated revenues more in line with other published sources, notably Census. EPA has chosen to use its own estimates, as revised, rather than other reported values, for three reasons:

- the production estimates are based on data submitted by 438 wet foundries in all size groups;
- not all foundries will have recovered equally from the recession; and
- conflicting estimates from other sources suggest the use of a lower estimate is appropriate to ensure that impacts are not underestimated.

To maintain consistency, EPA has also estimated corresponding reductions in capital and operating costs. These cost reductions incorporated the concept of "economies of scale." Engineers have found that increases in capacity generally do not require proportionate increases in cost. As an approximation, engineers use cost curves of the form

$$C_2 = C_1\left(\frac{P_2}{P_1}\right)^x$$

Where: P is production
C is cost
x is the cost adjustment exponent

Thus, the cost at production level 2 is equal to the cost at production level 1 times the ratio of production at level 2 to production at level 1, raised to the cost adjustment exponent.

These cost adjustment exponents may be different for each metal, employment size, and discharging process. In reviewing its data, EPA developed a total of 22 cost adjustment factors (11 for capital costs, 11 for annual costs), with values ranging from 0.05 to 0.93.[3] As an example of the impact of the cost adjustment factors, we can analyze the affect of a 50 percent reduction in production:

Impacts of 50 Percent Reduction in Production	
Cost Exponent	Cost Reduction (percent)
0.05	3
0.93	48
1.00	50

Using a factor of 0.05, a 50 percent reduction in revenue will lead to only a 3 percent reduction in treatment costs.

2. Estimate of Cotreatment Savings

Although cost estimates were separately developed for each individual discharging process, many foundries have several processes that each create a flow of process wastewater. For the same reasons used to develop cost factors, it is generally less expensive to treat a single larger stream than to install facilities to treat several smaller streams separately.

EPA analyzed several combinations of processes that it believes are typical of the foundry industry, and found that foundries cotreating the discharges from several processes gain significant benefits -- 36 percent of operating costs and 28.9 percent of capital costs. EPA has incorporated these savings into the estimated costs for any plant with two or more discharging processes.

3. Development of Annual Costs

EPA estimated compliance impacts by combining capital costs and operating and maintenance costs into a single equivalent annual cost.

---

[3]These cost adjustment factors may be found in the economic record supporting these effluent guidelines.

Annual costs are composed of two segments: operating costs imposed by requirements for power, labor, maintenance, chemicals, monitoring, and sludge and oil disposal, and capital recovery costs incurred in financing the equipment. As indicated, the operating costs were based on technical considerations as described in the Development Document in the public record. Capital recovery costs consist of the charges for depreciation and interest. As presented at proposal, depreciation charges were based upon a 10-year straight line depreciation. Interest charges were calculated as follows:

average interest charges = capital recovery - average principal payment

$$= P\left(\frac{i(1+i)^n}{(1+i)^n-1}\right) - \frac{P}{n}$$

Where: P = capital cost of control technology
i = rate of interest
n = number of years over which the capital equipment is depreciated and financed.

The analysis uses the DRI 1986 prime rate projection of 10.89 percent as the basis for computing interest expense with all plants paying a premium over the prime rate. Interest charges are based on a sliding scale with larger plants paying a lower interest premium:

Size	Premium over Prime Rate (percent)
Fewer than 10 employees	6
10 to 49 employees	6
50 to 99 employees	5
100 to 249 employees	5
250 or more employees	3

Thus, the interest rate used for foundries with 250 or more employees is 13.89 percent.

An example of capital and annual costs for the aluminum category for 10 to 49 employees is shown in Table III-1.

D. DEVELOPMENT OF MODEL PLANTS

This analysis relies on the use of model plants to represent the industry. Both technical and economic models were established. To provide sufficient detail, the industry was subcategorized at several levels: by metal, by employment size category, by discharge mode, by type of foundry (jobber or captive) and by financial status.

To estimate impacts, EPA developed financial models of typical plants. Data for the analysis were obtained from four major sources,

TABLE III-1

SAMPLE COMPLIANCE COSTS PER PLANT - ALUMINUM

(size = 10-49 employees)

(thousands of 1983 dollars)

Combination of Discharging Technologies	Mode	Number of Jobbers	Number of Captives	Total Dis-chargers	Option 1		Option 2		Option 3		Option 4	
					Capital	Annual	Capital	Annual	Capital	Annual	Capital	Annual
Casting Cleaning/ Casting Quench	Direct	3	1	4	34.6	14.0	43.1	16.8	45.8	19.3	52.6	22.9
Casting Cleaning/ Casting Quench/ Die Casting	Direct	1	0	1	34.6	14.0	61.5	30.5	65.6	34.3	79.7	41.6
Die Casting	Direct	3	1	4	0.0	0.0	25.9	20.8	27.8	22.7	38.1	28.2
Casting Quench	Indirect	17	3	20	17.4	9.4	23.4	11.4	25.3	13.1	34.9	18.5
Casting Quench/ Die Casting	Indirect	3	1	4	12.4	6.3	35.0	21.4	37.6	23.5	51.7	30.8
Casting Quench/ Mold Cooling	Indirect	3	1	4	44.7	19.2	53.5	23.2	56.9	26.1	73.3	33.9
Die Casting	Indirect	10	2	12	0.0	0.0	25.9	20.8	27.5	22.3	37.8	27.9
Die Casting/ Mold Cooling	Indirect	4	1	5	32.3	12.9	55.3	29.2	58.5	32.0	75.4	40.0
Die Casting/ Melting Furnace Scrubber	Indirect	3	1	4	15.6	7.1	40.5	26.4	44.1	29.3	51.4	33.0
Investment Casting	Indirect	4	1	5	37.1	14.4	42.6	17.1	51.9	21.8	67.4	29.4
Mold Cooling	Indirect	1	0	1	45.5	19.1	51.8	23.1	54.8	25.7	68.3	32.1
Melting Furnace Scrubber	Indirect	0	1	1	21.9	10.6	31.1	19.2	34.4	22.0	34.4	22.0
Dust Collection	Indirect	4	1	5	37.0	13.0	42.5	17.0	44.9	19.2	44.9	19.2

discussed below. Briefly, EPA combined estimates of average sales per foundry with values of financial ratios to construct pro forma, precompliance financial statements (balance sheets and income statements). EPA then incorporated the capital and annual costs of compliance into the financial statements to estimate the pro forma, postcompliance financial status of each plant.

1. Use of Subcategories

As stated, EPA developed model plants to estimate impacts. To obtain a sufficient degree of differentiation, EPA established models for many subcategories of the industry.

a. Metal Type

The first subcategorization was by metal type. Available data show that foundries generally specialize in a single metal. Census data show that in general the foundries casting a specific type of metal cast more than 90 percent of all production of that metal, and typically derive more than 90 percent of their revenue from casting that metal (see Chapter II). Also, different metals have different characteristics, and thus different potential end markets. Because of these differences, EPA has used eight metal types to represent the industry. In this analysis, the metals are ordered by Standard Industrial Classification (SIC) code:

SIC	METAL
3321	Gray iron (except ductile iron)
33211	Ductile iron (includes 33212)
3322	Malleable iron
3325	Steel (includes 3324)
3361	Aluminum
3362	Copper, Brass and Bronze (copper-base)
33691	Zinc
33692	Magnesium

b. Size Category

The foundry industry encompasses a wide range of sizes. The Census of Manufactures reports plant sizes ranging from fewer than five to more than 2,500 employees. EPA recognizes the potential for different impacts for foundries of different sizes. Based on its analysis of the industry and public comments, EPA has used five employment size segments to represent the industry:

- fewer than 10 employees
- 10 to 49 employees
- 50 to 99 employees

- 100 to 249 employees
- 250 or more employees.

Use of these size categories, combined with each of the eight metal categories, leads to a potential of 40 separate metal/employment size subcategories. In fact, EPA data show several metal/employment size subcategories with no discharging foundries.

The subcategories with no discharging foundries are ductile iron with fewer than 10 employees, malleable iron with fewer than 49 employees, steel with fewer than 10 employees, copper with fewer than 10 employees, and magnesium with fewer than 10 or more than 49 employees.

c. Jobber/Captive Category

EPA further recognizes that plant ownership may affect a plant's response to regulation. Previous EPA regulations have shown two categories of ownership. Jobber foundries are independently owned and operated plants selling castings on the open market. Captive foundries are plants that sell or transfer their products to other operations of the same company. The percentages of jobber and captive foundries in each subcategory were reported in Chapter II.

In computing the economic impacts, captive foundries were treated as though the financial decisions were made on a plant-by-plant basis and subject to the same financial tests as jobbers. The Agency has concluded, in accordance with current financial theory, that parent corporations most often treat their operations in different industries as separate companies, subject to the normal financial structure and restrictions of those industries. The Agency recognizes that this may undervalue any benefits of conglomeration, such as centralized accounting and scheduling, lower corporate borrowing costs, etc. For reasons explained more fully in Chapter VIII, Limitations of the Analysis, this treatment is believed to overstate impacts on the captive segment of the industry.

d. Economic Quartile Category

EPA recognizes that different foundries in the same size category casting the same metal may have different financial health. EPA has addressed this issue by using economic quartiles.

The concept of quartiles originates in statistics. If several items are measured, the individual measurements can be arranged in order of size. For example, if a group of similar castings were weighed, one would find that they did not have identical weights. The values of the weights can then be sorted, smallest to largest, and broken into four segments. The lowest one-fourth (one-quarter) of all values is the lowest quartile range. The upper one-fourth of values is the upper quartile range. The lower quartile value is the value separating the lower quartile from the second quartile, and is the value that exceeds one-fourth of all values. The upper quartile value is the value separating the upper quartile from the third quartile, and is the value that exceeds three-fourths of all values. The value separating the second and third quartiles is the median, and is the value that exceeds one-half of all values.

For this analysis, EPA has grouped financial ratios into quartiles. EPA has used the lower quartile value to represent all values in the lower quartile range. The upper quartile value is used to represent all values in the upper quartile range. The median value is used to represent all values in the second and third quartiles.

As discussed below, EPA has developed quartile and median values for four separate financial ratios: return on sales, sales to net worth, debt to net worth, and net fixed assets to net worth. These ratios have been combined to form three sets of financial ratios for each metal/employment size category, and are used to create three separate financial statements. EPA assumes that the lower and upper quartile statements each represent 25 percent of a metal/employment size category, while the median represents 50 percent.

2. Estimation of Precompliance Financial Statements

In this analysis, EPA has used model plants to represent the affected foundries. Precompliance financial statements were developed in three steps: first, estimated sales were developed for each metal/employment size subcategory; second, the ratios of various financial statement items were developed from various data sources for three quartiles of financial health; third, average sales were combined with the financial ratios to create three separate financial statements in each metal/employment size subcategory.

a. Estimation of Average Sales Per Foundry

Assumptions about sales per foundry play a critical role in the economic analysis, because foundry sales are used to establish firm size and income. The data from EPA's 308 survey form the basis for establishing cost estimates. To maintain consistency, EPA has based its estimate of average sales on the production figures reported by the survey respondents. Forecasted sales were adjusted to reflect the overall industry decrease in production from 1978 to the lowest point since then. For most metals, 1982 represented the lowest industry production level. For steel, however, 1983 was the year with the lowest tonnage shipped. These adjustment serve (1) to provide a conservative estimate of impacts, and (2) to make the revenue estimates more consistent with other sources, such as Census.

Recent data show the industry is recovering to some extent from the 1982 levels (see Table III-2). EPA has used the lower levels as a prudent measure in capturing impacts. To the extent the economic recovery in the industry continues, the impacts may be overstated. If the recovery slackens to 1982 levels, however, the impacts will not be understated. Given the improvements in most subcategories since 1982, the impacts presented in this analysis may be overstated.

TABLE III-2

TRENDS IN SHIPMENTS

Year	QUANTITY							
	Gray Iron	Ductile Iron	Malleable Iron	Steel NEC	Aluminum	Copper-Base	Zinc	Magnesium
	(millions of tons)				(billions of pounds)			
1972	13.467	1.835	0.961	1.584	1.916	0.920	0.938	0.050
1973	14.801	2.246	1.031	1.894	2.113	0.966	1.080	0.054
1974	13.458	2.203	0.912	2.091	1.857	0.857	0.843	0.058
1975	10.547	1.823	0.729	1.974	1.455	0.700	0.712	0.038
1976	11.923	2.245	0.848	1.767	1.971	0.682	0.869	0.053
1977	12.371	2.736	0.829	1.677	2.153	0.702	0.789	0.058
1978	13.140	2.984	0.790	1.857	2.287	0.743	0.760	0.051
1979	12.512	2.890	0.715	2.039	2.303	0.793	0.665	0.028
1980	9.399	2.400	0.450	1.879	1.690	0.592	0.486	0.025
1981	9.610	2.191	0.422	1.743	1.820	0.581	0.471	0.023
1982	6.393	1.822	0.284	1.017	1.605	0.456	0.405	0.018
1983	7.180	2.067	0.291	0.729	1.822	0.552	0.516	0.024
1984	8.014	2.607	0.360	0.956	1.830	0.625	0.565	0.024[a]
	PERCENTAGE CHANGE							
1978-82	-51	-39	-64	-45	-30	-39	-47	-65
1982-84	+25	+43	+27	-6	+14	+37	+40	+33
1978-84	-39	-13	-54	-49	-20	-16	-26	-53

SOURCE: U.S. Bureau of the Census, Current Industrial Reports.

[a]Estimated. Bureau of the Census estimates approximately 2-1/2 to 5 percent increase in magnesium castings from 1983 to 1984.

The calculation of average sales was conducted in four steps. The first step calculated the average sales price per casting, in dollars per unit weight. While different types of castings have different values on a price per pound basis, these differences seem unrelated to the size of the company. An average castings price was estimated using preliminary data from the 1982 Census of Manufactures, extrapolated to 1983 dollars using wholesale price indices. The Census of Manufactures reports both the quantity of shipments and the value of castings at the 7-digit SIC code level. For all categories listed, the quantity of shipments and the value were obtained. The value divided by the quantity is equal to the base price of castings in 1982 dollars. This price was then escalated to 1983 dollars using the price indices for ferrous and nonferrous metals in the 1984 U.S. Industrial Outlook, published by the Department of Commerce Bureau of Industrial Economics.

The second step determined the average shipments of castings. Average production and yield data were derived from responses to EPA's data collection efforts. These responses, collected in Data Collection Portfolios, are in the technical record. Table III-3 presents the average production and yield data, as well as the average annual sales per foundry, for each metal and size group.

The third step consisted of a simple multiplication of the average shipments times the average price of castings. The fourth step adjusted the average sales figures downward to reflect reductions in industry shipments from 1978 to 1982. In making this adjustment, EPA recognizes that sales vary from year to year. Industry sales in 1982 (or 1983 for steel) were the lowest in decades and represent the deepest recession since World War II. Use of 1982 shipment data thus present the lowest shipment data consistent with EPA's survey of 438 wet plants. As previously stated, the shipment data are now more consistent with other sources.

b. Estimation of Ratios

In the second phase of establishing precompliance financial statements, EPA estimated values for six financial statement ratios:

- sales to net worth (S/NW)
- return on sales (ROS)
- debt to net worth (D/NW)
- net fixed assets to net worth (NFA/NW)
- gross fixed assets to net fixed assets, and
- depreciation to gross fixed assets.

For the first four ratios, EPA used the FINSTAT database to estimate quartile values. This database (described below) has been developed and maintained by the Small Business Administration, and incorporates data from Dun & Bradstreet and Standard and Poor. In using this database, EPA eliminated the records of firms with ratios failing the closure criteria, as described below. To estimate the ratio of gross fixed assets to net fixed assets, EPA reviewed annual reports and Form 10-Ks submitted to the Securities and Exchange Commission by

TABLE III-3

CALCULATION OF AVERAGE SALES PER FOUNDRY

Metal/Size	Production[a] Short Tons per Day	Production[a] Short Tons per Year[b]	Yield (%)[a]	Tons Shipped per Year	1983 Average Price (thousand dollars per short ton)	1983 Average Sales per Foundry (thousand dollars per short ton)	Ratio of Shipments 1982-78 (Steel 1983-78)	Revised Sales per Foundry	Number of Dischargers[c]	Sales by Dischargers (thousand dollars)
Gray Iron										
Fewer than 10	20	5,200	0.66	3,432	0.810	2,781	0.486530	1,353	4	5,411
10 to 49	14	3,640	0.66	2,402	0.810	1,946	0.486530	947	81	76,708
50 to 99	38	9,880	0.66	6,521	0.810	5,283	0.486530	2,570	65	167,080
100 to 249	161	41,860	0.66	27,628	0.810	22,384	0.486530	10,891	118	1,285,095
250 or more	581	151,060	0.66	99,700	0.810	80,778	0.486530	39,301	75	2,947,575
Total									343	4,481,869
Ductile Iron										
Fewer than 10	20	5,200	0.56	2,912	0.846	2,464	0.610590	1,504	0	0
10 to 49	14	3,640	0.56	2,038	0.846	1,725	0.610590	1,053	14	14,742
50 to 99	38	9,880	0.56	5,533	0.846	4,681	0.610590	2,858	8	22,865
100 to 249	161	41,860	0.56	23,442	0.846	19,832	0.610590	12,109	30	363,278
250 or more	581	151,060	0.56	84,594	0.846	71,568	0.610590	43,699	19	830,275
Total									71	1,231,159
Malleable Iron										
Fewer than 10	20	5,200	0.48	2,496	1.666	4,160	0.359494	1,495	0	0
10 to 49	14	3,640	0.48	1,747	1.666	2,912	0.359494	1,047	0	0
50 to 99	38	9,880	0.48	4,742	1.666	7,903	0.359494	2,841	16	45,458
100 to 249	161	41,860	0.48	20,093	1.666	33,484	0.359494	12,037	38	457,417
250 or more	581	151,060	0.48	72,509	1.666	120,834	0.359494	43,439	15	651,583
Total									69	1,154,458
Steel										
Fewer than 10	20	5,200	0.59	3,068	2.719	8,342	0.392569	3,275	2	6,550
10 to 49	14	3,640	0.59	2,148	2.719	5,840	0.392569	2,292	19	43,557
50 to 99	38	9,880	0.59	5,829	2.719	15,850	0.392569	6,222	37	230,227
100 to 249	161	41,860	0.59	24,697	2.719	67,156	0.392569	26,363	48	1,265,432
250 or more	581	151,060	0.59	89,125	2.719	242,344	0.392569	95,137	28	2,663,825
Total									134	4,209,591

(Continued)

TABLE III-3 (Continued)

CALCULATION OF AVERAGE SALES PER FOUNDRY

Metal/Size	Production[a]		Yield (%)[a]	Tons Shipped per Year	1983 Average Price (thousand dollars per short ton)	1983 Average Sales per Foundry (thousand dollars per short ton)	Ratio of Shipments 1982-78 (Steel 1983-78)	Revised Sales per Foundry	Number of Dischargers[c]	Sales by Dischargers (thousand dollars)
	Short Tons per Day	Short Tons per Year[b]								
Aluminum										
Fewer than 10	12	3,120	0.71	2,215	4.074	9,024	0.701990	6,335	13	82,356
10 to 49	6	1,560	0.71	1,108	4.074	4,512	0.701990	3,168	103	326,257
50 to 99	32	8,320	0.71	5,907	4.074	24,065	0.701990	16,894	33	557,487
100 to 249	65	16,900	0.71	11,999	4.074	48,882	0.701990	34,315	62	2,127,532
250 or more	134	34,840	0.71	24,736	4.074	100,773	0.701990	70,742	21	1,485,577
Total									232	4,579,208
Copper-base										
Fewer than 10	8	2,080	0.69	1,435	1.786	2,563	0.612874	1,571	27	42,416
10 to 49	110	28,600	0.69	19,734	1.786	35,245	0.612874	21,601	52	1,123,250
50 to 99	72	18,720	0.69	12,917	1.786	23,070	0.612874	14,139	29	410,025
100 to 249	258	67,080	0.69	46,285	1.786	82,666	0.612874	50,664	15	759,961
250 or more	153	39,780	0.69	27,448	1.786	49,023	0.612874	30,045	10	300,450
Total									133	2,636,102
Zinc										
Fewer than 10	0.9	234	0.83	194	3.570	693	0.533279	370	5	1,849
10 to 49	7	1,820	0.83	1,511	3.570	5,393	0.533279	2,876	23	66,145
50 to 99	15	3,900	0.83	3,237	3.570	11,556	0.533279	6,163	15	92,439
100 to 249	82	21,320	0.83	17,696	3.570	63,173	0.533279	33,689	22	741,158
250 or more	25	6,500	0.83	5,395	3.570	19,260	0.533279	10,271	7	71,897
Total									72	973,489
Magnesium										
Fewer than 10	0.2	52	0.62	32	6.342	204	0.357499	73	1	73
10 to 49	0.8	208	0.62	129	6.342	818	0.357499	292	4	1,170
50 to 99	10	2,600	0.62	1,612	6.342	10,224	0.357499	3,655	2	7,310
100 to 249	0	0	0.62	0	6.342	0	0.357499	0	0	0
250 or more	0	0	0.62	0	6.342	0	0.357499	0	0	0
Total									7	8,553
Grand Total										19,274,428

[a]Based on data collected by EPA between 1978-1984.

[b]Based on 260 operating days per year.

[c]Includes direct, indirect and zero dischargers.

publicly held companies. These data showed that net (depreciated) fixed assets range from 40 to 60 percent of gross (historical value) fixed assets. EPA assumed that net fixed assets are 50 percent of gross fixed assets for all metals and employment size categories. EPA used data from the Bureau of Census Annual Survey of Manufactures to obtain the ratio of depreciation to gross fixed assets. Census reports the total gross fixed assets and depreciation for each industry at the 4-digit SIC level.

In summary, the ratios used and their sources are

Ratio	Source
Return on Sales	FINSTAT
Sales to Net Worth	FINSTAT
Debt to Net Worth	FINSTAT
Net Fixed Assets to Net Worth	FINSTAT
Gross Fixed Assets to Net Fixed Assets	Review of Financial Statements
Depreciation to Gross Fixed Assets	Annual Survey of Manufactures

(1) Description of the FINSTAT Database

The Small Business Administration (SBA) maintains the FINSTAT database so that it may assess the impacts of policies or regulations on firms of different sizes. The data in FINSTAT are originally collected by Dun & Bradstreet (D&B) as part of its credit reporting activities, and includes more than 3 million records spanning the 1975-1984 period.

SBA has leased the database from D&B and made several improvements. First, SBA merged data for large publicly-held corporations with the D&B database by incorporating data from Compustat (a database established by Standard and Poor). Second, where firms have supplied both interim and final statements to D&B, SBA removed the interim statements as being less reliable. Third, SBA reviewed each financial statement against five financial criteria that test the validity of balance sheet identities. Fourth, SBA developed "outlier" tests that removed a small fraction of firms having financial ratios substantially removed from the norm. By modifying the database through these four steps, SBA reduced the number of financial statements from about 3.4 million to about 1.4 million valid statements. Although ratios available from Dun & Bradstreet come from the same original data as FINSTAT, the data in FINSTAT have undergone more rigorous verification.

(2) Use of FINSTAT by EPA

SBA supplied approximately 2,000 financial records for firms whose SIC codes corresponded to the foundry industry. These records were of financial statements from the 1975 to 1984 time period. Upon review of the data, EPA determined that many of the records were not suitable for the analysis because they (1) failed to meet SBA's criteria for financial reasonableness, or (2) had financial ratios that failed the criteria established by EPA for its closure tests (see below). EPA made a further decision that quartile values would be developed only where the subcategory contained five or more financial records. Because there were only three valid statements for malleable iron foundries with 50 to 99 employees, the statements for this group were merged with statements for the 100 to 249 size category. In all 1,302 financial statements were used in establishing financial ratios.

EPA chose not to include financial statements that failed the financial criteria used for estimating impacts. EPA determined that when such financial statements were included, many metal/size groups showed lower quartile values indicating closure before the imposition of compliance costs. EPA considers that the inclusion of these ratios interferes with the analysis in two ways.

First, EPA believes that firms whose financial statements indicate failure represent baseline closures. In other words, EPA's studies suggest that those firms will be already closed by the date final regulations are promulgated, so that use of their ratios distorts the estimate of the ratios that will prevail at promulgation.

Second, use of those ratios would almost completely negate the use of an incremental analysis to estimate closures due to the regulation. If EPA were to include the financial statements that show closure, almost one-fourth of all foundries would be designated as "baseline" closures, and almost no foundries would be shown as incremental closures caused by the regulations. EPA believes that excluding those financial statements that portray precompliance closure will lead to more accurate estimates of the potential incremental closures caused by the regulations.

In summary, EPA rejected the records of firms with the weakest financial condition. If the records had not been rejected, the 1984 foundry population estimate would have shown a large number of baseline closures. By dropping the records, EPA is basing its analysis on those "better than marginal" firms that will survive to be subject to this rulemaking.

c. Construction of Financial Statements

To construct the financial statements, EPA had to address two issues:

- any one of the first four ratios can be used to allocate data in the upper, median, and lower quartiles; hence one of the ratios should be selected for construction purposes.
- once one of the ratios has been selected, internally consistent financial statements must be constructed.

In this study, the return on sales ratio is used for the initial allocation. Selection of return on sales as the ratio to define the quartile has no impact on the outcome of the tests; it only determines whether the model financial statements are considered "upper quartile" or "lower quartile." The problem of constructing internally consistent financial statements is illustrated below. The solution chosen by EPA is also given.

Consider three firms, Able, Baker, and Charley, with the following financial characteristics:

	Able	Baker	Charley
Sales	1,000	2,000	4,000
Income	100	80	240
Assets	1,000	1,000	1,000
Return on Sales (ROS)	10%	4%	6%
Return on Assets (ROA)	10%	8%	24%
Sales to Assets (S/A)	1	2	4

Using our three companies as the sample population, the ratios in the quartiles are as follows:

	Upper Quartile	Median	Lower Quartile
ROS	10% (A)	6% (C)	4% (B)
ROA	24% (C)	10% (A)	8% (B)
S/A	4 (C)	2 (B)	1 (A)

It is not true for any quartile that return on sales times sales to assets equals return on assets. Although this example is hypothetical, the same results are observed when examining the quartiles from the FINSTAT database. In deriving balance sheets from the quartile data, we have maintained the general relationship that increasing debt imposes interest costs that decrease net income and that the fraction of debt is smaller for larger companies. For deriving the model financial statements, we used the following characteristics:

- highest ROS with lowest D/NW, S/NW, and NFA/NW;
- median ROS with median D/NW, S/NW, and NFA/NW; and
- lowest ROS with highest D/NW, S/NW, and NFA/NW.

This procedure increases the likelihood of at least one quartile failing more than one of the closure tests and thus may overestimate potential impacts.

The following shows the specific construction of the financial statements using the above ratios:

NI = Sales x ROS (by quartile)

Net Worth = Sales x Net Worth to Sales (by quartile)

Debt = Debt to Net Worth x Net Worth (by quartile)

Assets = Debt + Net Worth

NFA = Net Worth x (Net Fixed Assets/Net Worth) (by quartile)

GFA = NFA x (Gross Fixed Assets/Net Fixed Assets)

Depreciation = GFA x (Depreciation/GFA)

Gross Income = NI adusted for taxes.

Where:

NI = Net Income;

ROS = Return on Sales;

NFA = Net (depreciated) Value of Fixed Assets; and

GFA = Gross (historical) Value of Fixed Assets.

Gross income (net before taxes) is estimated by "backing out" taxes. Taxes are assumed to be based on the following schedule:

- 20 percent of the first $25,000 of gross income
- 22 percent of the second $25,000 of gross income
- 46 percent of gross income greater than $50,000

Table III-4 provides an example of the development of precompliance financial statements in the aluminum, 10 to 49 employment size segment.

d. Comparison to Previous Analyses

This analysis has two main differences from previous analyses. First, EPA no longer assumes that 1985 will resemble any particular year for the purposes of estimating precompliance financial statements. Instead, EPA has used financial data from the entire period of 1975 to 1984 to estimate the financial statements. EPA believes the quartiles developed represent the widest feasible range, using the largest amount of data.

Second, EPA is basing its sales estimates on the results of its surveys, adjusted for sales declines between 1978 and 1982 (or 1983 for steel). EPA recognizes that the adjusted sales estimates are still higher than those shown in other data sources. However, EPA believes the data it gathered are the most reliable because they were supplied directly by 1,266 foundries. As shown in the technical record, EPA has made extensive efforts to verify its data sources, and has recontacted many foundries to confirm the values for shipments and employment.

TABLE III-4

SAMPLE DERIVATION OF PRECOMPLIANCE FINANCIAL STATEMENTS

Basis: Aluminum, 10 to 49 employees. Dollars in thousands.

	Upper Quartile	Median	Lower Quartile
1. Sales[a]	3,167.5	3,167.5	3,167.5
2. Return on Sales (%)[b]	6.44	4.67	3.17
3. Sales to Net Worth[b]	2.76	3.85	5.93
4. Debt to Net Worth (%)[b]	43.6	84.34	165.92
5. Fixed Assets to Net Worth (%)[b]	6.25	28.43	59.17
6. Gross Assets to Fixed Assets[c]	2	2	2
7. Depreciation to Assets (%)[d]	6.7464	6.7464	6.7464
8. Net Income (1 x 2)	203.98	147.92	100.41
9. Net Worth (1 ÷ 3)	1,147.6	822.7	534.1
10. Debt (4 x 9)	500.3	693.9	886.2
11. Total Assets (9 + 10)	1,648.0	1,516.6	1,420.3
12. Net Fixed Assets (5 x 9)	71.7	233.9	316.0
13. Gross Fixed Assets (6 x 12)	143.5	467.8	632.1
14. Depreciation (7 x 13)	9.7	31.6	42.6
15. Cash Flow (8 + 14)	213.66	179.52	143.0
16. ROA (8 ÷ 11) (%)	12.4	9.8	7.1
17. Debts/Assets (10 ÷ 11)(%)	30.4	45.8	62.4
18. Cash Flow to Debt (15 ÷ 10)(%)	42.7	25.9	16.1
19. Gross Income (8 + adj. for taxes)	354.5	250.8	162.8

[a]Based on 308 survey data.

[b]FINSTAT.

[c]Study of financial statements.

[d]Annual Survey of Manufactures.

It will be noted that the declines in sales to 1982 and 1983 levels that are incorporated into this analysis range between 30 and 65 percent, providing a substantial downward adjustment to the revenue figures. These adjustments provide the lowest estimate of shipments for foundries similar to those in EPA's database. Because of the losses of "economies of scale," they give the highest relative impact of the imposition of compliances costs, such as cost as a percentage of sales. They thus provide the most conservative estimate (highest potential impact) consistent with EPA's data sources.

3. Incorporation of Cost Estimates

Closures are based on the financial ratio values after compliance. These ratios are obtained by adjusting the precompliance financial statements to reflect compliance costs. For this analysis, EPA has assumed that compliance capital costs are financed entirely by debt. Net income after compliance is estimated by first subtracting the annual cost (including interest) and depreciation from the estimated precompliance gross income and then subtracting estimated tax liability. The increased depreciation is estimated assuming a schedule of 10-year straight line depreciation.

E. ESTIMATION OF IMPACTS

The fourth major step in the analysis is the actual calculation of impacts. The tests and threshold values used to estimate plant closures have been chosen on the basis of a literature search, the observed data for three firms in the metals processing industry that have gone bankrupt since 1978, and data for solvent firms in the industry. The background for the selection of tests and thresholds is explained in detail in Appendix A. The impact analysis is discussed below.

1. Choice of Tests

An intensive search of the financial literature was made in an effort to identify suitable tests and threshold values for the closure analysis. (See Appendix A for a detailed discussion.) On the basis of this search, the following three tests have been chosen to measure the economic impacts:[4]

- return on assets;
- total debt to total assets; and
- "Beaver's ratio" (cash flow to total debt).

---

[4]These tests were found to occur most frequently in the literature as significant tests of firm failure. Specific threshold values are derived from the seminal article by William Beaver, "Financial Ratios as Predictors of Business Failure, "Empirical Research in Accounting: Selected Studies, 1966.

2. Firm Failure Criterion

Compliance costs have been established for each known combination of discharging technologies. For aluminum foundries in the 10 to 49 employee segment, for instance, five combinations of discharging technologies were found in EPA's 1978 survey. The compliance costs for each combination were used to establish three separate, postcompliance balance sheets, one for each quartile.

Each test is applied separately to the derived financial statements of each quartile. In each case that a model plants fails two tests, the entire quartile represented by the financial statements is considered to fail. Twenty-five percent of the employment segment is represented by each of the upper and lower quartiles, and 50 percent by the median. Thus, if there are eight plants in an employment size category with a specific combination of discharging technologies, and the lower quartile fails at least two tests, then two firms (one-fourth of eight total) are estimated to close. By definition, the lower quartile is intended to represent one-fourth of the plants using that technology. The requirement that two of three tests fail recognizes that some firms continue in business even though one measure is bad. The requirement is also a recognition that the individual tests are not 100 percent effective, and may overstate closures. A close inspection of the individual plant data obtained from the agency's independent case study analysis showed that many firms do not close even when financial conditions exceed these closure criteria.

The failure criterion is derived from an examination of the data for bankrupt firms, which showed that companies did not file for bankruptcy unless they failed at least two tests. (Details of the examination are given in Appendix A, Section E.) This seems rational in principle. If a company has a very high fraction of debt, but also has sufficient income and cash flow to satisify investors and creditors, it would likely stay in business. If a company has low return on assets, but also fairly low debt and sufficient cash flow, again it would likely remain in business. In the third case, if a company had a low Beaver's ratio (cash flow to total debt) but low debt to assets and reasonable return on assets, it would again probably stay in business. However, if two ratios are below the threshold, there is much less chance of recovery.

3. Description of the Threshold Values and Application of Tests

a. Return on Assets

Return on assets is defined as net income after taxes divided by total book assets. In principle, this ratio measures the efficiency of the firm at generating income from its asset base. To apply the test, both income and assets must be adjusted for the compliance effects.

Postcompliance income was derived through the following steps:

- Precompliance gross income (GI) was estimated by adjusting the net income by the Federal corporate income tax rate;

  GI = NI + (estimated taxes)

  This analysis assumes a progressive tax scale: 20 percent tax on the first $25,000 of income, 22 percent on the next $25,000, and 46 percent on all income over $50,000. Compliance costs have been assumed to be tax deductible as an ordinary business expense, but the extent of the tax savings depends on the income of the foundry. Furthermore, the marginal tax bracket may change as taxable income changes, so that the postcompliance income is adjusted for taxes based on the postcompliance level.

- Postcompliance gross income (PCGI) was calculated from precompliance gross income minus the estimated annual cost of compliance (including debt service, depreciation, and operating costs);

  PCGI = GI - CAC (compliance annual cost).

- Postcompliance net income (PCNI) was taken from postcompliance gross income minus Federal corporate income taxes.

  PCNI = PCGI - (estimated taxes on postcompliance income).

Postcompliance assets (PCA) equals precompliance assets plus the capital cost of compliance, or

PCA = Assets + CCC (compliance capital cost).

The cut-off value for net income to total assets, as determined by Beaver, ranges from an average of 1 percent one year before failure to 3.5 percent five years before failure. On the basis of the observed values of the ratio for failed firms and firms currently in business, the Agency selected a reasonable cut-off value of 2.5 percent, or 0.025. (More detailed justification is given in Appendix A, Section E.) The test can be written as follows. A firm will fail if

PCROA < 0.025,

where: PCROA = PCNI/PCA, and
PCROA = Postcompliance return on assets.

b. Total Debt to Total Assets

Total debt to total assets is the ratio of all debt to total assets. Total debt is defined as anything that cannot be considered to be owner's equity, and it thus includes accounts payable and accrued expenses.

This ratio is computed as follows:

- Postcompliance debt equals precompliance debt plus the capital cost of compliance (assumed to be financed at 100 percent debt); and

  PC Debt = Debt + CCC.

- Postcompliance total assets equals precompliance total assets plus the capital cost of compliance.

  PC Assets = Assets + CCC.

For this study a value of 0.7 is selected as a reasonable cut-off for the debt to assets ratio. (Detailed justification is presented in Appendix A, Section E.) The test is written as follows. The firm will fail if

$$\text{PC Debt/PC Assets} > 0.7.$$

c. <u>Beaver's Ratio</u>

Beaver's ratio is defined as cash flow divided by total debt. For purposes of computing the ratio, cash flow is defined as net income after taxes plus depreciation. Methods for computing pre- and postcompliance net income and total debt have been explained above. Postcompliance cash flow will be computed in the following steps:

- Postcompliance depreciation is precompliance depreciation plus the depreciation of the compliance equipment, assumed to take place on a 10-year, straight line basis;[5] and

  PCDepreciation = Depreciation + CCC/10.

- Postcompliance cash flow (PCCF) is postcompliance income (computed as explained above) plus postcompliance depreciation.

  PCCF = PCNI + PCDepreciation.

This measure may be interpreted as an indication of a firm's ability to repay the interest and principal of borrowings. In Beaver's study, the cut-off value ranged from 0.05 one year before failure to 0.11 five years before failure. After analyzing the data for a few failed firms, examining the data for solvent firms, and evaluating the conditions in the economy, the study has selected 0.08 as an appropriate value. (More detailed justification is found in Appendix A, Section E.) The test is written as follows. The firm will fail if

---

[5]Recent changes in the tax laws allow more rapid depreciation for tax purposes. For companies using a more rapid depreciation, reported ROA will be less, but cash flow will be commensurately better. Although EPA believes the tax law changes benefited the foundry industry, the average effects on ROA and cash flow, and thus the required adjustments to threshold values, are unknown. As a result, this study assumes accounting practices in line with historical practices.

$$\frac{\text{PCCF}}{\text{Total Debt}} < 0.08$$

4. Sample Calculations

For every subcategory (at the level of metal/employment size/jobber-captive) all relevant costs were applied to all three quartiles. For example, for aluminum, 10 to 49 employees, there are three processes or combinations used by direct dischargers and ten processes or combinations used by indirect dischargers. Financial models were created for each process, for both jobbers and captives, for all three quartiles, for four levels of treatment, leading to a total of 276 financial statements.[6]

EPA made no assumptions as to which processes or combinations of processes are used by foundries in any quartile of financial health. Instead, EPA adopted an "expected value" approach. The method assumes that plants with a given process are equally well represented in all three financial quartiles. If a given process is estimated to be used by four plants, EPA assumes that one plant (25%) is in the lower quartile, two plants (50%) are at the median, and one plant (25%) is in the upper quartile. The financial tests are then performed for each quartile separately.

The concept of expected value extends even where there is only one occurrence of a process or combination of processes. In such an instance, 0.25 plants are allocated to the lower quartile, 0.5 plants to the median, and 0.25 plants to the upper quartile. To calculate aggregate impacts, EPA added up any fractional closures, and rounded to the nearest whole number.

Table III-5 presents an example of the calculations used to develop post-compliance balance sheets, using data for aluminum plants in the 10 to 49 employee subcategory that directly discharge process water from the casting cleaning process.

---

[6]Three process combinations are used by only one discharger. As shown in Table III-1, there are a total of 23 process combinations used by jobbers and captives.

TABLE III-5

SAMPLE DERIVATION OF POSTCOMPLIANCE FINANCIAL STATEMENTS

Basis: Aluminum, 10 to 49 Employee Size
Treatment of Wastewater from Directly Discharging
Jobber Foundries with the Casting Cleaning/Casting Quench
Process Combination at Option 1

	Upper Quartile	Median	Lower Quartile
1. Number of Dischargers (3 total)	0.75	1.5	0.75
2. Capital Cost	34.6	34.6	34.6
3. Annual Cost	14.0	14.0	14.0
4. Precompliance Net Worth	1,147.6	822.7	534.2
5. Precompliance Debt	500.3	693.2	886.3
6. Precompliance Total Assets	1,648.0	1,515.6	1,420.3
7. Precompliance Gross Income	354.5	250.8	162.8
8. Precompliance Depreciation	9.7	31.6	42.6
9. Postcompliance Debt (5 + 2)	534.3	727.8	920.9
10. Postcompliance Total Assets (4 + 9)	1,681.9	1,550.5	1,455.1
11. Postcompliance Gross Income (7 - 3)	340.5	236.8	148.8
12. Postcompliance Net Income (11 - taxes)	196.4	140.2	92.9
13. Postcompliance Depreciation (8 + (2 x (.1)))	13.2	35.1	46.1
14. Return on Assets (12 ÷ 10) (%)	11.7	9.0	6.4
15. Debts to Assets (9 ÷ 10) (%)	31.8	47.0	63.3
16. Cash Flow to Debt ((12 + 13)/9) (%)	39.2	24.1	15.1

CHAPTER IV

EFFLUENT CONTROL AND GUIDELINE COSTS

IV. EFFLUENT CONTROL AND GUIDELINE COSTS

EPA has developed compliance cost estimates for foundries within the framework of the metal type and employment size segmentation format described in Chapter III, Methodology. Two types of compliance cost estimates were developed: (1) those pertaining to equipment that discharging foundries have already collectively installed; and (2) those pertaining to required equipment that discharging foundries must install to comply with various levels of pollutant removal. For the analysis, only those costs still required to meet the standards for direct and indirect dischargers were considered. Expenditures already made for equipment in-place were regarded as having been spent for operational reasons.

Foundries incurring costs as a result of this regulation may incur two kinds of costs: one-time capital costs, and recurring operating and maintenance costs. The capital costs are those costs incurred when the water treatment equipment is first installed, and include costs for equipment design and installation.[1] Operating and maintenance costs are costs incurred on a periodic basis throughout the operation of the facility, and include operation and maintenance, labor and materials, sludge and oil disposal, energy and chemicals, and monitoring costs. Details of the cost estimation procedure are given in the Development Document in the technical record.

The costs were considered by EPA as the total costs to treat all occurrences of each individual process that were in existence as of the 1984 survey of plants. Costs have been provided for treatment at four levels, which involve increasingly higher levels of pollutant removal.

From the costs of treating individual processes, costs to treat the process combinations commonly found in the industry were developed. First, average costs per plant to treat discharges from each individual process were calculated. These average costs were then added together to provide an estimate of the costs to treat the processes and combinations of processes forecast to exist in 1986. An EPA analysis showed significant economies in cotreating the discharges from several processes. These economies averaged 28.9% of capital costs and 36% of operating costs, and were applied to each process combination.

The total treatment costs are shown in Tables IV-1 through IV-4. Additional tables, presenting the costs of treatment within each size category of each metal, are shown in Chapter VI.

---

[1]As shown below, this analysis is based on an assumption that capital costs are paid for by loans. In estimating total annual expenditures, the capital cost is converted to a series of payments of principal and interest, with charges to income for interest expense and depreciation. (Continued)

TABLE IV-1
COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY
(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries in 1986		1986 Compliance Costs (in thousands of 1983 dollars)			
			Capital Investment		Annual Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect
Total						
Gray Iron	91	145	4,662	8,758	1,640	3,113
Ductile Iron	27	25	3,036	1,167	1,058	413
Malleable Iron	21	29	573	1,064	205	373
Steel	43	64	1,706	2,350	614	861
Total Ferrous	182	263	9,978	13,339	3,517	4,759
Aluminum	45	131	2,524	3,627	949	1,400
Copper-base	63	54	7,946	4,355	3,369	1,650
Zinc	9	49	151	1,175	73	460
Magnesium	2	2	47	57	22	20
Total Nonferrous	119	236	10,669	9,214	4,413	3,530
Grand Total	301	499	20,647	22,553	7,930	8,290
Jobber						
Gray Iron	65	10	3,274	6,145	1,154	2,167
Ductile Iron	23	21	2,497	1,087	864	386
Malleable Iron	15	23	431	878	153	308
Steel	35	53	1,423	1,871	513	685
Total Ferrous	138	207	7,624	9,982	2,684	3,547
Aluminum	37	107	2,213	2,876	824	1,114
Copper-base	42	38	4,803	3,094	2,002	1,177
Zinc	7	38	105	834	52	334
Magnesium	2	2	47	57	22	20
Total Nonferrous	88	185	7,168	6,861	2,900	2,645
Grand Total	227	392	14,792	16,843	5,584	6,192
Captive						
Gray Iron	26	35	1,389	2,613	486	945
Ductile Iron	4	4	539	80	193	27
Malleable Iron	6	6	143	186	51	64
Steel	8	11	283	478	102	176
Total Ferrous	44	56	2,354	3,358	832	1,213
Aluminum	8	24	311	751	125	286
Copper-base	21	16	3,143	1,261	1,367	473
Zinc	2	11	47	341	21	126
Magnesium	0	0	0	0	0	0
Total Nonferrous	31	51	3,501	2,353	1,513	886
Grand Total	76	107	5,855	5,711	2,345	2,099

TABLE IV-2
COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY
(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries in 1986		1986 Compliance Costs (in thousands of 1983 dollars)			
			Capital Investment		Annual Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect
Total						
Gray Iron	91	145	13,899	19,772	6,091	8,522
Ductile Iron	27	25	6,546	2,475	2,836	1,061
Malleable Iron	21	29	2,387	2,432	1,109	1,072
Steel	43	64	4,377	5,409	1,849	2,370
Total Ferrous	182	263	27,209	30,088	11,885	13,025
Aluminum	45	131	3,040	6,005	1,337	3,230
Copper-base	63	54	8,208	4,607	3,607	1,871
Zinc	9	49	197	1,700	123	880
Magnesium	2	2	59	65	26	23
Total Nonferrous	119	236	11,504	12,377	5,093	6,004
Grand Total	301	499	38,713	42,466	16,979	19,029
Jobber						
Gray Iron	65	110	9,421	13,980	4,125	5,987
Ductile Iron	23	21	5,484	2,171	2,367	935
Malleable Iron	15	23	1,774	1,986	822	876
Steel	35	53	3,712	4,393	1,592	1,920
Total Ferrous	138	207	20,391	22,531	8,907	9,718
Aluminum	37	107	2,628	4,833	1,135	2,624
Copper-base	42	38	4,988	3,281	2,165	1,340
Zinc	7	38	138	1,243	89	665
Magnesium	2	2	59	65	26	23
Total Nonferrous	88	185	7,812	9,422	3,414	4,651
Grand Total	227	392	28,203	31,953	12,321	14,369
Captive						
Gray Iron	26	35	4,478	5,792	1,966	2,535
Ductile Iron	4	4	1,062	304	468	127
Malleable Iron	6	6	613	446	288	196
Steel	8	11	665	1,015	257	450
Total Ferrous	44	56	6,818	7,558	2,979	3,307
Aluminum	8	24	412	1,172	202	606
Copper-base	21	16	3,220	1,326	1,443	531
Zinc	2	11	59	457	34	215
Magnesium	0	0	0	0	0	0
Total Nonferrous	31	51	3,692	2,956	1,679	1,353
Grand Total	76	107	10,510	10,514	4,658	4,660

TABLE IV-3
COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY
(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries in 1986		1986 Compliance Costs (in thousands of 1983 dollars)			
			Capital Investment		Annual Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect
Total						
Gray Iron	91	145	15,702	22,152	7,099	9,892
Ductile Iron	27	25	7,450	2,799	3,341	1,245
Malleable Iron	21	29	2,641	2,736	1,259	1,245
Steel	43	64	4,854	5,900	2,144	2,691
Total Ferrous	182	263	30,647	33,587	13,843	15,073
Aluminum	45	131	3,353	6,440	1,599	3,652
Copper-base	63	54	9,012	4,944	4,173	2,112
Zinc	9	49	242	1,828	163	1,012
Magnesium	2	2	63	68	30	26
Total Nonferrous	119	236	12,669	13,280	5,964	6,801
Grand Total	301	499	43,316	46,867	19,806	21,875
Jobber						
Gray Iron	65	110	10,674	15,686	4,823	6,964
Ductile Iron	23	21	6,237	2,460	2,789	1,100
Malleable Iron	15	23	1,962	2,228	932	1,015
Steel	35	53	4,096	4,798	1,829	2,185
Total Ferrous	138	207	22,969	25,172	10,372	11,265
Aluminum	37	107	2,893	5,183	1,357	2,965
Copper-base	42	38	5,493	3,526	2,515	1,514
Zinc	7	38	170	1,338	117	765
Magnesium	2	2	63	68	30	26
Total Nonferrous	88	185	8,619	10,114	4,020	5,270
Grand Total	227	392	31,588	35,295	14,390	16,535
Captive						
Gray Iron	26	35	5,028	6,466	2,277	2,927
Ductile Iron	4	4	1,213	339	552	145
Malleable Iron	6	6	680	508	327	230
Steel	8	11	758	1,102	315	506
Total Ferrous	44	56	7,678	8,415	3,471	3,809
Aluminum	8	24	460	1,257	242	687
Copper-base	21	16	3,519	1,418	1,658	598
Zinc	2	11	72	490	45	247
Magnesium	0	0	0	0	0	0
Total Nonferrous	31	51	4,051	3,165	1,945	1,532
Grand Total	76	107	11,729	11,580	5,416	5,341

TABLE IV-4
COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY
(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries in 1986		1986 Compliance Costs (in thousands of 1983 dollars)			
			Capital Investment		Annual Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect
Total						
Gray Iron	91	145	17,816	25,041	7,945	11,450
Ductile Iron	27	25	8,171	3,111	3,621	1,434
Malleable Iron	21	29	2,931	2,994	1,376	1,398
Steel	43	64	5,455	6,381	2,352	2,891
Total Ferrous	182	263	34,373	37,526	15,295	17,172
Aluminum	45	131	4,086	8,052	1,929	4,452
Copper-base	63	54	9,583	5,700	4,460	2,487
Zinc	9	49	416	2,468	243	1,335
Magnesium	2	2	81	68	40	26
Total Nonferrous	119	239	14,166	16,289	6,673	8,299
Grand Total	301	499	48,538	53,815	21,968	25,471
Jobber						
Gray Iron	65	110	12,129	17,766	5,424	8,135
Ductile Iron	23	21	6,846	2,737	3,028	1,272
Malleable Iron	15	23	2,176	2,435	1,018	1,133
Steel	35	53	4,572	5,209	1,993	2,355
Total Ferrous	138	207	25,723	28,148	11,464	12,894
Aluminum	37	107	3,522	6,519	1,640	3,629
Copper-base	42	38	5,895	4,084	2,716	1,792
Zinc	7	38	299	1,826	176	1,012
Magnesium	2	2	81	68	40	26
Total Nonferrous	88	185	9,797	12,497	4,573	6,459
Grand Total	227	392	35,520	40,645	16,036	19,353
Captive						
Gray Iron	26	35	5,686	7,274	2,522	3,315
Ductile Iron	4	4	1,325	374	592	162
Malleable Iron	6	6	755	558	358	265
Steel	8	11	883	1,171	359	536
Total Ferrous	44	56	8,649	9,378	3,831	4,278
Aluminum	8	24	563	1,534	289	822
Copper-base	21	16	3,688	1,616	1,744	695
Zinc	2	11	117	643	67	323
Magnesium	0	0	0	0	0	0
Total Nonferrous	31	51	4,368	3,792	2,100	1,840
Grand Total	76	107	13,017	13,170	5,931	6,118

Although there are only nine foundry processes with the potential to produce process wastewaters, foundries vary greatly in the types and combinations of discharging processes. EPA's study showed that ferrous foundries in general have a wider diversity of discharging process combinations:

Metal-Type Industry	Direct Dischargers	Indirect Dischargers
Gray iron	20	18
Ductile iron	13	7
Malleable iron	7	8
Steel	10	8
Aluminum	16	13
Copper-base	8	7
Zinc	6	7
Magnesium	1	1

Additionally, the total costs indicated in the tables for the metal-type foundry industries differed significantly in their content. Table IV-5 shows the dominant discharging process combination as measured by the required treatment costs. For some metals, the treatment costs for one combination of discharging processes are so high that relatively few foundries contribute most of the costs. For other metals, the treatment costs are similar for all discharging processes.

TABLE IV-5

CONTRIBUTION OF THE MOST IMPORTANT DISCHARGER PROCESS OR PROCESS COMBINATION TO THE TOTAL COST FOR EACH METAL

(in thousands of dollars)

Option 3 -- Recycle/Lime Addition/ Settle/Filtration

Industry	Most Important Process	Total Dischargers with Process	Total Capital Cost for Process	Total Annual Cost for Process	Most Important Process as % of	
					Dischargers	Annual Costs
Gray Iron	Melting Furnace Scrubber/Slag Quench/Dust Collection	45	11,077	5,013	.19	.30
Ductile Iron	Slag Quench/Dust Collection	8	1,458	716	.15	.16
Malleable Iron	Dust Collection	19	1,834	961	.38	.38
Steel	Cast Quench/Dust Collection	22	3,043	1,404	.21	.29
Aluminum	Dust Collection	52	1,474	1,323	.30	.25
Copper-base	Direct Chill Casting	19	3,806	1,890	.16	.30
Zinc	Casting Quench	22	623	316	.37	.27
Magnesium	Casting Quench	2	64	30	.50	.54

CHAPTER V

ANALYSIS OF ECONOMIC IMPACTS

V. ANALYSIS OF ECONOMIC IMPACTS

EPA has estimated the potential economic impacts at four levels of stringency. The levels were based on EPA's judgement of potential levels of technology, and require increasing amounts of pollution control equipment. Based on a review of its database and the potential economic impacts, EPA has established effluent guidelines corresponding to the Best Practicable Control Technology Currently Available (BPT) and Best Available Control Technology Economically Achievable (BAT). In some instances BPT was set equal to BAT. New Source Performance Standards (NSPS) were considered identical to BAT. EPA has also reviewed the costs and impacts attributable to effluent guidelines for indirect dischargers (foundries whose effluent is treated by a publicly-owned treatment works (POTWs) before discharge to surface waters). Pretreatment Standards for New Sources (PSNS) were considered identical to Pretreatment Standards for Existing Sources (PSES), and generally need the same technologies as BAT.

This chapter presents a brief description of the four treatment options reviewed, and then discusses the potential economic impacts of each option.

A. BASIS FOR COMPLIANCE COSTS

Compliance-cost estimates for pollution control systems by foundries pertain to the "Best Practicable Technology Currently Available" (BPT) regulations and to "Best Available Control Technology Economically Achievable" (BAT) regulations. Pretreatment technologies (PSES) for foundries discharging indirectly to POTW's were considered identical to the BPT and BAT treatment alternatives for directly discharging foundries. Collectively, the proposed regulations involve four treatment options, and two alternative options considered where small business impacts initially appeared high. Listed below are brief descriptions of the various treatment technologies used for the four principal options.

1. Option 1: Recycle and Simple Settling

Option 1 is comprised of high rate recycle achieved by settling (including surface skimming for free oil removed in certain segments), and recycle to the process (including pH adjustment as required to maintain water chemistry balance between scaling and corrosion) and including cooling towers for some segments, followed by settling of the blowdown stream prior to discharge. Option 1 costs include the costs for the grinding scrubber operations of aluminum, copper, ductile iron, gray iron, malleable iron, magnesium, and steel plants. The grinding scrubber treatment is similar to Option 1, but requires complete recycle with no blowdown, and thus no blowdown treatment. Option 1 costs were not developed for the aluminum and zinc die casting segments or the ferrous dust collection and wet sand reclamation segments because the treatment systems would be inadequate for the treatment of wastes from these processes.

2. Option 2: Recycle, Lime Addition, and Settling

Option 2 consists of the addition of flocculation with lime and polymer to the Option 1 technology to facilitate metals precipitation and solids settling for blowdown treatment. This option also includes emulsion breaking for the aluminum and zinc die casting segments and chemical oxidation of organic matter for these two segments and also for ferrous dust collection and wet sand reclamation.

3. Option 3: Recycle, Lime Addition, Settling, and Filtration

Option 3 adds filtration of the effluent from the Option 2 facility through cartridge filters, multimedia filters, and pressure filters, depending on the size of the systems.

4. Option 4: Recycle, Lime Addition, Settling, Filtration, and Carbon Adsorption

Option 4 adds carbon adsorption treatment of the effluent from the Option 3 facility. Option 4 costs were determined only for those segments where the Option 3 effluent contained toxic organics at a level that could be reduced by this method of treatment.

B. ECONOMIC IMPACTS -- OVERVIEW

This section provides a brief summary of the potential economic impacts. More detailed discussions, with supporting information, are presented later in the chapter.

1. Plant Closure and Employment Loss Impacts

EPA has used the potential loss of employment and closure of plants as the primary measure of economic impacts. Precompliance financial statements were established, using the model financial ratios presented in Chapter II. Estimated compliance costs, in 1983 dollars, were imposed on the model financial statements to estimate postcompliance financial conditions. Where the model postcomplince financial statements failed two of three tests, the number of firms estimated to have those financial statements has been forecast to fail.[1]

As shown in Tables V-1 through V-4, overall impacts under each of the four options are expected to be low. Under Option 1, only four foundries (two casting gray iron and two casting magnesium) are expected to close. The associated job loss of 100 employees represents 0.07 percent of the 149,287 employees of discharging foundries. Under Option 4, a total of 24 foundries are judged potential closures. The

---

[1]Because EPA could not determine the specific identities of foundries that would incur costs to segregate noncontact cooling water, impacts are estimated assuming all foundries would incur these losses. Actually, only 30 percent are expected to incur the incremental cost.

TABLE V-1

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
Total										
Gray Iron	91	145	4,662	8,758	1,640	3,113	2	0	2	54
Ductile Iron	27	25	3,036	1,167	1,058	413	0	0	0	0
Malleable Iron	21	29	573	1,064	205	373	0	0	0	0
Steel	43	64	1,706	2,350	614	861	0	0	0	0
Total Ferrous	182	263	9,978	13,339	3,517	4,759	2	0	2	54
Aluminum	45	131	2,524	3,627	949	1,400	0	0	0	0
Copper-base	63	54	7,946	4,355	3,369	1,650	0	0	0	0
Zinc	9	49	151	1,175	73	460	0	0	0	0
Magnesium	2	2	47	57	22	20	1	1	2	46
Total Nonferrous	119	236	10,669	9,214	4,413	3,530	1	1	2	46
Grand Total	301	499	20,647	22,553	7,930	8,290	3	1	4	100
Jobber										
Gray Iron	65	10	3,274	6,145	1,154	2,167	1	0	1	27
Ductile Iron	23	21	2,497	1,087	864	386	0	0	0	0
Malleable Iron	15	23	431	878	153	308	0	0	0	0
Steel	35	53	1,423	1,871	513	685	0	0	0	0
Total Ferrous	138	207	7,624	9,982	2,684	3,547	1	0	1	27
Aluminum	37	107	2,213	2,876	824	1,114	0	0	0	0
Copper-base	42	38	4,803	3,094	2,002	1,177	0	0	0	0
Zinc	7	38	105	834	52	334	0	0	0	0
Magnesium	2	2	47	57	22	20	1	1	2	46
Total Nonferrous	88	185	7,168	6,861	2,900	2,645	1	1	2	46
Grand Total	227	392	14,792	16,843	5,584	6,192	2	1	3	73
Captive										
Gray Iron	26	35	1,389	2,613	486	945	1	0	1	27
Ductile Iron	4	4	539	80	193	27	0	0	0	0
Malleable Iron	6	6	143	186	51	64	0	0	0	0
Steel	8	11	283	478	102	176	0	0	0	0
Total Ferrous	44	56	2,354	3,358	832	1,213	1	0	1	27
Aluminum	8	24	311	751	125	286	0	0	0	0
Copper-base	21	16	3,143	1,261	1,367	473	0	0	0	0
Zinc	2	11	47	341	21	126	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0
Total Nonferrous	31	51	3,501	2,353	1,513	886	0	0	0	0
Grand Total	76	107	5,855	5,711	2,345	2,099	1	0	1	27

TABLE V-2

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
Total										
Gray Iron	91	145	13,899	19,772	6,091	8,522	3	2	5	135
Ductile Iron	27	25	6,546	2,475	2,836	1,061	0	0	0	0
Malleable Iron	21	29	2,387	2,432	1,109	1,072	0	0	0	0
Steel	43	64	4,377	5,409	1,849	2,370	0	0	0	0
Total Ferrous	182	263	27,209	30,088	11,885	13,025	3	2	5	135
Aluminum	45	131	3,040	6,005	1,337	3,230	0	0	0	0
Copper-base	63	54	8,208	4,607	3,607	1,871	0	0	0	0
Zinc	9	49	197	1,700	123	880	0	0	0	0
Magnesium	2	2	59	65	26	23	1	1	2	46
Total Nonferrous	119	236	11,504	12,377	5,093	6,004	1	1	2	46
Grand Total	301	499	38,713	42,466	16,979	19,029	4	3	7	181
Jobber										
Gray Iron	65	110	9,421	13,980	4,125	5,987	2	2	4	108
Ductile Iron	23	21	5,484	2,171	2,367	935	0	0	0	0
Malleable Iron	15	23	1,774	1,986	822	876	0	0	0	0
Steel	35	53	3,712	4,393	1,592	1,920	0	0	0	0
Total Ferrous	138	207	20,391	22,531	8,907	9,718	2	2	4	108
Aluminum	37	107	2,628	4,833	1,135	2,624	0	0	0	0
Copper-base	42	38	4,988	3,281	2,165	1,340	0	0	0	0
Zinc	7	38	138	1,243	89	665	0	0	0	0
Magnesium	2	2	59	65	26	23	1	1	2	46
Total Nonferrous	88	185	7,812	9,422	3,414	4,651	1	1	2	46
Grand Total	227	392	28,203	31,953	12,321	14,369	3	3	6	154
Captive										
Gray Iron	26	35	4,478	5,792	1,966	2,535	1	0	1	27
Ductile Iron	4	4	1,062	304	468	127	0	0	0	0
Malleable Iron	6	6	613	446	288	196	0	0	0	0
Steel	8	11	665	1,015	257	450	0	0	0	0
Total Ferrous	44	56	6,818	7,558	2,979	3,307	1	0	1	27
Aluminum	8	24	412	1,172	202	606	0	0	0	0
Copper-base	21	16	3,220	1,326	1,443	531	0	0	0	0
Zinc	2	11	59	457	34	215	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0
Total Nonferrous	31	51	3,692	2,956	1,679	1,353	0	0	0	0
Grand Total	76	107	10,510	10,514	4,658	4,660	1	0	1	27

TABLE V-3

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
Total										
Gray Iron	91	145	15,702	22,152	7,099	9,892	3	6	9	243
Ductile Iron	27	25	7,450	2,799	3,341	1,245	0	1	1	27
Malleable Iron	21	29	2,641	2,736	1,259	1,245	1	0	1	71
Steel	43	64	4,854	5,900	2,144	2,691	0	0	0	0
Total Ferrous	182	263	30,647	33,587	13,843	15,073	4	7	11	341
Aluminum	45	131	3,353	6,440	1,599	3,652	0	0	0	0
Copper-base	63	54	9,012	4,944	4,173	2,112	0	0	0	0
Zinc	9	49	242	1,828	163	1,012	0	0	0	0
Magnesium	2	2	63	68	30	26	1	1	2	46
Total Nonferrous	119	236	12,669	13,280	5,964	6,801	1	1	2	46
Grand Total	301	499	43,316	46,867	19,806	21,875	5	8	13	387
Jobber										
Gray Iron	65	110	10,674	15,686	4,823	6,964	2	5	7	189
Ductile Iron	23	21	6,237	2,460	2,789	1,100	0	1	1	27
Malleable Iron	15	23	1,962	2,228	932	1,015	1	0	1	71
Steel	35	53	4,096	4,798	1,829	2,185	0	0	0	0
Total Ferrous	138	207	22,969	25,172	10,372	11,265	3	6	9	287
Aluminum	37	107	2,893	5,183	1,357	2,965	0	0	0	0
Copper-base	42	38	5,493	3,526	2,515	1,514	0	0	0	0
Zinc	7	38	170	1,338	117	765	0	0	0	0
Magnesium	2	2	63	68	30	26	1	1	2	46
Total Nonferrous	88	185	8,619	10,114	4,020	5,270	1	1	2	46
Grand Total	227	392	31,588	35,295	14,390	16,535	4	7	11	333
Captive										
Gray Iron	26	35	5,028	6,466	2,277	2,927	1	1	2	54
Ductile Iron	4	4	1,213	339	552	145	0	0	0	0
Malleable Iron	6	6	680	508	327	230	0	0	0	0
Steel	8	11	758	1,102	315	506	0	0	0	0
Total Ferrous	44	56	7,678	8,415	3,471	3,809	1	1	2	54
Aluminum	8	24	460	1,257	242	687	0	0	0	0
Copper-base	21	16	3,519	1,418	1,658	598	0	0	0	0
Zinc	2	11	72	490	45	247	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0
Total Nonferrous	31	51	4,051	3,165	1,945	1,532	0	0	0	0
Grand Total	76	107	11,729	11,580	5,416	5,341	1	1	2	54

TABLE V-4

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- FOUNDRY INDUSTRY

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
Total										
Gray Iron	91	145	17,816	25,041	7,945	11,450	5	13	18	486
Ductile Iron	27	25	8,171	3,111	3,621	1,434	0	1	1	27
Malleable Iron	21	29	2,931	2,994	1,376	1,398	1	1	2	142
Steel	43	64	5,455	6,381	2,352	2,891	0	0	0	0
Total Ferrous	182	263	34,373	37,526	15,295	17,172	6	15	21	655
Aluminum	45	131	4,086	8,052	1,929	4,452	0	0	0	0
Copper-base	63	54	9,583	5,700	4,460	2,487	0	0	0	0
Zinc	9	49	416	2,468	243	1,335	0	0	0	0
Magnesium	2	2	81	68	40	26	2	1	3	69
Total Nonferrous	119	239	14,166	16,289	6,673	8,299	2	1	3	69
Grand Total	301	499	48,538	53,815	21,968	25,471	8	16	24	724
Jobber										
Gray Iron	65	110	12,129	17,766	5,424	8,135	4	11	15	405
Ductile Iron	23	21	6,846	2,737	3,028	1,272	0	1	1	27
Malleable Iron	15	23	2,176	2,435	1,018	1,133	1	1	2	142
Steel	35	53	4,572	5,209	1,993	2,355	0	0	0	0
Total Ferrous	138	207	25,723	28,148	11,464	12,894	5	13	18	574
Aluminum	37	107	3,522	6,519	1,640	3,629	0	0	0	0
Copper-base	42	38	5,895	4,084	2,716	1,792	0	0	0	0
Zinc	7	38	299	1,826	176	1,012	0	0	0	0
Magnesium	2	2	81	68	40	26	2	1	3	69
Total Nonferrous	88	185	9,797	12,497	4,573	6,459	2	1	3	69
Grand Total	227	392	35,520	40,645	16,036	19,353	7	14	21	643
Captive										
Gray Iron	26	35	5,686	7,274	2,522	3,315	1	2	3	81
Ductile Iron	4	4	1,325	374	592	162	0	0	0	0
Malleable Iron	6	6	755	558	358	265	0	0	0	0
Steel	8	11	883	1,171	359	536	0	0	0	0
Total Ferrous	44	56	8,649	9,378	3,831	4,278	1	2	3	81
Aluminum	8	24	563	1,534	289	822	0	0	0	0
Copper-base	21	16	3,688	1,616	1,744	695	0	0	0	0
Zinc	2	11	117	643	67	323	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0
Total Nonferrous	31	51	4,368	3,792	2,100	1,840	0	0	0	0
Grand Total	76	107	13,017	13,170	5,931	6,118	1	2	3	81

associated job loss of 724 employees represents 0.50 percent of the employment of discharging foundries.

In complying with the regulations, the estimated 800 discharging foundries would incur capital costs ranging from \$43.2 million under Option 1 to \$102.4 million under Option 4.[2] Total annual costs including operating costs, interest, and depreciation, would range from \$16.0 million under Option 1 to \$47 million under Option 4. Aggregate impacts at all four levels are:

Option	Potential Number of Closures	Total Capital Cost (\$ Thousands)	Total Annual Cost (\$ Thousands)	Potential Job Loss
1	4	43,200	16,220	100
2	7	81,179	36,008	181
3	13	90,183	41,681	387
4	24	102,353	47,439	724

2. Other Economic Impacts

Although EPA has used plant closures and employment loss as the primary measure of economic impacts, other potential adverse impacts have also been examined. These include:

- potential price impacts
- potential production impacts
- potential balance of trade impacts
- potential community effects

None of these four potential impacts is expected to be major. In general, potential price increases are less than 0.5 percent, and EPA expects that competition will preclude any price increase. The small number of closures, limited to small foundries, is expected to have a minor effect on the production capacity of the foundry industry. Under the selected options, five gray iron and one ductile iron foundries are listed as potential closures. These six closures account for only about 0.2 percent of total gray and ductile iron production. This regulation will have negligible impact on the U.S. balance of trade. Because of the low number of potential closures, EPA believes community effects will be small and widely scattered.

C. POTENTIAL CLOSURES AND EMPLOYMENT LOSSES FOR INDIVIDUAL METALS

Although overall impacts are very low, they are not uniformly spread over all metals and size categories. This section discusses the impacts on each metal in more detail. Closure estimates are made assuming that

---

[2]All costs in this chapter are in 1983 dollars, unless otherwise noted.

all plants incur the incremental cost of segregating noncontact cooling water. The estimates of costs are based on the assumption that only 30 percent of plants must segregate noncontact cooling water.

1. Potential Impacts on Gray Iron Foundries

As shown in Tables V-5 through V-8, estimated annual costs of treatment for gray iron range from $4,752 thousand at Option 1 to $19,396 thousand at Option 4. These costs could lead to closures of foundries with fewer than 50 employees:

Option	Potential Number of Closures	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)
1	2	13,420	4,752
2	5	33,671	14,613
3	9	37,854	16,991
4	18	42,857	19,396

The potential closures, which result from failure of the return on assets and Beaver's ratio tests, are all expected to occur in foundries with 10 to 49 employees, distributed proportionately between direct and indirect dischargers. Except for four potential closures of indirect dischargers treating only dust collection effluent at Option 4, all potential closures are for foundries treating effluent from melting furnace scrubbers. As expected, almost all of the potential closures are for firms in the lower quartile of financial health. In all cases of closures, annual costs were greater than 3.2 percent of sales.

2. Potential Impacts on Ductile Iron Foundries

As shown in Tables V-9 through V-12, the annual cost to treat the effluent from ductile iron foundries ranges from $1.5 million at Option 1 to $5.1 million at Option 4. Assuming that all foundries incur the cost to treat noncontact cooling water, one foundry with 10 to 49 employees could potentially close at Options 3 and 4. Overall costs and impacts are:

Option	Potential Number of Closures	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)
1	0	4,203	1,471
2	0	9,021	3,897
3	1	10,249	4,586
4	1	11,282	5,055

TABLE V-5

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- GRAY IRON

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	2	0	80	0	29	0	0	0	0
10-49	14	38	794	1,428	273	514	2	0	2	54
50-99	14	27	396	901	135	309	0	0	0	0
100-249	32	48	1,444	3,039	494	1,029	0	0	0	0
250 or more	31	30	2,028	3,310	739	1,232	0	0	0	0
Total	91	145	4,662	8,758	1,640	3,112	2	0	2	54
Jobber Foundries										
Fewer than 10	0	2	0	80	0	29	0	0	0	0
10-49	10	32	540	1,198	186	431	1	0	1	27
50-99	11	21	346	667	118	228	0	0	0	0
100-249	25	37	1,112	2,344	380	794	0	0	0	0
250 or more	19	18	1,275	1,857	470	685	0	0	0	0
Total	65	110	3,274	6,145	1,154	2,167	1	0	1	27
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	4	6	254	231	88	83	1	0	1	27
50-99	3	6	50	234	17	81	0	0	0	0
100-249	7	11	332	695	113	235	0	0	0	0
250 or more	12	12	753	1,453	269	547	0	0	0	0
Total	26	35	1,389	2,613	486	945	1	0	1	27

Note: Numbers may not add up to totals due to rounding.

TABLE V-6

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- GRAY IRON

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	2	0	94	0	36	0	0	0	0
10-49	14	38	1,182	2,864	442	1,086	3	2	5	135
50-99	14	27	990	2,029	368	761	0	0	0	0
100-249	32	48	3,125	5,538	1,336	2,320	0	0	0	0
250 or more	31	30	8,602	9,247	3,945	4,319	0	0	0	0
Total	91	145	13,899	19,772	6,091	8,522	3	2	5	135
Jobber Foundries										
Fewer than 10	0	2	0	94	0	36	0	0	0	0
10-49	10	32	837	2,414	315	915	2	2	4	108
50-99	11	21	787	1,588	291	584	0	0	0	0
100-249	25	37	2,380	4,273	1,017	1,791	0	0	0	0
250 or more	19	18	5,418	5,641	2,502	2,661	0	0	0	0
Total	65	110	9,421	13,980	4,125	5,987	2	2	4	108
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	4	6	345	450	127	170	1	0	1	27
50-99	3	6	203	471	77	177	0	0	0	0
100-249	7	11	745	1,265	319	529	0	0	0	0
250 or more	12	12	3,186	3,606	1,443	1,659	0	0	0	0
Total	26	35	4,478	5,792	1,966	2,535	1	0	1	27

Note: Numbers may not add up to totals due to rounding.

TABLE V-7

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- GRAY IRON

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	2	0	114	0	51	0	0	0	0
10-49	14	38	1,350	3,232	524	1,274	3	6	9	243
50-99	14	27	1,115	2,280	442	911	0	0	0	0
100-249	32	48	3,660	6,341	1,627	2,767	0	0	0	0
250 or more	31	30	9,577	10,185	4,506	4,888	0	0	0	0
Total	91	145	15,702	22,152	7,099	9,892	3	6	9	243
Jobber Foundries										
Fewer than 10	0	2	0	114	0	51	0	0	0	0
10-49	10	32	958	2,723	374	1,074	2	5	7	189
50-99	11	21	891	1,750	352	699	0	0	0	0
100-249	25	37	2,790	4,895	1,240	2,137	0	0	0	0
250 or more	19	18	6,036	6,203	2,857	3,003	0	0	0	0
Total	65	110	10,674	15,686	4,823	6,964	2	5	7	189
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	4	6	392	508	150	200	1	1	2	54
50-99	3	6	224	530	90	212	0	0	0	0
100-249	7	11	871	1,445	387	630	0	0	0	0
250 or more	12	12	3,541	3,982	1,649	1,885	0	0	0	0
Total	26	35	5,028	6,466	2,277	2,927	1	1	2	54

Note: Numbers may not add up to totals due to rounding.

TABLE V-8

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- GRAY IRON

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	2	0	138	0	77	0	0	0	0
10-49	14	38	1,582	3,735	643	1,694	5	13	18	486
50-99	14	27	1,298	2,615	548	1,136	0	0	0	0
100-249	32	48	4,124	7,053	1,900	3,198	0	0	0	0
250 or more	31	30	10,811	11,500	4,856	5,345	0	0	0	0
Total	91	145	17,816	25,041	7,946	11,450	5	13	18	486
Jobber Foundries										
Fewer than 10	0	2	0	138	0	77	0	0	0	0
10-49	10	32	1,128	3,148	459	1,427	4	11	15	405
50-99	11	21	1,035	2,011	436	873	0	0	0	0
100-249	25	37	3,151	5,448	1,452	2,472	0	0	0	0
250 or more	19	18	6,815	7,022	3,077	3,286	0	0	0	0
Total	65	110	12,129	17,766	5,424	8,135	4	11	15	405
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	4	6	454	587	184	268	1	2	3	81
50-99	3	6	263	604	112	726	0	0	0	0
100-249	7	11	973	1,605	447	727	0	0	0	0
250 or more	12	12	3,996	4,478	1,779	2,058	0	0	0	0
Total	26	35	5,685	7,274	2,522	3,315	1	2	3	81

Note: Numbers may not add up to totals due to rounding.

TABLE V-9

COMPLIANCE COSTS AND ECONOMIC IMPACTS — DUCTILE IRON

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	9	0	181	0	56	0	0	0	0
50-99	0	3	0	168	0	57	0	0	0	0
100-249	16	11	1,483	561	512	198	0	0	0	0
250 or more	11	2	1,553	258	546	102	0	0	0	0
Total	27	25	3,036	1,167	1,058	413	0	0	0	0
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	6	0	142	0	44	0	0	0	0
50-99	0	3	0	168	0	57	0	0	0	0
100-249	14	10	1,150	520	397	183	0	0	0	0
250 or more	9	2	1,346	258	468	102	0	0	0	0
Total	23	21	2,497	1,087	864	386	0	0	0	0
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	3	0	38	0	12	0	0	0	0
50-99	0	0	0	0	0	0	0	0	0	0
100-249	2	1	333	41	115	15	0	0	0	0
250 or more	2	0	206	0	78	0	0	0	0	0
Total	4	4	539	80	193	27	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-10

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- DUCTILE IRON

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	9	0	529	0	196	0	0	0	0
50-99	0	3	0	189	0	68	0	0	0	0
100-249	16	11	2,414	1,259	993	566	0	0	0	0
250 or more	11	2	4,131	498	1,843	231	0	0	0	0
Total	27	25	6,546	2,475	2,836	1,061	0	0	0	0
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	6	0	342	0	124	0	0	0	0
50-99	0	3	0	189	0	68	0	0	0	0
100-249	14	10	2,073	1,142	869	511	0	0	0	0
250 or more	9	2	3,410	498	1,499	231	0	0	0	0
Total	23	21	5,484	2,171	2,367	935	0	0	0	0
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	3	0	187	0	72	0	0	0	0
50-99	0	0	0	0	0	0	0	0	0	0
100-249	2	1	341	118	124	55	0	0	0	0
250 or more	2	0	721	0	344	0	0	0	0	0
Total	4	4	1,062	304	468	127	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-11

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- DUCTILE IRON

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	9	0	559	0	212	0	1	1	27
50-99	0	3	0	225	0	87	0	0	0	0
100-249	16	11	2,893	1,467	1,249	684	0	0	0	0
250 or more	11	2	4,557	549	2,092	262	0	0	0	0
Total	27	25	7,450	2,799	3,341	1,245	0	1	1	27
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	6	0	359	0	133	0	1	1	27
50-99	0	3	0	225	0	87	0	0	0	0
100-249	14	10	2,477	1,328	1,086	617	0	0	0	0
250 or more	9	2	3,760	549	1,703	262	0	0	0	0
Total	23	21	6,237	2,460	2,789	1,099	0	1	1	27
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	3	0	200	0	79	0	0	0	0
50-99	0	0	0	0	0	0	0	0	0	0
100-249	2	1	416	140	163	67	0	0	0	0
250 or more	2	0	797	0	389	0	0	0	0	0
Total	4	4	1,213	339	552	145	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-12

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- DUCTILE IRON

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	9	0	615	0	236	0	1	1	27
50-99	0	3	0	266	0	130	0	0	0	0
100-249	16	11	3,125	1,624	1,389	785	0	0	0	0
250 or more	11	2	5,047	606	2,231	285	0	0	0	0
Total	27	25	8,171	3,111	3,621	1,434	0	1	1	27
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	6	0	392	0	147	0	1	1	27
50-99	0	3	0	266	0	130	0	0	0	0
100-249	14	10	2,680	1,474	1,210	710	0	0	0	0
250 or more	9	2	4,167	606	1,819	285	0	0	0	0
Total	23	21	6,846	2,737	3,028	1,272	0	1	1	27
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	3	0	224	0	89	0	0	0	0
50-99	0	0	0	0	0	0	0	0	0	0
100-249	2	1	446	150	180	73	0	0	0	0
250 or more	2	0	880	0	413	0	0	0	0	0
Total	4	4	1,325	374	592	162	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

A closer review shows that the two closures occur for foundries treating effluent from dust collection. Closures are not predicted for the 70 percent of foundries that will not incur the cost to segregate noncontact cooling water. Further the two potential closures are based on an estimated one jobber and one captive closing. In fact, the potential closures occur for lower quartile firms only. Because there are only four plants incurring the cost to treat dust collection wastes, only one plant is a potential closure; the second "closure" is a result of disaggregation into jobber or captive status and subsequent rounding of partial closures. Taking all factors into account, EPA estimates only one ductile iron closure as a result of the regulation:

Closures shown	2.0
Actual estimated closures if all plants segregate noncontact cooling water	1.0 (25% of 4 plants)
Fraction of plants incurring cost to segregate noncontact cooling water	0.3
Actual estimated closures	0.3

The plant expected to fail has insufficient return on assets and cash flow to total debt.

3. Potential Impacts on Malleable Iron Foundries

As shown in Tables V-13 through V-16, the annual cost to treat discharges from the 50 discharging malleable iron foundries range from $0.6 million under Option 1 to $2.8 million under Option 4. Assuming that all foundries incur the incremental cost to segregate noncontact cooling water, EPA estimates that there would be one potential closure under Option 3 and two potential closures under Option 4. Overall costs and impacts are as follows:

Option	Potential Number of Closures	Potential Employment Lost	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)
1	0	0	1,637	578
2	0	0	4,819	2,181
3	1	71	5,377	2,505
4	2	142	5,925	2,774

All potential closures occur in the 50 to 99 employment size category and are due to failure of the return on assets and debt to assets tests. A close review of the data shows that the failures occur even though the total annual cost represents less that 1 percent of sales for the foundries considered potential closures.

TABLE V-13

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- MALLEABLE IRON

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	3	5	33	161	13	56	0	0	0	0
100-249	11	22	46	600	15	209	0	0	0	0
250 or more	7	2	494	303	176	107	0	0	0	0
Total	21	29	573	1,064	205	373	0	0	0	0
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	2	4	22	125	9	44	0	0	0	0
100-249	8	17	31	449	10	157	0	0	0	0
250 or more	5	2	378	303	135	107	0	0	0	0
Total	15	23	431	878	153	308	0	0	0	0
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	1	1	11	36	4	12	0	0	0	0
100-249	3	5	15	150	5	52	0	0	0	0
250 or more	2	0	116	0	42	0	0	0	0	0
Total	6	6	143	186	51	64	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-14

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- MALLEABLE IRON

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	3	5	169	183	65	69	0	0	0	0
100-249	11	22	745	1,638	361	735	0	0	0	0
250 or more	7	2	1,473	611	684	269	0	0	0	0
Total	21	29	2,387	2,432	1,109	1,072	0	0	0	0
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	2	4	112	143	43	54	0	0	0	0
100-249	8	17	543	1,232	264	553	0	0	0	0
250 or more	5	2	1,119	611	515	269	0	0	0	0
Total	15	23	1,774	1,986	822	876	0	0	0	0
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	1	1	56	41	22	14	0	0	0	0
100-249	3	5	203	406	97	181	0	0	0	0
250 or more	2	0	354	0	169	0	0	0	0	0
Total	6	6	613	446	288	196	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-15

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- MALLEABLE IRON

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	3	5	189	217	77	87	1	0	1	71
100-249	11	22	836	1,855	415	858	0	0	0	0
250 or more	7	2	1,616	665	768	301	0	0	0	0
Total	21	29	2,641	2,736	1,259	1,246	1	0	1	71
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	2	4	126	168	51	68	1	0	1	71
100-249	8	17	609	1,395	303	647	0	0	0	0
250 or more	5	2	1,227	665	578	301	0	0	0	0
Total	15	23	1,962	2,228	932	1,015	1	0	1	71
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	1	1	63	48	26	18	0	0	0	0
100-249	3	5	227	459	112	212	0	0	0	0
250 or more	2	0	389	0	190	0	0	0	0	0
Total	6	6	680	508	327	230	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-16

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- MALLEABLE IRON

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	3	5	213	240	87	110	1	1	2	142
100-249	11	22	925	2,015	472	959	0	0	0	0
250 or more	7	2	1,792	739	817	329	0	0	0	0
Total	21	29	2,931	2,994	1,376	1,398	1	1	2	142
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	2	4	142	183	58	83	1	1	2	142
100-249	8	17	674	1,514	345	721	0	0	0	0
250 or more	5	2	1,360	739	615	329	0	0	0	0
Total	15	23	2,176	2,435	1,018	1,133	1	1	2	142
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	1	1	71	57	29	27	0	0	0	0
100-249	3	5	251	501	127	238	0	0	0	0
250 or more	2	0	433	0	202	0	0	0	0	0
Total	6	6	755	558	358	265	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

4. Potential Impacts On Steel Foundries

As shown in Tables V-17 through V-20, potential total annual costs for the 107 directly and indirectly discharging steel foundries range from about $1.5 million under Option 1 to $5.2 million under Option 4. In all cases, the annual costs represent less than 1 percent of sales for all individual combinations of discharging processes. Aggregate costs at each Option are:

Option	Potential Number of Closures	Potential Employment Lost	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)
1	0	0	4,056	1,475
2	0	0	9,786	4,219
3	0	0	10,754	4,835
4	0	0	11,836	5,244

5. Potential Impacts on Aluminum Foundries

As shown in Tables V-21 through V-24, potential aggregate annual costs for the 176 directly and indirectly discharging aluminum foundries range from $2.35 million under Option 1 to $6.4 million under Option 4. The maximum annual cost for any model plant is only about 1.3 percent of sales. EPA does not anticipate any aluminum foundry closures as a result of the regulation. Total potential costs under each Option are:

Option	Potential Number of Closures	Potential Employment Lost	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)
1	0	0	6,151	2,349
2	0	0	9,045	4,567
3	0	0	9,793	5,251
4	0	0	12,138	6,381

6. Potential Impacts on Copper-Base Foundries

As shown in Table V-25 through V-28, potential annual costs for treating the discharge from the 117 directly and indirectly discharging foundries range from $5.0 million under Option 1 to $6.9 million under Option 4. Under Option 4, the incremental cost for treating the discharge from direct chill casting reaches a peak of 2.92 percent for direct dischargers with fewer than 10 employees. EPA expects no potential closures as a result of this regulation. Potential total costs under each Option are:

TABLE V-17

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- STEEL

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	2	0	57	0	20	0	0	0	0	0
10-49	0	10	0	97	0	42	0	0	0	0
50-99	11	21	279	667	107	239	0	0	0	0
100-249	19	19	756	525	274	206	0	0	0	0
250 or more	11	14	614	1,061	213	374	0	0	0	0
Total	43	64	1,706	2,350	614	861	0	0	0	0
Jobber Foundries										
Fewer than 10	1	0	29	0	10	0	0	0	0	0
10-49	0	8	0	77	0	33	0	0	0	0
50-99	9	18	235	566	90	203	0	0	0	0
100-249	16	16	633	436	230	172	0	0	0	0
250 or more	9	11	526	791	182	277	0	0	0	0
Total	35	53	1,423	1,871	513	685	0	0	0	0
Captive Foundries										
Fewer than 10	1	0	29	0	10	0	0	0	0	0
10-49	0	2	0	19	0	8	0	0	0	0
50-99	2	3	44	101	17	36	0	0	0	0
100-249	3	3	123	89	44	34	0	0	0	0
250 or more	2	3	87	269	31	97	0	0	0	0
Total	8	11	283	478	102	176	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-18

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- STEEL

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	2	0	70	0	24	0	0	0	0	0
10-49	0	10	0	283	0	114	0	0	0	0
50-99	11	21	325	1,102	144	429	0	0	0	0
100-249	19	19	1,589	1,363	668	639	0	0	0	0
250 or more	11	14	2,393	2,660	1,013	1,188	0	0	0	0
Total	43	64	4,377	5,409	1,849	2,370	0	0	0	0
Jobber Foundries										
Fewer than 10	1	0	35	0	12	0	0	0	0	0
10-49	0	8	0	227	0	91	0	0	0	0
50-99	9	18	272	948	121	370	0	0	0	0
100-249	16	16	1,321	1,133	557	533	0	0	0	0
250 or more	9	11	2,085	2,086	902	927	0	0	0	0
Total	35	53	3,712	4,393	1,592	1,920	0	0	0	0
Captive Foundries										
Fewer than 10	1	0	35	0	12	0	0	0	0	0
10-49	0	2	0	57	0	23	0	0	0	0
50-99	2	3	54	154	23	59	0	0	0	0
100-249	3	3	268	230	112	107	0	0	0	0
250 or more	2	3	308	575	111	261	0	0	0	0
Total	8	11	665	1,015	257	450	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-19

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- STEEL

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	2	0	74	0	31	0	0	0	0	0
10-49	0	10	0	326	0	140	0	0	0	0
50-99	11	21	346	1,166	168	488	0	0	0	0
100-249	19	19	1,817	1,520	798	734	0	0	0	0
250 or more	11	14	2,617	2,890	1,146	1,329	0	0	0	0
Total	43	64	4,854	5,900	2,144	2,691	0	0	0	0
Jobber Foundries										
Fewer than 10	1	0	37	0	16	0	0	0	0	0
10-49	0	8	0	260	0	112	0	0	0	0
50-99	9	18	289	1,004	141	421	0	0	0	0
100-249	16	16	1,508	1,263	663	611	0	0	0	0
250 or more	9	11	2,264	2,271	1,009	1,041	0	0	0	0
Total	35	53	4,096	4,798	1,829	2,185	0	0	0	0
Captive Foundries										
Fewer than 10	1	0	37	0	16	0	0	0	0	0
10-49	0	2	0	65	0	28	0	0	0	0
50-99	2	3	57	162	27	67	0	0	0	0
100-249	3	3	310	257	135	122	0	0	0	0
250 or more	2	3	354	618	137	289	0	0	0	0
Total	8	11	758	1,102	315	506	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-20

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- STEEL

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	2	0	73	0	32	0	0	0	0	0
10-49	0	10	0	375	0	166	0	0	0	0
50-99	11	21	344	1,230	168	518	0	0	0	0
100-249	19	19	2,076	1,620	909	800	0	0	0	0
250 or more	11	14	2,961	3,155	1,244	1,406	0	0	0	0
Total	43	64	5,455	6,381	2,353	2,891	0	0	0	0
Jobber Foundries										
Fewer than 10	1	0	37	0	16	0	0	0	0	0
10-49	0	8	0	300	0	133	0	0	0	0
50-99	9	18	287	1,061	141	448	0	0	0	0
100-249	16	16	1,714	1,346	751	667	0	0	0	0
250 or more	9	11	2,535	2,502	1,086	1,107	0	0	0	0
Total	35	53	4,572	5,209	1,993	2,355	0	0	0	0
Captive Foundries										
Fewer than 10	1	0	37	0	16	0	0	0	0	0
10-49	0	2	0	75	0	33	0	0	0	0
50-99	2	3	57	170	27	71	0	0	0	0
100-249	3	3	363	274	158	134	0	0	0	0
250 or more	2	3	426	653	158	299	0	0	0	0
Total	8	11	883	1,172	359	536	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-21

COMPLIANCE COSTS AND ECONOMIC IMPACTS — ALUMINUM

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	7	0	595	0	243	0	0	0	0	0
10-49	9	61	181	1,294	72	561	0	0	0	0
50-99	6	20	113	527	60	234	0	0	0	0
100-249	14	41	1,026	1,292	357	442	0	0	0	0
250 or more	9	9	609	475	218	164	0	0	0	0
Total	45	131	2,524	3,627	949	1,400	0	0	0	0
Jobber Foundries										
Fewer than 10	6	0	500	0	205	0	0	0	0	0
10-49	7	49	145	1,029	57	447	0	0	0	0
50-99	5	17	103	472	53	195	0	0	0	0
100-249	12	34	932	991	323	340	0	0	0	0
250 or more	7	7	533	384	186	133	0	0	0	0
Total	37	107	2,213	2,876	824	1,114	0	0	0	0
Captive Foundries										
Fewer than 10	1	0	95	0	38	0	0	0	0	0
10-49	2	12	36	265	14	114	0	0	0	0
50-99	1	3	10	95	7	39	0	0	0	0
100-249	2	7	94	301	33	102	0	0	0	0
250 or more	2	2	76	90	32	30	0	0	0	0
Total	8	24	311	751	125	286	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-22

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- ALUMINUM

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	7	0	684	0	311	0	0	0	0	0
10-49	9	61	348	2,145	183	1,135	0	0	0	0
50-99	6	20	172	1,102	105	603	0	0	0	0
100-249	14	41	1,100	2,068	420	1,171	0	0	0	0
250 or more	9	9	736	689	318	321	0	0	0	0
Total	45	131	3,040	6,005	1,337	3,230	0	0	0	0
Jobber Foundries										
Fewer than 10	6	0	575	0	262	0	0	0	0	0
10-49	7	49	277	1,710	145	903	0	0	0	0
50-99	5	17	151	922	86	506	0	0	0	0
100-249	12	34	1,000	1,638	383	951	0	0	0	0
250 or more	7	7	624	562	259	263	0	0	0	0
Total	37	107	2,628	4,833	1,135	2,624	0	0	0	0
Captive Foundries										
Fewer than 10	1	0	109	0	50	0	0	0	0	0
10-49	2	12	71	436	38	232	0	0	0	0
50-99	1	3	21	180	18	97	0	0	0	0
100-249	2	7	100	430	37	220	0	0	0	0
250 or more	2	2	112	127	60	58	0	0	0	0
Total	8	24	412	1,172	202	606	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-23

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- ALUMINUM

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	7	0	734	0	386	0	0	0	0	0
10-49	9	61	370	2,322	205	1,273	0	0	0	0
50-99	6	20	205	1,177	133	688	0	0	0	0
100-249	14	41	1,197	2,207	491	1,330	0	0	0	0
250 or more	9	9	846	734	384	361	0	0	0	0
Total	45	131	3,353	6,440	1,599	3,652	0	0	0	0
Jobber Foundries										
Fewer than 10	6	0	617	0	325	0	0	0	0	0
10-49	7	49	295	1,849	162	1,012	0	0	0	0
50-99	5	17	177	985	110	577	0	0	0	0
100-249	12	34	1,094	1,751	450	1,081	0	0	0	0
250 or more	7	7	709	597	310	295	0	0	0	0
Total	37	107	2,893	5,183	1,357	2,965	0	0	0	0
Captive Foundries										
Fewer than 10	1	0	117	0	61	0	0	0	0	0
10-49	2	12	76	473	42	261	0	0	0	0
50-99	1	3	27	192	23	110	0	0	0	0
100-249	2	7	103	456	41	250	0	0	0	0
250 or more	2	2	137	137	74	66	0	0	0	0
Total	8	24	460	1,257	242	687	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-24

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- ALUMINUM

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	7	0	860	0	452	0	0	0	0	0
10-49	9	61	453	2,963	248	1,606	0	0	0	0
50-99	6	20	306	1,494	179	847	0	0	0	0
100-249	14	41	1,384	2,712	575	1,574	0	0	0	0
250 or more	9	9	1,082	883	474	424	0	0	0	0
Total	45	131	4,086	8,052	1,929	4,452	0	0	0	0
Jobber Foundries										
Fewer than 10	6	0	724	0	381	0	0	0	0	0
10-49	7	49	360	2,371	197	1,284	0	0	0	0
50-99	5	17	266	1,250	151	711	0	0	0	0
100-249	12	34	1,262	2,171	526	1,285	0	0	0	0
250 or more	7	7	910	727	385	350	0	0	0	0
Total	37	107	3,522	6,519	1,640	3,630	0	0	0	0
Captive Foundries										
Fewer than 10	1	0	136	0	71	0	0	0	0	0
10-49	2	12	93	592	52	322	0	0	0	0
50-99	1	3	40	244	29	136	0	0	0	0
100-249	2	7	122	542	49	290	0	0	0	0
250 or more	2	2	172	157	89	75	0	0	0	0
Total	8	24	563	1,534	289	822	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-25

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- COPPER

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	16	11	487	436	208	181	0	0	0	0
10-49	20	28	1,912	2,643	723	1,008	0	0	0	0
50-99	16	5	1,017	730	430	271	0	0	0	0
100-249	6	6	3,323	200	1,448	69	0	0	0	0
250 or more	5	4	1,207	345	560	122	0	0	0	0
Total	63	54	7,946	4,355	3,369	1,650	0	0	0	0
Jobber Foundries										
Fewer than 10	13	9	392	354	167	147	0	0	0	0
10-49	16	22	1,577	2,037	594	777	0	0	0	0
50-99	9	3	589	461	249	170	0	0	0	0
100-249	3	3	1,781	115	764	40	0	0	0	0
250 or more	1	1	466	126	227	44	0	0	0	0
Total	42	38	4,803	3,094	2,002	1,177	0	0	0	0
Captive Foundries										
Fewer than 10	3	2	95	82	40	34	0	0	0	0
10-49	4	6	336	605	129	231	0	0	0	0
50-99	7	2	428	269	181	101	0	0	0	0
100-249	3	3	1,543	85	684	29	0	0	0	0
250 or more	4	3	741	219	333	78	0	0	0	0
Total	21	16	3,142	1,261	1,367	473	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-26

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- COPPER

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	16	11	541	495	242	209	0	0	0	0
10-49	20	28	2,038	2,785	832	1,153	0	0	0	0
50-99	16	5	1,049	755	464	301	0	0	0	0
100-249	6	6	3,349	210	1,487	74	0	0	0	0
250 or more	5	4	1,232	362	582	135	0	0	0	0
Total	63	54	8,208	4,607	3,607	1,871	0	0	0	0
Jobber Foundries										
Fewer than 10	13	9	436	402	195	170	0	0	0	0
10-49	16	22	1,678	2,148	682	891	0	0	0	0
50-99	9	3	608	477	268	188	0	0	0	0
100-249	3	3	1,799	122	789	43	0	0	0	0
250 or more	1	1	467	132	230	49	0	0	0	0
Total	42	38	4,988	3,281	2,165	1,340	0	0	0	0
Captive Foundries										
Fewer than 10	3	2	105	93	47	39	0	0	0	0
10-49	4	6	360	637	150	263	0	0	0	0
50-99	7	2	441	279	195	112	0	0	0	0
100-249	3	3	1,549	88	698	31	0	0	0	0
250 or more	4	3	765	230	352	86	0	0	0	0
Total	21	16	3,220	1,326	1,443	531	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-27

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- COPPER

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	16	11	622	526	338	267	0	0	0	0
10-49	20	28	2,231	3,005	931	1,269	0	0	0	0
50-99	16	5	1,235	798	598	337	0	0	0	0
100-249	6	6	3,606	231	1,662	85	0	0	0	0
250 or more	5	4	1,319	384	644	154	0	0	0	0
Total	63	54	9,012	4,944	4,173	2,112	0	0	0	0
Jobber Foundries										
Fewer than 10	13	9	501	428	272	217	0	0	0	0
10-49	16	22	1,838	2,318	764	979	0	0	0	0
50-99	9	3	715	504	345	211	0	0	0	0
100-249	3	3	1,940	136	882	50	0	0	0	0
250 or more	1	1	500	141	251	56	0	0	0	0
Total	42	38	5,493	3,526	2,515	1,514	0	0	0	0
Captive Foundries										
Fewer than 10	3	2	121	98	66	50	0	0	0	0
10-49	4	6	394	688	167	290	0	0	0	0
50-99	7	2	520	295	253	126	0	0	0	0
100-249	3	3	1,666	95	780	35	0	0	0	0
250 or more	4	3	819	243	393	98	0	0	0	0
Total	21	16	3,519	1,420	1,658	598	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-28

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- COPPER

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	16	11	719	645	402	344	0	0	0	0
10-49	20	28	2,447	3,482	1,028	1,485	0	0	0	0
50-99	16	5	1,336	903	654	395	0	0	0	0
100-249	6	6	3,721	230	1,713	84	0	0	0	0
250 or more	5	4	1,359	441	663	178	0	0	0	0
Total	63	54	9,583	5,700	4,460	2,487	0	0	0	0
Jobber Foundries										
Fewer than 10	13	9	581	525	325	280	0	0	0	0
10-49	16	22	2,031	2,689	850	1,148	0	0	0	0
50-99	9	3	766	570	375	247	0	0	0	0
100-249	3	3	2,021	135	916	50	0	0	0	0
250 or more	1	1	496	166	250	67	0	0	0	0
Total	42	38	5,896	4,084	2,716	1,792	0	0	0	0
Captive Foundries										
Fewer than 10	3	2	139	121	77	65	0	0	0	0
10-49	4	6	415	793	178	337	0	0	0	0
50-99	7	2	570	333	280	148	0	0	0	0
100-249	3	3	1,701	94	797	34	0	0	0	0
250 or more	4	3	863	275	412	111	0	0	0	0
Total	21	16	3,688	1,616	1,744	695	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

Option	Potential Number of Closures	Potential Employment Lost	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)
1	0	0	12,301	5,019
2	0	0	12,815	5,478
3	0	0	13,956	6,285
4	0	0	15,283	6,947

7. Potential Impacts on Zinc Foundries

As shown in Tables V-29 through V-32, potential costs for treating the discharges from the 58 directly and indirectly discharging zinc foundries range from $0.5 million under Option 1 to $1.6 million under Option 4. The annual cost to treat the discharge from casting quench operations for the two foundries with fewer than 10 employees range from 2.5 percent of sales under Option 1 to 5.5 percent of sales under Option 4. Because of the high profitablity and low debt of the foundries in this subcategory, however, EPA does not anticipate any potential closures as a result of the regulation.

Option	Potential Number of Closures	Potential Employment Lost	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)
1	0	0	1,326	533
2	0	0	1,897	1,003
3	0	0	2,070	1,175
4	0	0	2,884	1,575

8. Potential Impacts on Magnesium Foundries

As shown in Tables V-33 through V-36, annual costs for treating the discharges from the four directly and indirectly discharging magnesium foundries range from $42 thousand under Option 1 to $66 thousand under Option 4. Based on these costs, EPA estimates potential closures ranging from two under Option 1 to three under Option 4. These potential closures are based on average annual costs of 3.7 percent of sales or higher, and result from failure of the return on assets and Beaver's ratio tests. Potential costs and impacts under each of the four Options are:

TABLE V-29

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- ZINC

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	2	0	45	0	18	0	0	0	0
10-49	0	17	0	476	0	173	0	0	0	0
50-99	0	13	0	285	0	111	0	0	0	0
100-249	7	13	97	253	52	115	0	0	0	0
250 or more	2	4	54	116	21	44	0	0	0	0
Total	9	49	151	1,175	73	460	0	0	0	0
Jobber Foundries										
Fewer than 10	0	1	0	22	0	9	0	0	0	0
10-49	0	13	0	353	0	130	0	0	0	0
50-99	0	11	0	207	0	84	0	0	0	0
100-249	6	11	67	200	38	91	0	0	0	0
250 or more	1	2	38	51	14	19	0	0	0	0
Total	7	38	105	834	52	334	0	0	0	0
Captive Foundries										
Fewer than 10	0	1	0	22	0	9	0	0	0	0
10-49	0	4	0	122	0	43	0	0	0	0
50-99	0	2	0	79	0	27	0	0	0	0
100-249	1	2	30	52	14	23	0	0	0	0
250 or more	1	2	16	65	7	24	0	0	0	0
Total	2	11	47	341	21	126	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-30

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- ZINC

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	2	0	55	0	22	0	0	0	0
10-49	0	17	0	670	0	304	0	0	0	0
50-99	0	13	0	402	0	200	0	0	0	0
100-249	7	13	135	422	97	283	0	0	0	0
250 or more	2	4	62	152	26	71	0	0	0	0
Total	9	49	197	1,700	123	880	0	0	0	0
Jobber Foundries										
Fewer than 10	0	1	0	28	0	11	0	0	0	0
10-49	0	13	0	500	0	229	0	0	0	0
50-99	0	11	0	316	0	168	0	0	0	0
100-249	6	11	95	340	71	231	0	0	0	0
250 or more	1	2	43	59	17	25	0	0	0	0
Total	7	38	138	1,243	89	665	0	0	0	0
Captive Foundries										
Fewer than 10	0	1	0	28	0	11	0	0	0	0
10-49	0	4	0	170	0	75	0	0	0	0
50-99	0	2	0	86	0	32	0	0	0	0
100-249	1	2	40	81	25	52	0	0	0	0
250 or more	1	2	19	93	9	46	0	0	0	0
Total	2	11	59	457	34	215	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-31

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- ZINC

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	2	0	58	0	28	0	0	0	0
10-49	0	17	0	709	0	344	0	0	0	0
50-99	0	13	0	437	0	236	0	0	0	0
100-249	7	13	172	459	129	323	0	0	0	0
250 or more	2	4	69	165	33	81	0	0	0	0
Total	9	49	242	1,828	163	1,012	0	0	0	0
Jobber Foundries										
Fewer than 10	0	1	0	29	0	14	0	0	0	0
10-49	0	13	0	530	0	260	0	0	0	0
50-99	0	11	0	346	0	199	0	0	0	0
100-249	6	11	122	371	96	264	0	0	0	0
250 or more	1	2	48	62	22	29	0	0	0	0
Total	7	38	170	1,338	118	765	0	0	0	0
Captive Foundries										
Fewer than 10	0	1	0	29	0	14	0	0	0	0
10-49	0	4	0	179	0	84	0	0	0	0
50-99	0	2	0	91	0	37	0	0	0	0
100-249	1	2	51	88	34	59	0	0	0	0
250 or more	1	2	21	102	11	52	0	0	0	0
Total	2	11	72	490	45	247	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-32

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- ZINC

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	2	0	75	0	40	0	0	0	0
10-49	0	17	0	923	0	500	0	0	0	0
50-99	0	13	0	594	0	324	0	0	0	0
100-249	7	13	317	657	196	412	0	0	0	0
250 or more	2	4	99	219	47	109	0	0	0	0
Total	9	49	416	2,468	242	1,333	0	0	0	0
Jobber Foundries										
Fewer than 10	0	1	0	38	0	20	0	0	0	0
10-49	0	13	0	692	0	340	0	0	0	0
50-99	0	11	0	477	0	274	0	0	0	0
100-249	6	11	232	534	146	338	0	0	0	0
250 or more	1	2	67	84	30	39	0	0	0	0
Total	7	38	299	1,826	176	1,012	0	0	0	0
Captive Foundries										
Fewer than 10	0	1	0	38	0	20	0	0	0	0
10-49	0	4	0	231	0	109	0	0	0	0
50-99	0	2	0	117	0	50	0	0	0	0
100-249	1	2	85	122	50	74	0	0	0	0
250 or more	1	2	32	134	17	69	0	0	0	0
Total	2	11	117	643	67	323	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-33

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- MAGNESIUM

(Option 1 -- Recycle/Simple Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	2	2	47	57	22	20	1	1	2	46
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	2	2	47	57	22	20	1	1	2	46
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	2	2	47	57	22	20	1	1	2	46
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	2	2	47	57	22	20	1	1	2	46
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-34

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- MAGNESIUM

(Option 2 -- Recycle/Lime Addition/Settle)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	2	2	59	65	26	23	1	1	2	46
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	2	2	59	65	26	23	1	1	2	46
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	2	2	59	65	26	23	1	1	2	46
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	2	2	59	65	26	23	1	1	2	46
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-35

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- MAGNESIUM

(Option 3 -- Recycle/Lime Addition/Settle/Filtration)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	2	2	63	68	30	26	1	1	2	46
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	2	2	63	68	30	26	1	1	2	46
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	2	2	63	68	30	26	1	1	2	46
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	2	2	63	68	30	26	1	1	2	46
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

TABLE V-36

COMPLIANCE COSTS AND ECONOMIC IMPACTS -- MAGNESIUM

(Option 4 -- Recycle/Lime Addition/Settle/Filtration/Carbon Adsorption)

	Number of Discharging Foundries		Compliance Costs (in thousands of 1983 dollars)				Closures			
			Capital Investment		Annual Costs		Number of Foundries			Number of Employees
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Total	
All Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	2	2	81	68	40	26	2	1	3	69
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	2	2	81	68	40	26	2	1	3	69
Jobber Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	2	2	81	68	40	26	2	1	3	69
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	2	2	81	68	40	26	2	1	3	69
Captive Foundries										
Fewer than 10	0	0	0	0	0	0	0	0	0	0
10-49	0	0	0	0	0	0	0	0	0	0
50-99	0	0	0	0	0	0	0	0	0	0
100-249	0	0	0	0	0	0	0	0	0	0
250 or more	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0

Note: Numbers may not add up to totals due to rounding.

Option	Potential Number of Closures	Potential Employment Lost	Total Capital Cost ($ Thousands)	Total Annual Cost ($ Thousands)
1	2	46	104	42
2	2	46	124	49
3	2	46	131	56
4	3	69	149	66

D. SELECTION OF OPTIONS

Table V-37 shows the selected options for the Metal Molding and Casting effluent guidelines. The options chosen are based on EPA's estimates of economic impacts and other factors. National regulations have been chosen for all metals except magnesium.

Effluent guidelines for BPT (best practicable control technology current achievable) are set based on removal using Option 2 technology (partial recycle of process water followed by lime addition and settling). For steel and aluminum, removals under BAT (best available technology economically achievable), PSES (pretreatment standards for existing sources), NSPS (new source performance standards) and PSNS (pretreatment standards for new sources) have been set equal to BPT.

In general, standards for gray iron, ductile iron, malleable iron, copper-based metals and zinc have been set at the more stringent Option 3 treatment (partial recycle of process water followed by lime addition, settling and filtration). However, EPA has established lower levels of stringency for small gray and malleable iron foundries. For malleable iron foundries with fewer than 100 employees, BAT, PSES, NSPS, and PSNS are set equal to BPT. For gray iron foundries with fewer than 50 employees, PSES and PSNS have also been set equal to BPT.

E. OTHER IMPACTS

In estimating potential impacts, EPA places primary emphasis on potential closures and employment loss. However, as previously mentioned there are several other measures of economic impact, including

- potential price increases due to the regulation
- potential production loss due to the regulation
- potential balance of trade impacts
- potential community effects

The remainder of this section provides an analysis of each of these potential impacts.

TABLE V-37

SELECTED OPTIONS FOR EFFLUENT GUIDELINES

	BPT	BAT	PSES	NSPS	PSNS
Gray Iron	2	3	3[a]	3	3[a]
Ductile Iron	2	3	3	3	3
Malleable Iron	2	3[b]	3[b]	3[b]	3[b]
Steel	2	2	2	2	2
Aluminum	2	2	2	2	2
Copper-Base	2	3	3	3	3
Zinc	2	3	3	3	3
Magnesium	n.r.[c]	n.r.	n.r.	n.r.	n.r.

Option 1: Recycle and simple settle
Option 2: Recycle, lime addition, and settling
Option 3: Recycle, lime addition, settling and filtration
Option 4: Recycle, lime addition, settling, filtration, and carbon adsorption

BPT: Best practicable control technolgy currently available
BAT: Best available technology economically achievable
NSPS: New source performance standards
PSES: Pretreatment standards for existing sources
PSNS: Pretreatment standards for new sources

[a]For plants with fewer than 50 employees, PSES and PSNS are set at Option 2.

[b]For plants with fewer than 100 employees, BAT, PSES, NSPS, and PSNS are set at Option 2.

[c]n.r. means not regulated.

1. Potential Price Increases

In estimating potential impacts, EPA has assumed that foundries would be unable to pass the compliance costs on to customers. The assumption was based on estimates of competition both from domestic foundries not incurring costs and foreign foundries. Less than one-fourth of domestic foundries discharge process waters, and thus may incur costs. Further, several respondents to the International Trade Commission study claimed that they are already holding prices down in response to foreign competition. Although EPA is basing its estimates of impacts on the inability of foundries to raise prices, EPA has assessed the potential price increase required for foundries to fully pass along the cost increases to customers.

Table V-38 shows price pass-through requirements for all segments incurring costs. The values represent the highest increase in cost needed to fully recover compliance costs under the selected options. It can be seen that potential price increases are generally very low (less than one percent). In only seven cases do potential increases exceed one percent. Potential closures are shown only where the required price increase exceeds about three percent.

2. Potential Production Loss Due to the Regulation

EPA expects that production losses caused by this regulation will be minor. Under the selected options only six foundries (five gray iron and one ductile iron) are expected to close. Those six closures could lead to a loss of about 14,000 tons per year of production, or about 0.2 percent of combined gray and ductile iron production (see Table V-39). Production losses of this magnitude can be easily made up by the remaining foundries in the industry.

3. Potential Balance of Trade Impacts

This regulation is expected to have no significant impact on the U.S. balance of trade. This conclusion is based on three factors:

- Impacts have a minor share in the U.S. market.
- Potential price increases on affected foundries are minor.
- Most U.S. foundries incur no cost increase at all.

As shown in Chapter II, foreign imports have a very small share of the U.S. market. Although some specific casting types have had strong competition from imports, foreign castings overall account for only 2.6 percent of the total castings market. International Trade Commission figures also show that exports of U.S. castings have grown at the same time that imports have grown. Based on the data, it appears that factors such as transportation costs, service and responsiveness are strong enough to outweigh the price advantage of some foreign castings.

The second factor precluding large balance of trade effects is the small potential effect on prices. For almost all affected segments,

TABLE V-38

PRICE PASS THROUGH REQUIREMENTS FOR

ALL REGULATED SEGMENTS

(selected options)

Metal	Size	Number	% Change In Price	Closures
Gray Iron	Fewer than 10	2	1.31	no
	10 to 49	52	3.10	yes
	50 to 99	41	1.29	no
	100 to 249	80	0.51	no
	250 or More	61	0.39	no
	Overall	236	0.49	--
Ductile Iron	10 to 49	9	2.24	yes
	50 to 99	3	1.02	no
	100 to 249	27	0.60	no
	250 or More	13	0.42	no
	Overall	52	0.51	--
Malleable Iron	50 to 99	8	0.59	no
	100 to 249	33	0.32	no
	250 or More	9	0.27	no
	Overall	50	0.31	--
Steel	Fewer than 10	2	0.37	no
	10 to 49	10	0.50	no
	50 to 99	32	0.29	no
	100 to 249	38	0.13	no
	250 or More	25	0.09	no
	Overall	107	0.12	--
Aluminum	Fewer than 10	7	0.70	no
	10 to 49	70	0.60	no
	50 to 99	26	0.16	no
	100 to 249	55	0.08	no
	250 or More	28	0.05	no
	Overall	176	0.12	--

(Continued)

TABLE V-38 (Continued)

Metal	Size	Number	% Change In Price	Closures
Copper	Fewer than 10	27	1.43	no
	10 to 49	48	0.21	no
	50 to 99	21	0.31	no
	100 to 249	12	0.29	no
	250 or More	9	0.29	no
	Overall	117	0.28	--
Zinc	Fewer than 10	2	3.79	no
	10 to 49	17	0.70	no
	50 to 99	13	0.29	no
	100 to 249	20	0.07	no
	250 or More	6	0.18	no
	Overall	60	0.13	--

TABLE V-39

POTENTIAL PRODUCTION IMPACTS FOR SELECTED OPTIONS

	Gray Iron	Ductile Iron
Foundries Closed	5	1
Annual Sales per Foundry ($ thousands)	947	1,053
Sales Lost ($ thousands)	4,735	1,053
Sales by Dischargers in Size Category ($ thousands)	76,708	14,742
% of Category Sales Lost	6.17	7.1
Sales by Dischargers ($ millions)	4,482	1,231
% of Sales Lost	0.11	0.09
Tons Shipped per Foundry	2,402	2,038
Tons Lost	12,010	2,038
1982 Shipments of Metals (thousand tons)	6,393	1,822
% of Metal Shipments Lost	0.19	0.11

price increases are less than 0.5 percent of costs. For comparison, it should be noted that the value of the dollar fell 11 percent between February and August, 1985, leading to an equivalent increase in the cost of imported castings. Relative to such fluctuations in the cost of imports, the cost increase to affected foundries is minimal.

The third factor is the small population of affected foundries. Although 800 foundries discharge process waters and thus incur costs, more than 3,000 foundries do not. The competitiveness of the 3,000 foundries not incurring costs will not be affected by this regulation.

To summarize, only a fraction of foundries incur cost increases, which are minor relative to recent changes in the value of the U.S. dollar. As a result, EPA concludes that potential balance of trade impacts are minor.

4. Community Effects

Because of the use of model plant analysis to determine impacts, there is no way to determine which specific foundries will close rather than comply with the regulations. In the absence of precise community location of the affected foundries, the analysis assumes that the distribution of closures will be the same as for foundries in general. Foundries are located in four regions composed of various states, as defined in the Census of Manufactures. These regions have been used as the basis for an analysis of community effects. Table V-40 lists the four regions and the states included in those regions.

The analysis of community effects has been confined to an illustrative distribution of the closures among the four regions. Closed foundries are assumed to have the same distribution as all foundries casting the metal. Table V-41 shows that nearly half of the six plant closures at the selected options might occur in the North Central region, with another one-quarter of them in the Northeast region.

Because of the small number of closures spread over the four regions and the low total employment loss, significant adverse impacts in any one community are not expected.

TABLE V-40

LIST OF REGIONS AND STATES WITHIN REGIONS

Northeast	North Central	South	West
Maine	Ohio	Delaware	Washington
Vermont	Indiana	Maryland	Oregon
Massachusetts	Illinois	Virginia	California
Rhode Island	Michigan	West Virginia	Montana
Connecticut	Wisconsin	North Carolina	Idaho
New York	Minnesota	South Carolina	Nevada
New Jersey	Iowa	Georgia	Utah
Pennsylvania	Missouri	Florida	Arizona
New Hampshire	North Dakota	Kentucky	New Mexico
	South Dakota	Tennessee	Colorado
	Nebraska	Alabama	Wyoming
	Kansas	Mississippi	Hawaii
		Arkansas	Alaska
		Louisiana	
		Oklahoma	
		Texas	

TABLE V-41

PROJECTED REGIONAL DISTRIBUTION OF CLOSURES
IN EMPLOYMENT-SIZE SEGMENTS

Employment-Size Segment	Total Closures	Northeast	North Central	South	West
Gray Iron					
10 to 49	5	1	2	1	1
Ductile Iron					
10 to 49	1	--	1	0	--
Total	6	1	3	1	1
Distribution	100%	17%	50%	17%	17%

CHAPTER VI

NEW SOURCE IMPACTS

VI. NEW SOURCE IMPACTS

The basis for new source performance standards (NSPS) and pretreatment standards for new sources (PSNS), as established under Section 306 of the Clean Water Act, is the best available demonstrated control technology. Builders of new facilities have the opportunity to install the best available production processes and waste-water treatment technologies, without incurring the added costs and restrictions encountered in retrofitting an existing facility. Therefore, Congress directed EPA to require that the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies be installed in new facilities. For regulatory purposes new sources include greenfield plants and major modifications to existing plants.

The potential economic impact of concern to EPA in evaluating new source regulations is the extent to which these regulations represent a barrier to the construction of new facilities or exert pressures on existing plants to modernize, and thereby reduce the growth potential of the industry.

In evaluating the potential economic impact of the NSPS/PSNS regulations on new sources, it is necessary to consider the costs of the regulations relative to the costs incurred by existing sources under the BAT/PSES regulations. Under this regulation, new source requirements are the same as those for existing sources.[1] Therefore, no incremental costs will be incurred by new source plants. Consequently, new sources will not be operating at a cost disadvantage relative to existing sources due to this regulation. The economic effects resulting from the regulations are not significant (production cost increases range from 0.11 to 0.43 percent across all subcategories except magnesium) and, therefore, will not in themselves pose a barrier to entry.

The magnesium subcategory is exempt from coverage under this regulation. As previously reported, the costs of the treatment options were projected to result in closure of from two (under Options 1, 2 or 3) to three (under Option 4) out of four existing discharging magnesium plants. These closures reflected annual compliance costs amounting to 4.2 percent of production costs. Given the significance of the compliance costs, plants in this subcategory are not included under the regulation. This extends to new magnesium foundries, where the Agency believes that the compliance costs would create a significant barrier to entry.

---

[1]This includes the provisions for small gray and malleable iron plants. The PSNS requirements for small gray iron foundries are less stringent, as are the NSPS and PSNS requirements for small malleable iron foundries.

CHAPTER VII

SMALL BUSINESS ANALYSIS

VII. SMALL BUSINESS ANALYSIS

This chapter analyzes the possible economic consequences resulting from small foundry compliance with the proposed regulations. The purpose is to determine if the regulations will impose a significant economic impact on a substantial number of small entities (i.e., small businesses).

A. SMALL FOUNDRY SIZE CRITERIA

Under Section 3 of the Small Business Act (13 CFR Part 121), "small business" is defined by the number of a firm's employees and by the dollar volume of a firm's net income. For the foundry industry specifically, the Small Business Act also specifies that the maximum employee size for "small" foundries ranges from 500 for ferrous foundries to 1,000 for nonferrous foundries, and that the maximum net income size for all "small" foundries is $2 million. On the basis of the SBA size criteria, most foundries qualify as small businesses. Of all 3,664 foundries that were operating in 1978, 96 percent were small according to the SBA employee size criteria, and 98 percent were small according to the SBA net income criteria.

However, the Small Business Act recognizes that basic, narrow definitions may not be applicable to an entire industry, particularly when it has an extreme diversity of plant sizes. In such instances, the Act permits the use of alternate criteria that more realistically delineate the maximum size of "small business."

In the foundry industry, there is an extreme diversity of plant sizes. In 1978, 61 percent of the 3,664 foundries had fewer than 50 employees, and those plants shipped only 6 percent of the industry's tonnage. In sharp contrast, 29 percent of the foundries had between 50-249 employees, and they collectively had a 31 percent shipments share. Another 10 percent of the foundries having at least 250 employees accounted for 63 percent of all tonnage shipped by the foundry industry.

Foundry managers and trade groups recognize operational differences between foundries in three employment-size groups, and they frequently describe those groups as small, medium, and large, respectively. However, disagreement exists as to the precise cutoff for small foundries. Based on these considerations, and the apparent threshold of economic impacts shown in Chapter V, EPA is continuing to define small foundries as those foundries having fewer than 50 employees.

B. IMPACT ANALYSIS FRAMEWORK

The analysis of economic impacts for the foundry industry was confined to foundries that cast one of eight metal types as their major metal. The analysis started by assigning foundries to categories based on the major metal cast, the foundry's number of employees, and the relative importance of castings shipments to jobber and captive markets. Estimates of the foundry population in 1986 were based on an enumeration of foundries operating in 1983, with modifications made to reflect known changes from 1983 to 1984. The projected 1986 segment populations were then distributed between dry and wet foundries, with the wet plants being further distributed between (1) zero dischargers, and (2) direct and indirect dischargers. Compliance investment costs (capital costs) and annual costs (operating costs plus capital recovery) were developed by EPA within the framework of the segmentation format.

C. CLOSURES FOR SMALL AND LARGE FOUNDRIES

The most visible and critical portion of the overall impact analysis pertained to determination of the number of foundries that might close rather than comply with the proposed regulations. Both jobber and captive plants were expected to be subject to the same economic criteria. It is assumed that economic factors on a plant-level basis are the determining factors, and that small plants owned by larger corporate entities are treated similarly to any other investment. Closure thresholds were based on a review of the literature on financial distress[1] and a review of the historical operating behavior of foundries.

Using the methodology described in Chapter III, EPA estimates that 800 of the 3,853 foundries projected for 1986 would be direct or indirect dischargers. Compliance with Option 1 treatment by all of those dischargers would require $43.2 million of capital costs and $16.2 million of annual costs, based on 1983 dollars. Application of the financial tests indicated that four foundries might close rather than install Option 1 technology. This number is 0.4 percent of all wet foundries (direct, indirect, and zero dischargers).

For this analysis, the Agency has determined that small foundries are those with fewer than 50 employees. Consequently, in 1986 there would be 346 small wet foundries among a total of 2,511 small foundries having 42,323 employees. Compliance with Option 1 treatment by the 250 small dischargers would, in 1983 dollars, involve $10.8 million of capital costs and $4.2 million of annual costs. The financial tests indicated that the four potential closures at Option 1 consist of two small gray iron foundries and two small magnesium foundries, employing a total of 100 persons.

The four small foundry closures attributable to Option 1 would be equivalent to 1.6 percent of the small wet foundries. The 100 workers that would face unemployment because of the closures would represent 1.3 percent of the employees for all small wet foundries.

---

[1]Most studies on financial distress use bankruptcy as the definition of distress. A few use wider definitions, such as failure to pay preferred stock dividends or lack of sufficient funds to cover checks.

Compliance by the 250 small foundry dischargers with Option 4, which is the most stringent of the alternate treatment levels, would increase the compliance capital and annual costs to $19.2 million and $9.0 million, respectively, in 1983 dollars. Applying those costs to the financial tests indicated that 22 small foundries employing 582 workers might close rather than comply with Option 4. Those 22 closures represent 6.4 percent of small wet foundries, and their employment is 7.8 percent of the employees of small wet foundries.

To provide perspective, closure determinations for the larger foundries (i.e., those with 50 or more employees) are also detailed. Of the 1,342 larger foundries projected to be operating in 1986, 713 would generate process wastewater, either as direct, indirect, or zero dischargers. For them to comply with Option 1, capital and annual costs of $32.4 million and $12.1 million, respectively, would be required, based on 1983 dollars.

The 550 larger discharging plants would be employing more than 144,015 workers in 1986, which is 51 percent of the 284,140 total employment by all 1,342 larger foundries. The Agency expects that one malleable iron foundry employing 76 persons mights close rather than comply with the regulations if Option 3 were the selected option, while 2 malleable iron foundries employing a total of 142 persons might close rather than install Option 4 technology.

D. OTHER POTENTIAL IMPACTS

EPA also investigated the relative impact of the regulations as measured by changes in financial performance. Three ratios in particular were examined: the annual cost as a percentage of sales (Table VII-1) and the annual cost as a percentage of the cost of production (Table VII-2), and the change in return on assets (Table VII-3). As is expected, costs are relatively greater for smaller foundries. For four metals (steel, aluminum, copper-base and zinc), costs remains less than one percent of sales for both size groups under all options. Costs for gray and ductile iron are more substantial, exceeding one percent of sales at Option 1 for small gray iron foundries, and at Option 2 for small ductile iron foundries. Costs exceed 3 percent of sales for magnesium foundries for all options. Comparison of compliance costs as a percentage of the costs of production yields similar trends.

E. REDUCTION OF IMPACT ON SMALL BUSINESSES

The Clean Water Act allows EPA to apply less stringent regulations to small plants if the Agency determines that the regulations are not economically achievable for small plants. Accordingly, the regulation establishes less stringent limitations and standards for small foundries in two subcategories where impacts were significant.

For two metals, gray iron and malleable iron, EPA is establishing less stringent standards for smaller foundries. Based on the estimates of impacts, EPA is establishing PSES and PSNS for gray iron foundries

TABLE VII-1

ANNUAL COMPLIANCE COSTS AS A PERCENTAGE OF SALES
FOR AFFECTED SMALL AND LARGE FOUNDRIES
(percent)

Metal	Option 1		Option 2		Option 3		Option 4	
	Small	Large	Small	Large	Small	Large	Small	Large
Gray Iron	1.57	0.11	3.01	0.39	3.56	0.45	4.69	0.49
Ductile Iron	0.52	0.16	2.08	0.41	2.24	0.49	2.49	0.54
Malleable Iron	NA	0.73	NA	0.27	NA	0.31	NA	0.34
Steel	0.21	0.04	0.47	0.11	0.58	0.13	0.67	0.14
Aluminum	0.33	0.04	0.61	0.08	0.70	0.09	0.87	0.11
Copper-base	0.20	0.36	0.22	0.26	0.26	0.29	0.30	0.31
Zinc	0.39	0.04	0.66	0.08	0.75	0.10	0.99	0.13
Magnesium	3.63	NA	4.20	NA	4.80	NA	5.69	NA

NA = Not applicable.

TABLE VII-2

ANNUAL COMPLIANCE COSTS AS A PERCENTAGE OF COST OF PRODUCTION FOR AFFECTED SMALL AND LARGE FOUNDRIES

(percent)

Metal	Option 1		Option 2		Option 3		Option 4	
	Small	Large	Small	Large	Small	Large	Small	Large
Gray Iron	1.69	0.14	3.23	0.42	3.82	0.49	4.98	0.54
Ductile Iron	0.63	0.17	2.22	0.44	2.39	0.52	2.66	0.58
Malleable Iron	NA	0.08	NA	0.29	NA	0.33	NA	0.37
Steel	0.25	0.04	0.55	0.12	0.68	0.14	0.79	0.15
Aluminum	0.36	0.04	0.68	0.09	0.77	0.10	0.96	0.12
Copper-base	0.23	0.40	0.25	0.28	0.29	0.32	0.34	0.34
Zinc	0.42	0.04	0.72	0.09	0.82	0.10	1.08	0.14
Magnesium	3.87	NA	4.48	NA	5.12	NA	6.07	NA

NA = Not applicable.

TABLE VII-3

CHANGE IN RETURN ON ASSETS FOR

AFFECTED SMALL AND LARGE FOUNDRIES

(percent)

Metal	Option 1		Option 2		Option 3		Option 4	
	Small	Large	Small	Large	Small	Large	Small	Large
Gray Iron	-28.38	-2.13	-51.01	-6.67	-58.93	-7.67	-73.74	-8.61
Ductile Iron	-10.75	-2.89	-35.95	-7.17	-38.57	-8.40	-42.77	-9.24
Malleable Iron	NA	-1.19	NA	-4.28	NA	-4.88	NA	-5.40
Steel	-2.07	-0.63	-4.61	-1.72	-5.54	-1.95	-6.32	-2.11
Aluminum	-4.90	-0.69	-8.42	-1.26	-9.55	-1.43	-11.78	-1.73
Copper-base	-2.86	-3.80	-3.20	-3.96	-3.63	-4.47	-4.19	-4.73
Zinc	-5.99	-0.84	-9.54	-1.58	-10.68	-1.85	-13.95	-2.53
Magnesium	-64.41	NA	-72.93	NA	-81.07	NA	-93.04	NA

NA = Not applicable.

with fewer than 50 employees based on Option 2 technology, while larger gray iron foundries must comply with standards based on Option 3. For the malleable iron subcategory, EPA is establishing across the board standards (BAT, NSPS, PSES, and PSNS) based on Option 2 for foundries with fewer than 100 employees, while larger malleable iron foundries must achieve removals based on Option 3.

EPA found that impacts on magnesium foundries are sufficiently severe to warrant an exemption of magnesium foundries from the regulation. It should be noted that all discharging foundries in the magnesium foundry were found in the 10-49 employment size subcategory, and that closures were projected beginning at 50 percent at Option 1.

F. REGULATORY FLEXIBILITY ACT

This regulation does not cause significant adverse economic impact upon small foundries. The Agency has incorporated less stringent requirements into the regulation for small foundries (gray iron and malleable iron) where the compliance costs had significant effects on plants in the small size categories. Additionally, the Agency has excluded one subcategory (magnesium) from the regulation due largely to the effects of compliance costs on plants in the subcategory, all of which are small. Because the regulation does not create significant economic impacts on a substantial number of small foundries, a separate Regulatory Flexibility Analysis has not been prepared.

CHAPTER VIII

LIMITATIONS OF THE ANALYSIS

VIII. LIMITATIONS OF THE ANALYSIS

A. FORECASTS OF SHIPMENTS

EPA has used the shipments data collected in its 308 survey as the basis for estimating plant revenues. A review of other sources, notably Census, shows that average revenues for some plants, particularly in the smaller size categories, may be lower. EPA has made many efforts to confirm the survey results, calling many foundries in 1982 to verify production and employment values. The values used reflect the submissions of 438 wet foundries responding directly to this rulemaking. EPA has reduced the per plant shipment values by the decline in industry production measured between 1978 (the base year for the survey) and 1982 (or 1983 for steel). The use of the production decline factors produces a lower bound on the production from plants similar to those in EPA's data base, while also leading to values more consistent with other data sources. Despite the Agency's efforts, it is possible that 1986 shipments may be underestimated.

B. SELECTION OF RATIOS

EPA has selected three ratios to estimate impacts: return on assets, debt to assets, and cash flow to total debt. The estimated post-compliance value of each ratio for each quartile is used. If values for two of the ratios fall below the threshold values, a model plant is forecast to close.

Much of the literature on financial statement analysis has been oriented to multivariate functions, which include in one function several important ratios. The benefit of a multivariate function is that the effect of countervailing influences can be measured. That is, a company with some poor financial ratios and some good financial ratios will show up as less likely to fail than one with uniformly poor financial ratios. Unfortunately, the existing multivariate functions cannot be applied to the foundry industry, because they require data not available, such as (1) the market value of stock (not relevant to privately held companies), (2) the year-to-year changes in ratios (not available if looking at how imposition of compliance cost would impact forecast financial ratios), and (3) the relationship of a firm's ratios to the industry median and quartiles (irrelevant if only examining median and quartile ratios).

Although multivariate functions could be more accurate for closure analysis, they require data that are only available at the level of individual firms, and frequently require data only available for publicly held companies. The three univariate measures we have chosen were extensively investigated by Beaver. Although Beaver examined many other, similar ratios, these were the most effective. They, or very similar ratios, have appeared as parts of the multivariate functions. The interpretations of the ratios in the context of forecasting failure are clear. We believe they represent the best of the techniques that can be applied to the data available in the foundry industry.

C. USE OF SAME TESTS FOR CAPTIVES AND JOBBERS

This analysis assumes that captive plants and jobbers operate under the same financial conditions. Beaver's original threshold values were established by examining larger, publicly held companies, so the values should be consistent with those applied by parent corporations.

If the analysis errs, we believe that it may overestimate impacts on captive plants. In general, the Dun & Bradstreet data show that larger companies are financially in better shape. Small, captive plants, supported by the overall financial structure of the parent organization, should be healthier than small, independent firms. Furthermore, captive plants satisfy the economic needs of assured supply and dedicated scheduling to the parent firm, functions whose value cannot be quantified by an outside observer. Captive plants owned by large corporations may also have access to professional management techniques generally available in large corporations, including electronic record keeping and improved financial management.

Last of all, larger corporations have easier access to credit markets. This is not to say that the controllers of large corporations would automatically allocate funds to foundry operations. Instead, it suggests that if the decision is made to install pollution control equipment rather than close down foundry operations, a larger corporation is more likely to be able to borrow the funds. Hence, small foundries owned by larger corporations should have readier access to debt markets than small, independent foundries.

D. DERIVATION OF COMPOSITE FINANCIAL STATEMENTS FROM QUARTILE RATIOS

Consider three firms, Able, Baker, and Charley, with the following financial characteristics:

	Able	Baker	Charley
Sales	1,000	2,000	4,000
Income	100	80	240
Assets	1,000	1,000	1,000
ROS	10%	4%	6%
ROA	10%	8%	24%
Sales to Assets	1	2	4

By definition, the return on assets of a firm equals the return on sales times the sales to assets ratio:

$$ROA = ROS \times S/A$$

This is true for the three firms shown. When compiling quartiles, however, the same does not hold true. Using our three companies as the sample population, the ratios in the quartiles are as follows:

	Upper Quartile	Median	Lower Quartile
ROS	10% (A)	6% (C)	4% (B)
ROA	24% (C)	10% (A)	8% (B)
S/A	4 (C)	2 (B)	1 (A)

It is not true for any quartile that return on sales times sales to assets equals return on assets. Although this example is hypothetical, the same results are observed when examining the quartiles published by Dun & Bradstreet. In deriving balance sheets from the quartile data, we have attempted to maintain the general relationship that increasing debt imposes interest costs that decrease net income, and that the fraction of debt is smaller for larger companies. In 1978, Dun & Bradstreet published quartile data on return on sales, debt to net worth (D/NW), and sales to net worth (S/NW). For deriving the model financial statements, we used the following characteristics:

- highest ROS with lowest D/NW and S/NW;
- median ROS with median D/NW and S/NW; and
- lowest ROS with highest D/NW and S/NW.

This procedure would increase the likelihood of at least one quartile failing more than one of the closure tests, and may overstate impacts.

APPENDIX A

REVIEW OF FINANCIAL RATIOS AS PREDICTORS OF BANKRUPTCY

APPENDIX A

REVIEW OF FINANCIAL RATIOS AS PREDICTORS OF BANKRUPTCY

A. INTRODUCTION

EPA is required to determine the estimated economic impact of the regulations it promulgates. Frequently, the calculation has been performed by estimating the impact of the additional compliance costs on the financial statements of the impacted firms and inferring the number of closures by the extent of the impact. Where the impact on a firm resulted in a financial ratio, such as debt divided by total assets, that exceeded a threshold value, the firm or class of firms was deemed to be a potential closure.

Public comments on proposed regulations have questioned both the ratios used and the threshold values selected. This paper addresses the issues of theoretical and empirical justification inherent in the use of any financial test.

Part B, Summary of the Use of Financial Ratios, shows the broad use of financial ratios to predict financial distress, both in the academic literature and within EPA. As will be shown, several types of ratios have recurred consistently as being reasonable predictors. While the different studies used different statistical methodologies and different ratios, all of them demonstrated that the financial ratios of failed and non-failed firms are consistently different, and that the financial ratios of failed and non-failed firms differ before failure.

Part C, Discussion of Specific Tests, presents the tests that (1) have appeared most frequently in the literature, or (2) seem to have rational explanations for their effectiveness. For each test, the discussion highlights the theoretical considerations of the use of the test, the empirical history of its use, and any available threshold values.

Part D, Financial Tests Proposed for Forecasting Foundry Closures, gives three ratios considered to have both empirical justification and sufficient publicly available data to allow for their use.

Part E, Selection of Thresholds, presents the basis of the threshold values chosen for each test. In particular, observations from the Dun & Bradstreet financial data and from a review of recently bankrupt metal companies are given, along with an interpretation of the data.

Part F, Interpretations of Results, explains why this analysis uses the criteria that a model plant must fail two of three financial tests.

Part G, Summary, briefly presents the ratios chosen for this study, and the reason for their selection, and the threshold values chosen.

B. SUMMARY OF THE USE OF FINANCIAL RATIOS

1. Academic Literature

Prediction of financial distress is important to many segments of the business community such as bankers, investors, company managers, regulatory bodies, and business competition. As early as 1908, bankers and lenders were using the current ratio (the ratio of the current assets of a company to its current liabilities) to predict loan repayment (Beaver, 1966, p. 71). As financial accounting developed more structure, more ratios could be examined. "(T)he development of financial statement analysis in the 1920's and 1930's was characterized by extensive data collection and the proliferation of new ratios (Lev, 1974, p. 3)." Threshold values for each ratio were determined on an *ad hoc* basis, with no theoretical or empirical justification. Further, analysts could receive conflicting estimates of the solvency of a firm when looking at ratios individually.

Starting in the mid-1960s, researchers started using statistical techniques to determine the actual effectiveness of the various financial ratios. The academicians had widely varying goals, and in many cases used widely variant tests. Virtually all, however, found that financial ratios of failed and non-failed firms differ before failure.

For example, Tamari, in 1966, presented a formula for a weighted average of several ratios. Although he was able to correctly classify 97% of the non-failed and 52% of the failed firms in his sample, the weights used were arbitrary and the cut-off value was sample-specific. In consequence, there was little reason to think the formula would be applicable to a new selection of firms.

William Beaver, in 1966, was the first researcher to examine the actual distribution of ratios for failed and non-failed firms to determine appropriate thresholds. While Beaver did not solve the problem of conflicting results from different interpretations, he did at least demonstrate that some ratios were better than others, and that threshold values could be determined from a review of actual firms.

Concurrently with Beaver, Horrigan (1966) investigated long-term bond ratings as a function of financial ratios. Using multiple regression analysis, he developed a function that could predict bond ratings to within one classification. While not directly related to financial distress, the bond rating of a company will affect its cost of aquiring funds, and thus its cost of doing business. In addition, lower bond ratings presumably reflect the analysts' opinions about potential future financial distress.

Lev (reported in Moyer, 1977) used a univariate model based on the balance sheet decomposition measure. The balance sheet decomposition measure is a measure of the change in the relative proportions of balance sheet measures from year to year. Failed firms show greater changes, and thus have larger measures. The methods chosen by Lev and Horrigan, although widely cited, were not used in many further studies.

The next major analytical technique was promoted by Edward Altman in 1968. Using multiple discriminant analysis (MDA), Altman derived a function of five ratios, four from the financial statement and one incorporating market value of equity. Like Beaver, Altman used a paired sample design, with bankrupt firms being matched with non-bankrupt firms of equivalent asset size and comparable industry. In later years, Altman continued to apply multiple discriminant analysis, determining specific functions for railroads and brokerage houses. In 1977, he estimated the parameters for a new, seven-variable discriminant model (Altman, Haldeman, and Narayanan, 1977).

Following Altman's lead, other investigators applied multiple discriminant analysis. Blum (1974) used discriminant analysis while investigating the "failing company" doctrine, which is used as a defense in antitrust cases. Deakin (1972) applied discriminant analysis to firms that had gone bankrupt or were liquidated, and confined himself to 14 ratios obtained from balance sheet and income statement items. Sinkey (1975) applied multiple discriminant analysis to identify problem banks. Edmister (1972) compiled a quite complicated discriminant function using a series of dummy variables. The study was supported by the Small Business Administration and was specifically concerned with small firms.

Moyer (1977) reviewed the performance of the original Altman model against larger firms drawn from a later time period, finding the error rate to be higher than for Altman's original sample. When Moyer reestimated the parameters of the model, he found that the coefficients had changed. Further examination seemed to show that two of Altman's variables, sales to total assets and market value of equity to book value of debt, offer little additional information to the model. In a further test, he compared the Altman model to a two-variable discriminant model composed of Beaver's cash flow to total debt ratio and Lev's balance sheet decomposition measure, two univariate measures expected to predict well. The Altman model had about the same error rate, but the distribution of errors was different. Specifically, the

Altman model predicted fewer non-failing firms as failing, while the other model predicted fewer failing firms as non-failing.

Jarrod Wilcox (1971, 1973) sought to establish a theory of bankruptcy. As a basis, he adopted the "Gamblers' Ruin" model. The Gamblers' Ruin model presents the probability of ultimate bankruptcy given the average gain or loss per period, the initial reserves, and the probability of gains or losses. Reviews published with the 1973 paper were sharply critical, and there has been little follow-up work.

As empirical tests using discriminant analysis proliferated, other researchers examined the violations of statistical assumptions that came from the use of ratios. Gupta and Huefner (1972) used IRS data to cluster manufacturing companies by ratios, and presented what they believed to be meaningful groupings for four financial ratios. To the extent that industry characteristics affect financial ratios, tests based on cross-industry patterns will be less valid for any specific industry. Eisenbeis (1977) surveyed the literature on multiple discriminant analysis and listed several common errors, with the most severe error being the use of samples in which the classification is either inexact (e.g., determined by subjective analysis), not inclusive of the entire relevant population, or not necessarily discrete. Other problems arise from inconsistencies in _a priori_ probability estimates, violation of the underlying statistical assumptions of the technique used, and pooling of data across time.

Lev and Sunder (1979) examined the general issue of using ratios. As they found, "a major reason for using financial variables in the form of ratios is to control for the systematic effect of size on the variables under examination . . . . (C)ontrol for size by the ratio form is adequate only under very restrictive conditions (Lev and Sunder, 1979, pp. 187-188)." Deakin (1976) examined the distribution of financial ratios. Use of multiple discriminant analysis assumes, among other things, that the variables are distributed normally. Deakin found that most ratios are not distributed normally, that transformations (such as taking the logarithm or the square root) sometimes improve the distribution, and that ratios of companies within a given industry may be distributed more normally than ratios compiled from several industries. Frecka and Hopwood (1983) also examined the distribution of financial ratios. They found that the distributions are highly skewed, but that a normal distribution could be obtained for most ratios by deleting outliers and using a transformation of the data. Further, they cite one study using discriminant analysis in which the results were "strongly influenced by a small number of observations (Frecka and Hopwood, 1983, p. 127)."

Ohlson (1980) reviewed the available literature and demonstrated that, beyond statistical inconsistencies of the MDA model, previous studies had potential timing problems (use of financial statements not available before bankruptcy) and that the matched sample technique potentially hid information. Instead, Ohlson used a conditional logit analysis, which is claimed to avoid any prespecification of the statistical distribution of predictors. In addition, his study used recent (1970-1977) data, and had a relatively large sample (105 bankrupt, and 2,058 non-bankrupt firms). However, Ohlson specifically excluded small, privately held companies (Ohlson, 1980, p. 114). Further, Ohlson did not use any hold-out sample to provide a test of the predictive ability outside of the original sample.

Not surprisingly, each author has attempted to extend the literature. As seen, these attempts have resulted in the use of widely divergent statistical techniques and forms of equations. They have also resulted in the selection of quite different variables. Altman (1968) and Beaver (1966), the authors of the classical papers, used almost entirely different sets of ratios. Following them, other authors selected from either Beaver's list or Altman's list, but rarely looked at both. In addition, the later authors frequently tried to develop new ratios, incorporating either industry norms, the tenets of financial theory, or financial variables peculiar to a specific industry. Table 1 shows the wide variety of ratios examined. From that list, we have selected the financial ratios discussed in Section C.

TABLE 1

FINANCIAL RATIOS EXAMINED IN STUDIES
OF THE PREDICTION OF FINANCIAL DISTRESS

RATIOS / AUTHORS	Beaver, '66	Beaver,[1] '68a	Altman,[2] '68	Altman[2] et al '77	Altman[2] '73	Blum,[2] '74	Deakin,[2] '72	Edmister,[2,3]	Horrigan[2] '66	Lev,[1] '69	Moyer,[2,4] '77	Ohlson,[2] '80	Wilcox, '71, '73
Cash flow/current liab.								*					
Cash flow/sales	+												
Cash flow/total assets	+												
Cash flow/net worth	+												
Cash flow/total debt	*	*		+		*	*				, , *		
Net income/sales	+								*				
Net income/total assets	*	*					*					*	
Net income/net worth	+												
Net income/total debt	+			+									
Current liab/total assets	+												
Long-term liab/total assets	+					*							
Current and long-term liab/total assets	+											*	
Current liab + long-term liab + pref. stock/total assets	*	*			+		*		*				

+ - Variable tested. Not included as "best" predictor.

* - Variable tested. Showed discriminating ability.

[1] Variables tested in dichotomous classification tests.

[2] Variables incorporated into multivariate functions.

[3] Edmister used dummy variables based on the relationship of a company's ratios to thresholds.

[4] Moyer tested three models.

TABLE 1

FINANCIAL RATIOS EXAMINED IN STUDIES OF THE PREDICTION OF FINANCIAL DISTRESS

AUTHORS / RATIOS	Beaver,[1] '66	Beaver,[1] '68a	Altman,[2] '68	Altman,[2] et al '77	Altman,[2] '73	Blum,[2] '74	Deakin,[2] '72	Edmister,[2,3]	Horrigan[4] '66	Lev,[1] '69	Moyer,[2] '77	Ohlson,[2] '80	Wilcox, '71, '73
Cash/total assets	+	+					*						
Quick assets/total assets	+	+					*						
Current assets/total assets	+	+					*						
Working capital/total assets	*	+	*	+	+		*				*, *	*	
Cash/current liab	+	+					*						
Quick assets/current liab	*	+					*						
Current assets/current liab	+	+		+			*					*	
Cash/sales	+	+					*						
Receivables/sales	+												
Inventory/sales	+												
Quick assets/sales	+	+					*						
Current assets/sales	+	+					*						
Working capital/sales	+	+					*		*				
Net worth/sales	+							*	*				
Total assets/sales	+		*	+							*		
Cash interval	+												
Defensive interval	+												

TABLE 1

FINANCIAL RATIOS EXAMINED IN STUDIES OF THE PREDICTION OF FINANCIAL DISTRESS

AUTHORS / RATIOS	Beaver,[1] '66	Beaver,[1] '68a	Altman,[2] '68	Altman,[2] et al '77	Altman,[2] '73	Blum,[2] '74	Deakin,[2] '72	Edmister,[2,3]	Horrigan[4] '66	Lev,[1] '69	Moyer,[2] '77	Ohlson,[2] '80	Wilcox, '71, '73
No credit interval	*												
Total assets	*			*					*			*	
Retained earnings/total assets			*								*, *,		
EBIT/total assets			*	*	*						*, *,		
Mkt value equity/book debt			*			*					*, ,		
Net available for total cap/total cap				+									
Sales/total capital				+									
EBIT/sales				+									
NATC/sales				+									
Tangible assets				+									
Interest coverage				*									
Fixed charge coverage				+	+								
Working capital/long-term debt				+									
Retained earnings/total assets				*	*								
Book equity/total capital				+									
Other, off-balance sheet				*, +		*		*					

TABLE 1

FINANCIAL RATIOS EXAMINED IN STUDIES
OF THE PREDICTION OF FINANCIAL DISTRESS

AUTHORS / RATIOS	Beaver,[1] '66	Beaver,[1] '68a	Altman,[2] '68	Altman,[2] et al '77	Altman,[2] '73	Blum,[2] '74	Deakin,[2] '72	Edmister,[2,3]	Horrigan[4] '66	Lev,[1] '69	Moyer,[2] '77	Ohlson,[2] '80	Wilcox, '71, '73
"Quick flow" ratio[5]						*							
Industry specific					+, *								
Cash flow/fixed charges					*								
Net quick assets/inventory						*							
Balance sheet decomposition										*	, , *		
TL > TA dummy												*	
Funds/total liabilities												*	
"Gambler's Ruin"													*

[5] Quick flow = cash + notes receivable + securities + (annual sales/12) ÷ (COGS − Depreciation + G&A + Interest) ÷ 12

2. Summary

Financial ratios have a long history of use as predictors of financial distress. Various ad hoc rules date back at least to 1908. Since 1966, researchers have used a wide variety of tests to demonstrate the validity of using financial ratios in this context. Financial ratios of various sorts also have a wide precedent of use within several of the EPA offices. Despite potential statistical problems, both single variable threshold models and multiple variable functions have measured differences between the balance sheets of firms that later failed and those that did not.

C. DISCUSSION OF SPECIFIC TESTS

Over the years, financial analysts and accountants have grouped individual financial ratios into four basic categories:

- profitability;
- solvency;
- liquidity; and
- efficiency.

More detailed statistical studies have found seven to eight groupings of financial ratios (Pinches and others, 1973, and Gombola and Ketz, 1983). After excluding many of the ratios using short-term assets and liabilities, however, the four categories listed provide a close approximation to the statistically determined patterns.

The remainder of this section will discuss, in turn, the ratios comprising each category. Ratios that are commonly used either in the literature or in previous work by EPA have been considered. In addition, the potential for using a multivariate test will be reviewed.

1. Profitability Measures

a. Return on Assets

Return on assets (ROA) is computed as the ratio of net income after taxes divided by total assets. Beaver tested this ratio in 1966, finding it to be the best of four "net income" ratios in predictive ability. In 1980, Ohlson used the ratio as one of seven of the variables making up his predictive function. ROA has a strong advantage from the standpoint of availability, because it requires only the net income and the total assets, both of which are reported in financial statements.

From a more theoretical standpoint, the ratio has potential disadvantages. Its principal drawback is that its use confuses the separate issues of the productivity of the capital base and the financing of the asset base. It is easy to show (see Table 2) that two firms having identical assets, sales, and costs, but different financial structures, will show different ROA. Depending on the specific numbers chosen, the firm that provides the higher return on net worth (the residual amount representing the owners' interest in the firm) will have the lower ROA. If an assumption is made that firms within an industry either seek, or should seek, a common financial structure, some of the problems with the ratio seem less severe.

b. EBIT Divided by Total Assets

Earnings before interest and taxes (EBIT) divided by total assets is another profitability measure that has been popular in the literature. In particular, Altman used the measure in two of his discriminant functions, while Moyer's review of Altman's work also showed the measure to be a successful predictor. However, this measure is much harder to determine if detailed financial statements are not available. Dun & Bradstreet reports only values for return on net worth. While D&B also reports ratios such as long-term debt to total

TABLE 2

COMPARISON OF RETURN ON ASSETS FIGURES

	Non-Leveraged	Leveraged
Debt	0	500
Net Worth	1000	500
Total Assets	1000	1000
Sales	2000	2000
EBIT	200	200
Interest[a]	0	50
Gross Income	200	150
Taxes[b]	100	75
Net Income	100	75
EBIT/TA (%)	20	20
ROA (%)	10	7.5
Return on Net Worth (%)	10	15
EBIAT/TA (%)[c]	10	10

Remarks: Firms have the same total assets, sales, and costs before interest. However, the firm with the higher return on net worth, which could be more valuable to the owners, shows a lower return on total assets. From the standpoint of economic value of the assets, however, the firms are identical, as shown by both the EBIT and the EBIAT.

[a]Assumes interest rate of 10%.
[b]Assumes tax rate of 50%.
[c]EBIAT (earnings before interest but after taxes) = Net income + (1-tax rate) x interest payments.

assets, it is easily shown that the median values provided by D&B cannot be combined to give a consistent balance sheet. Even using the ratio of long-term debt to total assets to estimate the amount of interest-bearing debt would not be sufficient, because both the amount of taxes and the interest rate must be estimated as well.

Theoretically, EBIT divided by total assets is a little more satisfactory than ROA because the earnings' value used is before the considerations of financing. Because tax effects are not included, the effects of special tax effects are not taken into account, which may serve to penalize some industries. The literature has not provided threshold values of EBIT divided by total assets on a univariate basis. Altman provided the mean value for failed and non-failed firms in both his 1968 and 1977 papers. From an investment standpoint, one could say that any firm not providing an EBIT divided by total assets greater than the before tax return on a comparable investment would be a poor investment, and that the firm could be liquidated in favor of other investments. However, doing so would confuse the historical cost basis of the financial statements with the salvage value of the firm. The two values are not necessarily related.

c. <u>EBIAT Divided by Total Assets</u>

The use of earnings before interest but after taxes (EBIAT) has not been pursued in the literature on financial distress. As with EBIT, calculation of the numerator requires manipulation of the published data. Again, the D&B industry norms do not report a median value by industry, so that use of EBIAT would require several assumptions about interest rates, amount of interest-bearing debt, and tax structures.

In principle, use of EBIAT gives the after-tax profitability of a firm's assets without confusing the issue of financing. As a result, it should provide the best estimate of the profitability of the firm, and also give a value that would be directly comparable to other potential investments. It would be appropriate to compare EBIAT divided by total assets to after-tax returns on treasury notes, possibly adjusted for a risk premium. As with the use of EBIT, however, the use of "total assets" as measured by the financial statements may not be a true measure of the value of the assets employed.

d. Return on Sales

Return on sales (ROS) has been used in several of the EPA economic impact studies. Its principal virtue is the relatively small amount of data necessary -- only the value of production and the cost of the compliance on an annualized basis. Unfortunately, the measure has not been popular in studies on financial distress. Beaver (1966, p. 106) showed ROS to be fairly successful, but not the best of the "net income" measures (ROA, ROS, return on net worth, return on debt). Altman's unsuccessful investigation of EBIT to sales is the only reported attempt at using any measure of return on sales in multivariate studies. A possible reason is that researchers assume that many firms use "cost-plus" pricing, where the prices are developed to get a fairly constant margin. Truth of the assumption would tend to violate comparable assumptions in the field of economics.

Return on sales has been included in factor analysis studies. In those studies, which attempted to determine whether there were common measures of the performance of firms, return on sales tended to correlate highly with a dimension of "return on investment," along with cash flow to total debt and income to assets.

2. Solvency Measures

a. Cash Flow to Total Debt

This ratio was Beaver's "best" predictor of financial distress, and is commonly referred to as the "Beaver's ratio." As defined by Beaver, cash flow consists of the net income plus depreciation of a firm. Computationally, the ratio is easy to derive from financial statements. Dun & Bradsteet does not provide an industry norm for depreciation, but the Census does record total assets employed and total depreciation by 4-digit SIC. With appropriate manipulation (ignoring the potential inconsistencies in the use of median data), an estimate of depreciation can be calculated and added to a derived value of the median net income to total debt. For use of Beaver's ratio, the appropriate measure of total debt is all liabilities of the firm. This includes such items as accounts payable, taxes payable, bank loans, and capitalized leases.

b. Total Debt to Total Assets

The first issue to be resolved in the use of total debt to total assets as a predictor is the definition to be used. Total debt to total assets generally refers only to current plus long-term liabilities, and does not include preferred stock. In Beaver's study, however, the best of the "debt to total asset" ratios was the measure using total debt plus preferred stock. For firms having no preferred stock, the measures are identical. Another common measure, total debt to net worth, is exactly equivalent to debt to total assets. Dun & Bradstreet report an industry norm for total debt to net worth, but apparently do not include preferred stock.

Use of some measure of debt to assets has been very popular in the literature. Beaver tried several, and found total debt plus preferred stock to be the best measure of debt. Horrigan used the same measure in his study on bond ratings. Altman found that the measure was not the best one from a multivariate sense when he studied the over-the-counter brokerage industry. Instead, he found retained earnings to total assets to be a better predictor, possibly because it captures aspects of the age and past profitability of the firm. Ohlson used the normal definition of total debt (i.e., not including preferred stock) in his 1980 study.

For a long time, analysts have used a threshold of total debt to total assets of 0.5. The reasoning, as explained in the Dun & Bradstreet publications, is that if the ratio is higher, the creditors have more at stake than the owners. Beaver, however, found that the actual threshold when predicting failure is somewhat higher. For predictions one year, four years, and five years out, the threshold was fairly stable at .57 to .58. Beaver's study used data from the period 1954-1964. Through the intervening years, average debt levels for most firms have risen.

c. Interest Coverage

Interest coverage, computed as EBIT divided by total interest charges, is a measure sometimes mentioned as an indication of the flexibility of the firm. Its only use in the academic literature on financial distress is in Altman's 1977 study, where interest coverage entered as part of a multivariate function. Although Altman didn't perform any dichotomous testing of the efficiency of the variable as a predictor on its own, he did find that there were significant differences between the interest coverages of failed and non-failed firms. The threshold value frequently suggested by credit analysts and stock analysts is two — the earnings before interest and taxes should be at least twice the fixed interest charges. Using a threshold value of two does not mean a company is extremely profitable, merely that it is not in imminent danger of failing.

3. Liquidity Measures

In the traditional literature, liquidity measures provide a measure of a firm's ability to meet its short-term (less than one year until due) obligations. Firms that may easily meet the obligations are considered liquid; those which cannot are considered illiquid. Three common measures of liquidity are the current ratio (current assets[1] divided by current liabilities), the quick ratio (quick assets[2] divided by current liabilities), and net working capital[3] divided by total assets. Net working capital divided by total assets has been a frequently used variable in the empirical studies, and is one of the few variables pursued by both Altman and Beaver. The potential effects of the regulations on the short-term items in the balance sheet are unknown, but are expected to be low. Thus, these tests will not be useful in estimating the impacts of the regulations.

4. Efficiency Measures

Measures of efficiency are intended to reflect the extent to which assets are used. Although many measures are possible, the one that has received the most attention is sales to total assets. Beaver found that this ratio is not a very good predictor of financial distress. Altman included the ratio in his 1968 multivariate function, but not in his 1977 version. Moyer's review in 1977 of Altman's work also concluded that sales to total assets is not a particularly good predictor. From the standpoint of assessing the economic impacts of regulations, it is hard to see how the use of this variable would be implemented.

5. Multivariate Measures

Concurrent use of several univariate tests suffers from the problem of potentially inconsistent interpretations. A common trend in

---

[1]Current assets generally include cash, marketable securities, accounts receivable, and inventories.

[2]Quick assets are assets assumed to be readily convertible to cash: cash, marketable securities, and accounts receivable (which can be sold to external credit collection agencies).

[3]Net working capital is the difference between current assets and current liabilities.

the academic literature has been the attempt to develop a multivariate function that could be said to balance the impact of several aspects of a firm's financial performance. Of all the tests proposed in the literature, only the function given by Ohlson in 1980 uses variables that can all be derived either from financial statements or by manipulation of industry-wide data. Most of the variables are implicit in the Dun & Bradstreet industry norms, but "funds divided by total liabilities" corresponds to Beaver's ratio and must be computed by adding the Census report of industry depreciation to the net income to total debt figure. The problem still remains, however, of the potential inconsistencies in the use of industry median values. In addition, two of Ohlson's variables require year-to-year changes in the ratios, increasing the number of assumptions to be made and the potential error in application.

D. FINANCIAL TESTS PROPOSED FOR FORECASTING FOUNDRY CLOSURES

A suitable test for assessing the economic impacts of regulations on the foundry industry should meet three criteria:

- strong empirical justification;
- threshold values derived from recent data; and
- simple, consistent application to available data sources.

Table 3 provides a review of the most likely tests, the data available for applying each test, and the issues involved in using the data to apply the tests. Section C has already reviewed the empirical and theoretical justifications of the tests.

Three ratios satisfy most of the criteria:

- return on assets;
- total debt to total assets; and
- Beaver's ratio (cash flow to total debt).

TABLE 3

COMPARISON OF UNIVARIATE RATIO TESTS

Test	Data Required	Data on Hand	Issues
ROA	1. Net Income 2. Assets Can be computed from: ROA plus assets; ROA plus net income; Net income plus assets.	Dun & Bradstreet: ROA (as ratio) and total assets: median values by 4 digit SIC/ asset size class (see list). 1979-1982. Iron Castings Society: Mean "capital employed" by sales class aggregate for iron foundries. Steel Founders' Society Profit before taxes and "capital employed" by sales level-aggregate for steel foundries. Robert Morris Assoc. Median profit before taxes/total assets plus average assets, by asset size class. Data only for all ferrous and all non-ferrous foundries. FINSTAT: Individual company data from 1977-1980 giving employment, asset size from Dun & Bradstreet data base.	To calculate employment effects, would like to have relationship between assets or net income and employment. Use of median values by size category only allows one test to be made for each size class. Median assets need not correspond to median ROA, leading to use of incompatible data. Use of before tax earnings ratio would require guess of tax structure.

(Continued)

COMPARISON OF UNIVARIATE RATIO TESTS (Continued)

Test	Data Required	Data on Hand	Issues
EBIT/Total Assets	1. Earnings before interest and taxes (EBIT) 2. Total assets EBIT can be obtained: - Directly from corporate financial statement; - From ratio plus total assets; - From net income plus taxes plus interest.	Dun & Bradstreet Median total assets Median ROA Median total liab to NW Median Current liab to NW Median Return on NW - derive long term liab to assets - guess interest rate - guess tax rate - calculate EBIT/total assets. Robert Morris Associates Median EBIT/interest Median Profit before taxes/total assets (can be combined to EBIT/ total assets) average assets by asset size category. Steel Founders' Society average profit before taxes average total assets - no data relevant to interest payments. Iron Castings Society average operating profit average capital employed - no data relevant to interest payments.	Multiplication of medians does not necessarily lead to median value of another ratio. Potential error in guessing tax rates, interest payments. D&B provides no data on average or median tax payments. RMA asset sizes are not the same as Dun & Bradstreet, and do not correspond to SRI. RMA data is only available at level of ferrous or non-ferrous foundries.
EBIAT/Total Assets	1. Earnings Before Interest and After Taxes (EBIAT) 2. Total Assets EBIAT requires EBIT plus taxes.	Same as for EBIT/Total Assets.	Same restrictions and issues as for EBIT, plus the requirement of additional calculation.

(Continued)

COMPARISON OF UNIVARIATE RATIO TESTS (Continued)

Test	Data Required	Data on Hand	Issues
ROS	1. Net Income 2. Sales Can be derived from ROS ratio plus either net income or sales.	Dun and Bradstreet Median ROS Median net income Median sales. Robert Morris Associates Median sales/total assets Median EBT/total assets Median EBT/sales. Steel Founders' Society average profit before taxes average sales. Iron Castings Society average operating profit average sales. FINSTAT abbreviated balance sheets and income statements 1977-1980 by 4-digit SIC.	Use of median net income divided by median sales does not yield median ROS. RMA data available only at level of ferrous or non-ferrous foundries. Would need to use FINSTAT data to correlate ROS to predictor of failure.
Cash Flow/ Total Debt	1. Cash Flow 2. Total Debt Cash flow requires net income plus depreciation. If net income to total debt is available, need either total debt plus total depreciation or depreciation to total debt.	Dun and Bradstreet Median ROS Median total liab to NW (combine to return on debt) Median fixed assets to net worth (combine to get fixed assets to total debt). May <u>infer</u> depreciation by guessing average depreciation rate.	Combining median values does not necessarily yield median values. Depreciation rate must be obtained from separate not necessarily compatible source.

(Continued)

COMPARISON OF UNIVARIATE RATIO TESTS (Continued)

Test	Data Required	Data on Hand	Issues
Cash Flow/ Total Debt (Continued)	Total debt can be derived from total assets plus debt to assets.	Robert Morris Associates Median sales to total assets Median profit before taxes to total assets Median depreciation to sales Median debt to net worth. Census (Annual Survey of Manufactures) Total gross depreciable assets (not depreciated) Total annual depreciation (by 4-digit SIC). Iron Castings Society average capital employed average net worth (difference is average total debt) average operating profit - Insufficient data.	RMA data available only at level of ferrous or non-ferrous foundries. Census gives depreciation vs gross fixed assets; D&B provides ratios incorporating only net fixed assets.
Total Debt/ Total Assets	Total Debt/Total Assets plus total debt or total assets Total Debt/Net Worth plus total debt or net worth Total Debt and Net Worth Total Debt and Total Assets.	Dun & Bradstreet Median total liab to net worth Median total assets (also median total liab and median net worth). RMA Median debt to net worth Median total assets Median net worth.	Medians not consistent. RMA data not broken down by metal type. Projections of "typical" asset size and relation to employment unclear.

(Continued)

COMPARISON OF UNIVARIATE RATIO TESTS (Continued)

Test	Data Required	Data on Hand	Issues
Interest Coverage EBIT/interest payments	EBIT interest payments Interest payment could be obtained from debt times interest rate.	See EBIT/Total Assets Robert Morris Associates EBIT/total interest directly profit before taxes to total interest from EBIT/total interest.	Many assumptions re: interest rates, tax rates, interest bearing debt, etc. Requires combinations of median data.

Applying these ratios as tests will require some assumptions about the internal consistency of different ratios, but fewer than for the other possible tests. Primarily, these three ratios have a strong empirical base. No single ratio has been studied in recent, publicly available financial distress studies, so threshold values for the univariate tests must be inferred from the values obtained in older studies.

1. Return on Assets

Of the ratios examined, this best fulfills the requirements. Although there are theoretical objections to its use (i.e., its incorporation of the financing method), Beaver found it to be a successful predictor. Use of the test requires relatively little manipulation of the published data, because D&B publishes ROA directly. All that is needed to apply the ratio is a measure of total assets, which is needed for virtually all tests. The application of the test is relatively insensitive to the financing method chosen, because the cost of compliance is an asset whether financed through debt or equity. The return variable, however, will be sensitive to financing considerations.

Beaver's 1966 study provides an indication of an appropriate threshold. Although the one year to failure cut-off was 0-2%, the values for three to five years before failure consistently ranged between 2%-4%.

2. Total Debt to Total Assets

This ratio has a long history in the *ad hoc* financial literature, in the academic literature, and in EPA studies. Beaver found it to be a fairly good predictor of failure. The principal drawback to the ratio is its sensitivity to financing. Assumption of all equity financing, for example, will show an improved financial health for all firms by increasing the asset base and lowering the value of the ratio. Assumption of all debt financing will have a large impact on balance sheets, particularly of small firms. For purposes of estimating financial impact, however, all debt financing will be assumed.

Another problem is that the threshold is somewhat more difficult to determine. Beaver found a value of .57-.58 in both the short-term (one year) and long-term (four to five years) timeframes. In the mid-term (two to three years), however, the threshold value dropped to the range of .49-.51. Because the critical timeframe is likely to be the short term, a base value of debt to assets of .57 seems appropriate.

3. Cash Flow to Total Debt

Cash flow to total debt was Beaver's most "successful" ratio. It has a fairly simple economic interpretation -- operations must generate enough cash to meet the debt service, or the company will fall into a trap of borrowing to meet the interest payments.

There are drawbacks to the use of Beaver's ratio. The principal drawback is the inconsistency of the publicly available depreciation data. The data available provides the industry total of gross (undepreciated), fixed asset value and total depreciation claimed, in dollars. Simple division gives a mean value of the ratio of depreciation to historical cost, not depreciation as a fraction of net fixed assets. The D&B industry composites only provide ratios using net fixed assets. Assuming that depreciable lifetimes have historically been based on average useful lifetimes, and that replacement of assets will occur on a fairly steady level, assets will, on average, be 50% depreciated. Thus, depreciation to net fixed assets will be about twice depreciation to gross fixed assets. A review of publicly held metal working companies verified that net fixed assets generally range from 40% to 60% of gross fixed assets.

E. SELECTION OF THRESHOLDS

Beaver's study used 1954-1964 data. Since then, many changes have occurred in the underlying financial and economic conditions. Inflation has risen, debt levels have increased on balance sheets, and interest rates have risen.

We have selected as a basis Beaver's short-term (one year) threshold values. Because of the variability of corporate performance from year to year, it would be inappropriate to use long-term threshold values as a comparison to quartile-base financial statements. Such a comparison would imply that the same firms remain in the same relative financial position year after year. In addition, the academic studies themselves show declining performance for the models as the time span of the forecast is increased. This is no doubt caused by the variability of earnings for companies. From that standpoint, using a short-term test is more relevant than using a long-term test.

The specific thresholds have been established after reviewing Beaver's work, changes in fundamental economic conditions, the financial ratios of the foundry industry, and the financial statements of three metal working companies that have filed for Chapter XI bankruptcy in the last three years: Revere Brass and Copper, Steelmet, and McLouth Steel. None of the three filed for bankruptcy even when the return on assets was as low as 2%-4%. Steelmet returned only 4% on assets and had a debt to assets ratio of 79% in 1980, but did not file for bankruptcy until 1982, after losing money and increasing its fraction of debt in 1981. Revere survived while making 5% on assets, and having a Beaver's ratio of 0.14. Only after return on assets dropped to 2%, and the Beaver's ratio fell to 0.08, did Revere file for bankruptcy. McLouth followed the same pattern. It made 2% on assets in 1979, lost 12% on assets in 1980, and filed for bankruptcy even later. Between 1979 and 1980, its debt to asset ratio climbed from 62% to 73%, while its Beaver's ratio fell from 0.12 to -0.10.

After reviewing these data and the ratio data for firms in the foundry industry, the following threshold values have been selected.

1. Return on Assets

The threshold value for return on assets has been chosen as 2.5%. As seen in the review of bankrupt firms, bankruptcy was declared only after return on assets fell to 2% or less. Reviewing financial ratios for the foundry industry, three segments with positive income showed lower quartile ratios for return on assets of less than 3.5%. These segments were the upper quartile of steel, NEC, with fewer than 10 employees (ROA = 2%), the lower quartile of aluminum, 10-49 employees (ROA = 3.4%), and the lower quartile of magnesium, 50-249 employees (ROA = 3.5%).

In the belief that the threshold should be somewhat above that found for bankrupt firms, but below that normally found in the industry, the analysis used an intermediate value of 2.5%.

2. Debt to Total Assets

The analysis uses a threshold value of 70% debt. In Beaver's study, the cut-off values for debt to assets ranged from .50 to .57. There has been a substantial structural shift in the economy since the research was done between 1964-1966, with companies at all levels taking on more debt. Since 1978, the shift has been particularly noticeable. For aluminum foundries, the lower quartile number for the debt to asset ratio (exceeded by 25% of the firms) has been 64%, 61%, 60%, and 57% in the years 1978-1981, consecutively. For gray iron foundries, the debt to asset ratio was .57, .50, .57, and .61 in the years 1978-1981. Revere's debt to asset ratio ranged from 58% to 65% in the three years before bankruptcy, but climbed to 91% in the year Revere declared bankruptcy. Steelmet's debt to asset ratio was 79%-80% in the two years preceding bankruptcy, and dropped to 77% the year of bankruptcy. McLouth's debt to asset ratio rose from 62% to 73% in one year. We do not know how soon thereafter McLouth declared bankruptcy.

In reviewing computed debt to asset ratios for the foundry industry, it was noted that a few quartiles of some metals have debt to asset ratios above 60%, some as high as 68%. The highest values computed were 74% and 89%, for copper with fewer than 10 employees and for steel, NEC, with fewer than 10 employees. This analysis uses a threshold value of 70% because it is above common values for the debt to asset ratio, but below the value before failure for known bankrupt firms.

3. Beaver's Ratio

The threshold value for Beaver's ratio was selected to be 8%. The highest Beaver's ratio value for the three bankrupt firms studied was 8% (for Revere), with all others being lower.

Estimated Beaver's ratio values from the Dun & Bradstreet data were generally high. For some quartiles, for very small (less than 10 employees) firms, the values were negative. The lowest positive value for larger firms was 9.5%, for the lower quartile of aluminum, 10-49 employees. The lower quartile for malleable iron shows a negative Beaver's ratio for firms with 50 or more employees.

4. Summary

Although the threshold values we have selected are stringent, they seem to reflect the actual behavior of firms if faced with the prospect and costs of bankruptcy.

F. INTERPRETATIONS OF RESULTS

The third issue in the use of financial ratio-based tests is the interpretation of results. If one ratio falls below its threshold value while the other two pass, how should the firm be rated?

Examination of the data for the three bankrupt firms shows that companies did not file for bankruptcy unless they failed at least two tests. This seems rational in principle. If a company has a very high fraction of debt, but also has sufficient income and cash flow to satisfy investors and creditors, it would likely stay in business. If a company has low income in one period, but still has both sufficient cash flow and moderate debt, again it would likely stay in business. In the third case, if a company has a low Beaver's ratio (cash flow to total debt) but low debt to assets and reasonable return on assets, it would again probably stay in business.

However, if two ratios are below the threshold, there is much less chance of recovery. It is considerations such as these that have promoted the development of multivariate functions.

G. SUMMARY

Financial ratios have a long history of use in the financial distress literature. Statistical research since 1966 proves that financial ratios are different between failed and non-failed firms. Given the large number of foundries, and the need to predict the economic impacts at the time of compliance, use of aggregate ratios seems to be a reasonable means to predict industry-wide impacts.

Based on the data available for the foundry industry and the empirical findings, three ratios best meet the criteria used as a basis for selection:

- return on assets;
- total debt to total assets; and
- Beaver's ratio.

Financial variables to compute these ratios are available at the 4-digit SIC level for virtually all the foundry segments. With the assumptions outlined for each ratio, the data may be applied in a rational, consistent manner.

However, several changes have occurred in average balance sheet composition and overall economic conditions since Beaver's study. In addition, several studies have shown that using industry-specific data is desirable when drawing conclusions about financial ratios. Because of these factors, normal financial ratios for foundries and ratios for recently bankrupt metal companies were reviewed to determine reasonable threshold values for foundries in the 1980s. The review has resulted in the use of the following threshold values and criteria for failure:

- return on assets 2.5% minimum
- total debt to total assets 70% maximum
- Beaver's ratio 8% minimum
- Failure if two of three ratios surpass thresholds.