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# Economic Impact Analysis of the Halogenated Solvent Cleaning NESHAP

## DRAFT

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# 1.0 INDUSTRY PROFILE

## 1.1 Introduction

This industry profile details the various market characteristics of the industries potentially affected by the NESHAP limiting halogenated solvent emissions from organic solvent cleaners (also called degreasers).* The industries include manufacturers of degreasers, manufacturers of halogenated solvents used in degreasing, and industries that use degreasers.

Industries that use degreasers will be directly impacted by the NESHAP because they will incur control costs. Manufacturers of solvents used in degreasing and manufacturers of degreasing equipment will be indirectly impacted by the regulation. For example, demand for solvents and degreasing equipment will decrease if output in the user industries decreases in response to an attempt to recover control costs by increasing prices. The substitution of alternative cleaning systems or nonhalogenated solvents for cleaning methods using halogenated solvents would also affect both halogenated solvent and degreasing equipment manufacturers.

The profile will first examine the manufacture of degreasing equipment and halogenated solvents. Subsequently, there will be an examination of the industries using degreasers.

## 1.2 Degreasing Equipment

Degreasers are used to remove water-insoluble soils such as grease, waxes, carbon deposits, oils, fluxes, and tars. Among the surfaces cleaned are plastics, metals, fiberglass, and printed circuit boards. Degreasing takes

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*Though the degreasing NESHAP may also limit HAP emissions, it has not yet been determined which HAPs will be regulated. Thus, the profile only addresses halogenated solvents.

place prior to production processes such as painting, plating, inspection, repair, assembly, heat treatment, and machining. To remove the soils, degreasers use a variety of solvents.

Besides varying in size, from bench-top models to industrial-size models, degreasers also vary in technological sophistication, from a simple tank containing solvent to an automated, multi-stage system.[1] However, degreasers are usually categorized into three groups: cold cleaners, open top vapor cleaners (OTVCs), and in-line (conveyorized) cleaners.

Used most often for maintenance cleaning and the routine cleaning of small parts, cold cleaners use room temperature solvent to clean equipment and parts. These solvents are primarily aliphatic petroleum distillates, alochol blends, or napthas.[2] Only a certain type -- the carburetor cleaner -- uses halogenated solvents.[3] Cold cleaners are batch-operated; this means that their operation is discontinuous and on an as-needed basis.

An OTVC cleans parts and equipment by suspending them in the heated vapors of a solvent. OTVCs, like cold cleaners, are batch-operated. Unlike cold cleaners, they are rarely used for maintenance cleaning because cold cleaners are less expensive to operate for this type of work.[4] Exceptions include the maintenance cleaning of electrical components, small equipment parts, and aircraft parts, where the degree of cleanliness provided by an OTVC is necessary. OTVCs are widely used in metalworking operations.[5]

The final type of degreaser is the in-line or conveyorized (vs. batch) cleaner. The five types of in-line cleaners using halogenated solvents are cross-rod, monorail, belt, strip, and printed circuit board processing equipment (including photoresist strippers, flux cleaners, and

developers).[6] In-line cleaners can use either a cold-cleaning process or a vapor-cleaning process; the majority use vapor cleaning.[7] An in-line cleaner is used mainly in manufacturing facilities where there is a constant stream of parts to be cleaned. In these situations the advantages of a conveyorized system outweigh the lower capital cost of a batch-operated OTVC.[8] One of these advantages is that an in-line cleaner greatly reduces manual parts handling associated with cold cleaners and OTVCs. Another advantage is that in-line cleaners are usually tailored to the specific production environment rather than being of a generic design.

The manufacture of degreasers is part of the broad SIC 3559, Special Industry Machinery, Not Elsewhere Classified.[9] There is little published information concerning the manufacturers of degreasers. The most recent data available are from a 1987 survey of producers of cold cleaners and OTVCs by the JACA Corporation of Fort Washington, PA.[10,11] The survey identified about 50 companies that in 1986 supplied cold cleaners to metal cleaning operations. Among these, some of the major producers were Safety-Kleen, Phillips Manufacturing (a wholly-owned subsidiary of Safety-Kleen), Kleer-Flo, Graymills, Build-All, R&D/Kamas (a division of Fountain Industries), and Crest Ultrasonics.

Cold cleaner units ranged in price from $100 to $5,000 in 1986. Between 25,000 and 50,000 cold cleaners were estimated to have been sold in 1986, over half of which were carburetor or immersion cleaners sold to automotive repair shops.

Approximately 75 companies manufactured OTVCs in 1986. Two companies, Detrex and Baron-Blakeslee, accounted for 50 percent of 1986 production. Other major producers included Phillips Manufacturing, Crest Ultrasonics, Delta

Industries, and Cooper Company. Between 1,000 and 2,000 OTVCs were sold in 1986, ranging approximately in price from $1,500 to $340,000.

There are a number of SIC industries which use degreasing equipment. These user industries are discussed in Section 1.4.

The most recent data concerning the number of degreasers using halogenated solvents are from 1987.[12] In that year there were approximately 100,000 cold cleaners, 25,000 to 35,000 OTVCs, 2,000 to 3,000 in-line vapor cleaners, and 500 to 1,000 in-line cold cleaners using halogenated solvents.

Though there are no published forecasts available for the production of halogenated solvent cleaners, it can be assumed that demand will to some extent be influenced by the degree of substitution of alternative cleaning systems.

## 1.3 Halogenated Solvents Used In Degreasing

There are five halogenated solvents used by degreasers.[13] They are methylene chloride (MC), perchloroethylene (PCE), trichloroethylene (TCE), 1,1,1-trichloroethane (TCA), and trichlorotrifluoroethane (CFC-113). The first four have been designated for regulation by the degreasing NESHAP.

The manufacture of solvents used in degreasing is classified in SIC 2842, Specialty Cleaning, Polishing, and Sanitation Preparations.[14] Table 1 lists the manufacturers of the four solvents. Dow Chemical U.S.A. currently manufactures all four solvents. Both PPG Industries, Inc. and Vulcan Materials Company produce three of the four solvents. TCA has the largest amount of capacity dedicated to its production (477 million kilograms per year) while TCE has the smallest (145 millions kilograms per year).

TABLE 1. U.S. PRODUCERS OF METHYLENE CHLORIDE (MC), PERCHLOROETHYLENE (PCE), 1,1,1-TRICHLOROETHANE (TCA), TRICHLOROETHYLENE (TCE), 1992

| Chemical | Company | Capacity ($10^6$ kg/yr) |
|---|---|---|
| MC | Dow Chemical U.S.A. | 104 |
| | Occidental Chemical Corp. | 50 |
| | Vulcan Materials Company | 95 |
| | | 249 |
| PCE | Dow Chemical U.S.A. | 41 |
| | PPG Industries, Inc. | 91 |
| | Vulcan Materials Company | 91 |
| | | 223 |
| TCA | Dow Chemical U.S.A. | 227 |
| | PPG Industries, Inc. | 159 |
| | Vulcan Materials Company | 91 |
| | | 477 |
| TCE | Dow Chemical U.S.A. | 54 |
| | PPG Industries, Inc. | 91 |
| | | 145 |

Sources: Chemical Marketing Reporter, January 20, 1992, January 27, 1992, February 3, 1992, March 2, 1992.

Table 2 presents production data for the four solvents. Production levels in the mid to latter 80s were down from the beginning of the decade for MC, PCE, and TCE. This trend resulted from decreased demand, particularly for metal degreasing applications.[15] In response to rising disposal costs, users of the solvents began recycling them, contributing to this decreased demand.[16,17] The largest drop in production from 1980 to 1990 was the 50 percent decrease in PCE production. TCA experienced increased production from 1987 to 1989; the chemical was being substituted for trichlorotrifluoroethane (CFC-113) and a number of VOC compounds.[18]

The various end uses of the four solvents are listed in Table 3. It is apparent that TCE is the most reliant on degreasing end-uses; 90 percent of 1992 consumption is accounted for by vapor degreasing applications. Degreasing applications (vapor degreasing, cold cleaning, and electronics cleaning) account for the majority, 52 percent, of TCA consumption. Fifteen percent of MC consumption involves degreasing applications. PCE is the least reliant on degreasing applications, which only currently consume 13 percent of output.

Historical data concerning the domestic consumption of the four halogenated solvents in degreasing applications are contained in Table 4A. As shown, PCE, TCE, and TCA were, in recent years, the major commercial solvents, accounting for 90 to 95 percent of the markets for solvents used in metal degreasing.[19] The consumption of all four chemicals edged downward throughout the decade. Demand was stagnant in recent years, particularly from 1984 to 1987. Not until the period of 1987 to 1989 did the consumption of MC, PCE, and TCE recover. In 1991, the consumption for

TABLE 2. U.S. PRODUCTION OF METHYLENE CHLORIDE (MC), PERCHLOROETHYLENE (PCE), 1,1,1-TRICHLOROETHANE (TCA), AND TRICHLOROETHYLENE (TCE), 1980-1990

| | Quantity ($10^6$ kg) | | | |
|---|---|---|---|---|
| | MC | PCE | TCA | TCE |
| 1990 | 213 | 174 | 355 | 76 |
| 1989 | 213 | 215 | 352 | 50 |
| 1988 | 230 | 227 | 317 | 50 |
| 1987 | 233 | 215 | 315 | 88 |
| 1986 | 254 | 184 | 294 | 75 |
| 1985 | 262 | 225 | 268 | 77 |
| 1984 | 250 | 231 | 303 | 88 |
| 1983 | 265 | 248 | 266 | 91 |
| 1982 | 241 | 265 | 270 | 86 |
| 1981 | 269 | 313 | 279 | 117 |
| 1980 | 256 | 347 | 314 | 121 |

Sources: Facsimile. Risotto, S., Halogenated Solvents Industry Alliance, to Jenkins, A., JACA Corp. March 12, 1992. Information concerning halogenated solvents.

TABLE 3. USES OF METHYLENE CHLORIDE (MC), PERCHLOROETHYLENE (PCE), 1,1,1-TRICHLOROETHANE (TCA), AND TRICHLOROETHYLENE (TCE), 1992

| | | Percent of Total Consumption |
|---|---|---|
| MC: | paint removal/stripping | 31% |
| | plastics | 16% |
| | flexible polyurethane foam | 14% |
| | pharmaceuticals | 11% |
| | metal cleaning/degreasing | 11% |
| | aerosols | 8% |
| | electronics | 4% |
| | miscellaneous | 5% |
| PCE: | dry cleaning/textile processing | 50% |
| | chemical intermediate | 27% |
| | metal cleaning | 13% |
| | miscellaneous | 10% |
| TCA: | vapor degreasing | 31% |
| | cold cleaning | 18% |
| | aerosols | 12% |
| | adhesives | 10% |
| | chemical intermediates | 10% |
| | coatings and inks | 7% |
| | textiles | 4% |
| | electronics | 3% |
| | miscellaneous | 5% |
| TCE: | vapor degreasing | 90% |
| | chemical intermediate and miscellaneous | 10% |

Sources: Chemical Marketing Reporter, January 20, 1992, January 27, 1992, February 3, 1992, March 2, 1992.

TABLE 4A: U.S. CONSUMPTION OF METHYLENE CHLORIDE (MC), PERCHLOROETHYLENE (PCE), 1,1,1-TRICHLOROETHANE (TCA), TRICHLOROETHYLENE (TCE) IN DEGREASING APPLICATIONS[a], 1985-1991

| | Quantity ($10^6$ kg) | | | |
|---|---|---|---|---|
| | MC | PCE | TCA | TCE |
| 1991 | 18.8 | 16.2 | 123.8[b] | 42.0 |
| 1989 | 13.9 | 31.4 | 169.5 | 17.5 |
| 1987 | 22.4 | N/A | N/A | 56.0 |
| 1985 | 23.4 | 30.6 | 163.5 | 73.3 |

[a]Include metal cleaning and electronics cleaning by vapor degreasing or cold cleaning.
[b]Estimate.
N/A - Not available

Sources: Chemical Marketing Reporter, Chemical Profiles from: March 2, 1992, February 3, 1992, January 27, 1992, January 20, 1992, January 23, 1989, February 6, 1989, July 1, 1989, July 8, 1989; Halogenated Solvents Industry Alliance, "White Paper -- Perchloroethylene," June 1991, "White Paper -- 1,1,1-Trichloroethane," May 1991; "White Paper -- Methylene Chloride, February 1989, "White Paper - Trichloroethylene," April 1989, "White Paper -- 1,1,1-Trichloroethane," June 1987, "White Paper - Methylene Chloride," May 1987, "White Paper -- Trichloroethylene," November 1986, "White Paper -- Perchloroethylene," August 1987; Facsimile. Risotto, S., Halogenated Solvents Industry Alliance, to Jenkins, A., JACA Corp. March 12, 1992. Information concerning halogenated solvents.

all the solvents fell drastically. The consumption of PCE in metal degreasing dropped 48 percent from 1989 to 1991. Consumption has dropped as there has been more solvent recycling and switching to alternative solvents in response to environmental regulations and sharply rising disposal costs for waste solvents.

Table 4B shows the 1991 consumption of the four solvents in degreasing applications by degreaser type. 40.4 percent (81.2 million kilograms) of total solvent consumption was accounted for by batch vapor cleaners. Batch cold cleaners consumed 37.5 percent (75.4 million kilograms) of the solvents. Overall, batch cleaners (cold cleaning and vapor cleaning) accounted for 77.9 percent of solvent consumption in degreasing applications.

The historical average realized prices of the four halogenated solvents are listed in Table 5. Halogenated solvent prices are influenced by the level of imports, raw material costs, and capacity.[21] The price of MC reached a decade-high of 52 cents per kilogram in 1984, and settled at 46 cents per kilogram by 1990, 6 cents below the 1980 price. The price of PCE fluctuated throughout the period, reaching a decade-high of 49 cents per kilogram in 1989 then falling to 33 cents in 1990. In 1985 the price of TCA was a decade-high of 69 cents per kilogram, and subsequently fell to 59 cents by 1990. In 1988, TCE climbed to its decade-high of 66 cents per kilogram.

Of the four solvents PCE is the most heavily imported (Table 6). MC imports peaked in 1984, and declined through 1991 to 3.2 million kilograms. The peak year for PCE imports occurred in 1986 when 72.2 million kilograms were imported. Imports of PCE subsequently fell to 31.8 million

TABLE 4B. CONSUMPTION OF METHYLENE CHLORIDE (MC), PERCHLOROETHYLENE (PCE), 1,1,1-TRICHLOROETHANE (TCA), AND TRICHLOROETHYLENE (TCE) BY DEGREASER TYPE, 1991

| Solvent | 1991 Consumption ($10^6$ Kg) | Consumption in Cold Cleaning ($10^6$ Kg) | | | | Consumption in Vapor Cleaning ($10^6$ kg) | |
|---|---|---|---|---|---|---|---|
| | | Batch Cleaners | In-Line Batch Cleaners | Cold Carburetor Cleaners | Photo-resist Stripping | Batch Cleaners | In-Line Cleaners |
| MC | 18.8 | 6.9 | - | 1.3 | 4.4 | 4.5 | 1.7 |
| PCE | 16.2 | 4.7 | - | - | - | 8.4 | 3.1 |
| TCA | 123.8 | 62.1 | 8.4 | - | - | 38.9 | 14.4 |
| TCE | 42.0 | 1.7 | - | - | - | 29.4 | 10.9 |
| Total | 200.8 | 75.4 | 8.4 | 1.3 | 4.4 | 81.2 | 30.1 |
| Percent of Total[a] | 100% | 37.5% | 4.2% | .6% | 2.2% | 40.4% | 15.0% |

[a]Does not add to 100 due to rounding.

Sources: Chemical Marketing Reporter, January 20, 1992, January 27, 1992, February 3, 1992, March 2, 1992; Facsimile. Sorrels, L., EPA to Holmes C., JACA Corp. March 13, 1992.

TABLE 5. AVERAGE REALIZED PRICE OF METHYLENE CHLORIDE (MC), PERCHLOROETHYLENE (PCE), 1,1,1-TRICHLOROETHANE (TCA), AND TRICHLOROETHYLENE (TCE), 1980-1989

| | Price (¢/kg) | | | |
|---|---|---|---|---|
| | MC | PCE | TCA | TCE |
| 1990 | 46 | 33 | 59 | N/A |
| 1989 | 47 | 49 | 62 | N/A |
| 1988 | 40 | 44 | 62 | 66[a] |
| 1987 | N/A | 37 | 70 | 60[a] |
| 1986 | 38 | 36 | 64 | 60[a] |
| 1985 | N/A | 42 | 68 | 64[a] |
| 1984 | N/A | N/A | N/A | N/A |
| 1983 | 42 | 37 | 55 | N/A |
| 1982 | N/A | N/A | N/A | N/A |
| 1981 | N/A | N/A | N/A | N/A |
| 1980 | 49 | 35 | 53 | 43 |

[a]Estimated
N/A - Not available.

Sources: U.S. International Trade Commission. Synthetic Organic Chemicals, 1983, 1986, 1988, 1989, 1990; Mannsville Chemical Products Corporation, "Chemical Products Synopsis -- Perchloroethylene," February, 1989; Mannsville Chemical Products Corporation, "Chemical Products Synopsis-Trichloroethylene," February, 1989, Mannsville Chemical Products Corporation, "Chemical Products Synopsis -- 1,1,1-Trichloroethane," October, 1990.

TABLE 6. U.S. IMPORTS OF METHYLENE CHLORIDE (MC), PERCHLOROETHYLENE (PCE), 1,1,1-TRICHLOROETHANE (TCA), TRICHLOROETHYLENE (TCE), 1980-1989

| | Quantity ($10^6$/kg) | | | |
|---|---|---|---|---|
| Year | MC | PCE | TCA | TCE |
| 1990 | 8.8 | 24.9 | 2.8 | 31.4 |
| 1989 | 7.4 | 20.5 | 6.0 | 26.7 |
| 1988 | 12.4 | 27.0 | 7.1 | 6.0 |
| 1987 | 18.4 | 24.5 | 8.8 | 8.8 |
| 1986 | 16.8 | 27.5 | 8.8 | 17.3 |
| 1985 | 25.6 | 10.3 | 5.5 | 19.8 |
| 1984 | 28.9 | 13.1 | 2.0 | 14.0 |
| 1983 | 19.9 | 24.7 | 0.0 | 15.0 |
| 1982 | 18.0 | 20.0 | 0.0 | 6.2 |
| 1981 | 14.2 | 35.5 | 0.0 | 8.3 |
| 1980 | 11.5 | 34.0 | 0.0 | 3.5 |

Sources: Facsimile. Risotto, S., Halogenated Solvents Industry Alliance, to Jenkins, A., JACA Corp. March 12, 1992. Information concerning halogenated solvents.

kilograms in 1991. TCA experienced increased imports from 1984 to 1988; imports fell in 1991. After 19.8 million kilograms were imported in 1985, imports of TCE fell to 1.4 million kilograms in 1991.

The growth prospects for halogenated solvents are unfavorable. In June 1991, Chemical Engineering reported that the Freedonia Group, a Cleveland-based market research firm, forecast that over the 1990s the production of halogenated solvents would drop by approximately three percent.[22] There will be technological improvements in vapor degreasers, making more efficient use of solvent.[23] Emission control equipment will also reduce fugitive emissions.[24] The recycling of halogenated solvents will become more prevalent.[25] Finally, alternative solvents may be substituted. These include water or aqueous-based detergents, nonhalogenated solvents (e.g., terpenes, Stoddard solvents, mineral spirits), and newly developed solvents that are partially hydrogenated CFCs or blends of partially hydrogenated CFCs and nonhalogenated solvents.[26]

More recent forecasts by Chemical Marketing Reporter predict negative growth of consumption for MC, TCA, and TCE.[27,28,29] The demand for domestically produced MC will be depressed by increased environmental regulation, including OSHA's revised PEL (permissible exposure level) proposal, and EPA's dry cleaning NESHAP. Growth in consumption is forecast to decline 3 percent per year through 1996. Environmental regulation, specifically the Clean Air Act and Montreal Protocol, are forcing the phase out of TCA production. Consumption is forecast to decline 11.6 percent per year through 1996. TCE consumption is forecast to decline 2.6 percent per year through 1996; it is being regulated because it helps create smog. Only PCE consumption is expected to grow (7% per year through 1996) because of its use in dry cleaning applications.[30]

Consumption of PCE is expected to grow despite increased regulation by OSHA and EPA.

One final point is that all four solvents are regulated by the Hazardous Organics NESHAP (HON) under the Clean Air Act. Thus, besides any control costs imposed by the degreasing NESHAP, there will also be additional control costs due to the HON.

## 1.4 Industries Using Degreasing Equipment

Degreasing is performed in a variety of industries. Because the process is so widespread, it is not possible to identify the specific establishments and products that would be affected by a degreasing NESHAP. The economic analysis must instead rely on a definition of the industries that use degreasing equipment and any associated data available.

In a 1976 study, Eureka Laboratories identified 38 3-digit and one 2-digit SIC industries that use degreasers.[31] In Table 7, the 39 user industries are listed according to the 1972 SIC classification system used in the Eureka Laboratories. The table also indicates which codes were redefined in the SIC classification system. It should be noted that two other industries perform the same services as SIC 753, Automotive Repair shops. These industries are SIC 551, Motor Vehicle Dealers and SIC 554, Gasoline Service Stations. Because they were not identified by the Eureka Laboratories study, they are discussed only in section 1.5.

### Industry Structure

In 1987, the classification system was reorganized. Sixteen industries were affected by this reorganization. However, in four industries the changes were only redistributive within the 3-digit grouping, which does not affect the aggregate data for that industry. These four industries were SICs 336, 349, 353, and 361.

TABLE 7. INDUSTRIES USING DEGREASING EQUIPMENT, BY 1972 AND 1987 BASIS

| SIC Code, 1972 Basis | Industry Name | SIC Code Redefined in 1987 |
|---|---|---|
| 254 | Partitions and Fixtures | |
| 259 | Misc. Furniture and Fixtures | |
| 332 | Iron and Steel Foundries | |
| 335 | Nonferrous Rolling and Drawing | |
| 336 | Nonferrous Foundries | *** |
| 339 | Misc. Primary Metal Products | |
| 342 | Cutlery, Handtools, and Hardware | |
| 343 | Plumbing and Heating, Except Electric | |
| 344 | Fabricated Structural Metal Products | |
| 345 | Screw Machine Products, Bolts, Etc. | |
| 346 | Metal Forgings and Stampings | |
| 347 | Metal Services, n.e.c. | |
| 348 | Ordnance and Accessories, n.e.c. | |
| 349 | Misc. Fabricated Metal Products | *** |
| 351 | Engines and Turbines | |
| 352 | Farm and Garden Machinery | |
| 353 | Construction and Related Machinery | *** |
| 354 | Metalworking Machinery | *** |
| 355 | Special Industry Machinery | *** |
| 356 | General Industrial Machinery | *** |
| 357 | Office and Computing Machines | *** |
| 358 | Refrigeration and Service Machinery | |
| 359 | Misc. Machinery, Except Electrical | *** |
| 361 | Electric Distributing Equipment | *** |
| 362 | Electrical Industrial Apparatus | *** |
| 364 | Electric Lighting and Wiring Equipment | *** |
| 366 | Communication Equipment | *** |
| 367 | Electronic Components and Accessories | *** |
| 369 | Misc. Electrical Equipment and Supplies | *** |
| 371 | Motor Vehicles and Equipment | |
| 372 | Aircraft and Parts | |
| 376 | Guided Missiles, Space Vehicles, Parts | |
| 379 | Misc. Transportation Equipment | |
| 381 | Engineering and Scientific Instruments | *** |
| 382 | Measuring and Controlling Devices | *** |
| 39 | Misc. Manufacturing Industries | |
| 401 | Railroads - Maintenance | |
| 458 | Air Transport - Maintenance | |

TABLE 7. (CONTINUED)

| SIC Code, 1972 Basis | Industry Name | SIC Code Redefined in 1987 |
|---|---|---|
| 753 | Auto Repair | |

Misc. - Miscellaneous.
n.e.c. - Not elsewhere classified.

Sources: U.S. Department of Commerce, Bureau of the Census, 1982 Census of Manufactures, 1987 Census of Manufactures.

Eleven 3-digit industries did change in aggregate terms. These eleven were SICs 354, 355, 356, 357, 359, 362, 364, 366, 369, 381, and 382. For more specific information on how these industries changed refer to Appendix A. There were changes in SIC 367, but it is not known whether they were merely redistributive or affecting the aggregate. Table 8 compares 1987 and 1982 revenues for the user industries. Revenues are reported in nominal dollars. The two years are comparable except for those industries whose redefinition in 1987 resulted in aggregate changes. These include SICs 354, 355, 356, 357, 359, 362, 364, 366, 369, 381 and 382. SIC 371, Motor Vehicles and Equipment, had revenues of $205.9 billion in 1987, the highest among the industries under consideration. It also had the most revenue in 1982. SIC 339, Miscellaneous Primary Metal Products, had the least revenue, $2.9 billion, in 1987.

Table 9 lists the number of establishments, employment, and revenue in 1987 of the industries using degreasing equipment. It is evident from the table that the 114,601 establishments in SIC 753, Auto Repair, were the most in any industry. This total was comparable to the 140,880 establishments of the 36 industries in manufacturing. The second largest industry in terms of total establishments is SIC 359, Industrial Machinery, Not Elsewhere Classified, with 22,348. The fewest number of establishments, 141, were in SIC 376, Guided Missiles, Space Vehicles, Parts.

Employment in the user industries ranged from 31,800 in SIC 339, Miscellaneous Primary Metal Products, to 751,400 in SIC 371. Revenue ranged from $2.9 billion in SIC 339 to the $205.9 billion in SIC 371.

To provide a more detailed picture of the number of establishments and revenue, Table 10 and Table 11

TABLE 8. REVENUES FOR THE INDUSTRIES USING DEGREASING EQUIPMENT, 1987 AND 1982

| SIC Code | Industry Name | 1987 Revenue (thousands of 1987 $) | 1982 Revenue (thousands of 1982 $) | Industries Whose 1987 and 1982 Revenues Aren't Directly Comparable |
|---|---|---|---|---|
| 254 | Partitions and Fixtures | $5,537,200 | $3,709,900 | |
| 259 | Misc. Furniture and Fixtures | $3,740,100 | $2,390,100 | |
| 332 | Iron and Steel Foundries | $10,627,700 | $9,641,500 | |
| 335 | Nonferrous Rolling and Drawing | $33,282,200 | $25,462,900 | |
| 336 | Nonferrous Foundries (castings) | $6,315,000 | $4,603,200 | |
| 339 | Misc. Primary Metal Products | $2,907,000 | $2,066,300 | |
| 342 | Cutlery, Handtools, and Hardware | $13,480,600 | $10,081,700 | |
| 343 | Plumbing and Heating, Except Electric | $5,282,700 | $4,003,300 | |
| 344 | Fabricated Structural Metal Products | $40,416,100 | $34,904,300 | |
| 345 | Screw Machine Products, Bolts, Etc. | $7,890,200 | $5,834,400 | |
| 346 | Metal Forgings and Stampings | $28,409,800 | $20,057,100 | |
| 347 | Metal Services, n.e.c. | $7,789,500 | $5,124,800 | |
| 348 | Ordnance and Accessories, n.e.c. | $7,643,600 | $4,992,900 | |
| 349 | Misc. Fabricated Metal Products | $24,339,900 | $22,274,100 | |
| 351 | Engines and Turbines | $14,570,400 | $13,039,700 | |
| 352 | Farm and Garden Machinery | $11,474,300 | $13,108,200 | |
| 353 | Construction and Related Machinery | $24,622,300 | $32,037,500 | |
| 354 | Metalworking Machinery | $22,003,500 | $18,149,600 | *** |
| 355 | Special Industry Machinery | $17,096,100 | $13,127,800 | *** |
| 356 | General Industrial Machinery | $24,120,500 | $24,458,800 | *** |
| 357 | Computer and Office Equipment | $60,626,500 | $43,027,500 | *** |
| 358 | Refrigeration and Service Machinery | $23,234,900 | $16,449,900 | |
| 359 | Industrial Machinery, n.e.c. | $19,921,400 | $14,496,700 | *** |
| 361 | Electric Distribution Equipment | $8,196,800 | $8,108,200 | |
| 362 | Electrical Industrial Apparatus | $15,266,300 | $13,825,100 | *** |
| 364 | Electric Lighting and Wiring Equipment | $18,004,000 | $12,047,800 | *** |
| 366 | Communications Equipment | $34,000,600 | $46,426,000 | *** |
| 367 | Electronic Components and Accessories | $50,257,700 | $34,516,800 | *** |
| 369 | Misc. Electrical Equipment and Supplies | $21,230,300 | $12,543,500 | *** |

TABLE 8. (CONTINUED)

| SIC Code | Industry Name | 1987 Revenue (thousands of 1987 $) | 1982 Revenue (thousands of 1982 $) | Industries Whose 1987 and 1982 Revenues Aren't Directly Comparable |
|---|---|---|---|---|
| 371 | Motor Vehicles and Equipment | $205,923,100 | $112,269,600 | |
| 372 | Aircraft and Parts | $77,304,100 | $52,026,700 | |
| 376 | Guided Missiles, Space Vehicles, Parts | $26,285,200 | $14,398,000 | |
| 379 | Misc. Transportation Equipment | $6,032,800 | $4,527,000 | |
| 381 | Search and Navigation Equipment | $36,366,800 | N/A | *** |
| 382 | Measuring and Controlling Devices | $26,042,000 | $14,632,800 | *** |
| 39 | Misc. Manufacturing Industries | $32,012,000 | $26,891,400 | |
| 401 | Railroads - Maintenance | $4,338,334 | N/A | |
| 458 | Air Transport - Maintenance | $6,138,218 | N/A | |
| 753 | Auto Repair | $28,664,181 | N/A | |

Misc. - Miscellaneous.
N/A - Not available.
n.e.c. - Not elsewhere classified.

Sources: Air Transport Association of America. Air Transport 1989: The Annual Report of the U.S. Scheduled airline Industry; Interstate Commerce Commission, Bureau of Accounts, Transportation Statistics in the United States (for the year ended December 31, 1987); U.S. Department of commerce, Bureau of the Census. 1987 Census of Manufactures, 1982 Census of the Manufactures, 1987 Census of Service Industries.

TABLE 9. NUMBER OF ESTABLISHMENTS, EMPLOYMENT, AND REVENUE FOR THE INDUSTRIES USING DEGREASING EQUIPMENT, 1987

| SIC Code | Industry Name | Number of Establish-ments | Employment | Revenue (thousands of $) |
|---|---|---|---|---|
| 254 | Partitions and Fixtures | 2,459 | 74,100 | $5,537,200 |
| 259 | Misc. Furniture and Fixtures | 2,086 | 49,900 | $3,740,100 |
| | TOTAL | 4,545 | 124,000 | $9,277,300 |
| 332 | Iron and Steel Foundries | 1,231 | 129,800 | $10,627,700 |
| 335 | Nonferrous Rolling and Drawing | 1,069 | 163,000 | $33,282,200 |
| 336 | Nonferrous Foundries (castings) | 1,689 | 79,500 | $6,315,000 |
| 339 | Misc. Primary Metal Products | 977 | 31,800 | $2,907,400 |
| | TOTAL | 4,966 | 404,100 | $53,132,500 |
| 342 | Cutlery, Handtools, and Hardware | 2,328 | 145,200 | $13,480,600 |
| 343 | Plumbing and heating, Except Electric | 833 | 45,500 | $5,282,700 |
| 344 | Fabricated Structural Metal Products | 12,583 | 407,200 | $40,416,000 |
| 345 | Screw Machine Products, Bolts, Etc. | 2,572 | 94,700 | $7,890,200 |
| 346 | Metal Forgings and Stampings | 4,070 | 255,300 | $28,409,800 |
| 347 | Metal Services, n.e.c. | 5,265 | 112,600 | $7,789,500 |
| 348 | Ordnance and Accessories, n.e.c. | 376 | 87,600 | $7,643,600 |
| 349 | Misc. Fabricated Metal Products | 7,528 | 261,700 | $24,339,900 |
| | TOTAL | 35,555 | 1,409,800 | $135,252,400 |
| 351 | Engines and Turbines | 359 | 86,900 | $14,570,400 |
| 352 | Farm and Garden Machinery | 1,799 | 82,000 | $11,474,300 |
| 353 | Construction and Related Machinery | 3,473 | 188,300 | $24,622,300 |
| 354 | Metalworking Machinery | 11,466 | 267,700 | $22,003,500 |
| 355 | Special Industry Machinery | 4,557 | 169,100 | $17,096,100 |
| 356 | General Industrial Machinery | 3,952 | 240,400 | $24,120,500 |
| 357 | Computer and Office Equipment | 2,052 | 327,700 | $60,626,500 |
| 358 | Refrigeration and Service Machinery | 2,105 | 190,400 | $23,234,900 |
| 359 | Industrial Machinery, n.e.c. | 22,348 | 291,900 | $19,921,400 |
| | TOTAL | 52,091 | 1,844,400 | $217,669,900 |
| 361 | Electric Distribution Equipment | 760 | 77,000 | $8,196,000 |
| 362 | Electrical Industrial Apparatus | 2,206 | 165,500 | $15,266,300 |
| 364 | Electric Lighting and Wiring Equipment | 1,951 | 166,600 | $1,004,000 |
| 366 | Communications Equipment | 1,506 | 260,200 | $34,000,600 |
| 367 | Electronic Components and Accessories | 5,836 | 546,400 | $50,257,700 |
| 369 | Misc. Electrical Equipment and Supplies | 2,328 | 188,000 | $21,230,300 |
| | TOTAL | 14,587 | 1,403,700 | $146,955,700 |

TABLE 9. (CONTINUED)

| SIC Code | Industry Name | Number of Establish-ments | Employment | Revenue (thousands of $) |
|---|---|---|---|---|
| 371 | Motor Vehicles and Equipment | 4,438 | 751,400 | $205,923,100 |
| 372 | Aircraft and Parts | 1,622 | 596,000 | $77,304,100 |
| 376 | Guided Missiles, Space Vehicles, Parts | 141 | 213,700 | $26,285,200 |
| 379 | Misc. Transportation Equipment | 1,118 | 49,400 | $6,032,800 |
| | TOTAL | 7,319 | 1,610,500 | $315,545,200 |
| 382 | Search and Navigation Equipment | 1,064 | 369,400 | $36,26,800 |
| 382 | Measuring and Controlling Devices | 4,168 | 264,700 | $26,042,000 |
| | TOTAL | 2,252 | 654,100 | $62,308,800 |
| 39 | Misc. Manufacturing Industries | 16,573 | 3374,300 | $32,012,000 |
| | TOTAL MANUFACTURING | 140,888 | 7,834,900 | $972,153,800 |
| 401 | Railroads - Maintenance | N/A | N/A | $4,338,334 |
| 458 | Air Transport - Maintenance | N/A | 51,233 | $6,138,218 |
| 753 | Auto Repair | 114,601 | 485,566 | $20,664,181 |
| | GRAND TOTAL* | 255,489 | 8,361,699 | $1,011,295,533 |

*-Excludes establishment data for SICs 401 and 458 as well as employment data for SIC 401.
Misc. - Miscellaneous.
N/A - Not available.
n.e.c. - Not elsewhere classified.

Sources: Air Transport Association of America. Air Transport 1989; The Annual Report of the U.S. Scheduled Airline Industry; Interstate Commerce Commission, Bureau of Accounts, Transportation Statistics in the United States (for the year ended December 31, 1987); U.S. Department of Commerce, Bureau of the Census. 1987 Census of Manufactures, 1987 Census of the Service Industries.

disaggregate these two statistics by the employment-size class of the establishments in each user industry. In Table 10 the distribution of establishments is addressed. The auto repair industry, SIC 753, had the greatest percentage (98%) of establishments employing zero to 19 employees. In contrast, only 23 percent of the establishments in SIC 376 had 19 or fewer employees. For establishments with 20 to 99 employees, SIC 332, Iron and Steel Foundries, had the highest concentration (39%); only two percent of the establishments in SIC 753 had that number of employees. Finally, 51 percent of the establishments in SIC 376 employed more than 100 people. In SIC 753, no establishments existed which fell into this category.

Table 11 details the distribution of revenue in the user industries by employment-size class. Some data were not disclosed, or were unavailable. In many cases, the user industries had the greatest percentage of revenue being generated by the establishments with the most employees. A marked example of this phenomenon is SIC 372, Aircraft and Parts; 97 percent of this industry's revenue was earned by establishments employing more than 100 people. Exceptions include SICs 347 and 359; establishments with 20 to 99 employees had the most revenue for these two industries.

Table 12 lists the capacity utilization rates for the industries from 1985 to 1988. These utilization rates are practical rates, derived by dividing actual output by the engineering capacity. The trends in each industry vary both by percentage of capacity utilized and in which year the highest utilization rate occurred. SIC 379, Miscellaneous Transportation Equipment, typically had the lowest utilization rates over the four-year period. The highest utilization rates on average were achieved by SIC 342, Cutlery, Handtools, and Hardware.

TABLE 10. DISTRIBUTION OF ESTABLISHMENTS BY EMPLOYMENT-CLASS SIZE FOR THE INDUSTRIES USING DEGREASING EQUIPMENT, 1986

| SIC Code | Industry Name | Total Establish-ments | Distribution of Establishments by Employment-Size Class | | | Percent of Total Establishments | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1-19 | 20-99 | 100+ | 1-19 | 20-99 | 100+ |
| 254 | Partitions and Fixtures | 2,458 | 1,602 | 691 | 165 | 65% | 28% | 7% |
| 259 | Misc. Furniture and Fixtures | 2,086 | 1,582 | 392 | 102 | 76% | 19% | 5% |
| 332 | Iron and Steel Foundries | 1,231 | 448 | 480 | 303 | 36% | 39% | 25% |
| 335 | Nonferrous Rolling and Drawing | 1,069 | 311 | 336 | 422 | 29% | 31% | 39% |
| 336 | Nonferrous Foundries (castings) | 1,689 | 899 | 580 | 210 | 53% | 34% | 12% |
| 339 | Misc. Primary Metal Products | 977 | 584 | 352 | 41 | 60% | 36% | 4% |
| 342 | Cutlery, Handtools, and Hardware | 2,330 | 1,369 | 629 | 332 | 59% | 27% | 14% |
| 343 | Plumbing and heating, Except Electric | 833 | 511 | 194 | 128 | 61% | 23% | 15% |
| 344 | Fabricated Structural Metal Products | 12,585 | 7,828 | 3,936 | 821 | 62% | 31% | 7% |
| 345 | Screw Machine Products, Bolts, Etc. | 2,572 | 1,466 | 909 | 197 | 57% | 35% | 8% |
| 346 | Metal Forgings and Stampings | 4,070 | 2,129 | 1,426 | 515 | 52% | 35% | 13% |
| 347 | Metal Services, n.e.c. | 5,265 | 3,606 | 1,502 | 157 | 68% | 29% | 3% |
| 348 | Ordnance and Accessories, n.e.c. | 376 | 217 | 57 | 102 | 58% | 15% | 27% |
| 349 | Misc. Fabricated Metal Products | 7,530 | 4,902 | 2,025 | 603 | 65% | 27% | 8% |
| 351 | Engines and Turbines | 359 | 167 | 92 | 100 | 47% | 26% | 28% |
| 352 | Farm and Garden Machinery | 1799 | 1,254 | 398 | 147 | 70% | 22% | 8% |
| 353 | Construction and Related Machinery | 3,474 | 2,057 | 1,001 | 416 | 59% | 29% | 12% |
| 354 | Metalworking Machinery | 11,445 | 8,548 | 2,465 | 432 | 75% | 22% | 4% |
| 355 | Special Industry Machinery | 4,557 | 2,931 | 1,269 | 357 | 64% | 28% | 8% |
| 356 | General Industrial Machinery | 3,952 | 2,047 | 1,312 | 593 | 52% | 33% | 15% |
| 357 | Computer and Office Equipment | 2,052 | 1,113 | 521 | 418 | 54% | 25% | 20% |
| 358 | Refrigeration and Service Machinery | 2,104 | 1,142 | 552 | 410 | 54% | 26% | 19% |
| 359 | Industrial Machinery, n.e.c. | 22,346 | 18,983 | 3,074 | 289 | 85% | 14% | 1% |

TABLE 10. (CONTINUED)

| SIC Code | Industry Name | Total Establish-ments | Distribution of Establishments by Employment-Size Class | | | Percent of Total Establishments | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1-19 | 20-99 | 100+ | 1-19 | 20-99 | 100+ |
| 361 | Electric Distribution Equipment | 760 | 350 | 214 | 196 | 46% | 28% | 26% |
| 362 | Electrical Industrial Apparatus | 2,206 | 1,295 | 534 | 377 | 59% | 24% | 17% |
| 364 | Electric Lighting and Wiring Equipment | 1,951 | 969 | 594 | 388 | 50% | 30% | 20% |
| 366 | Communications Equipment | 1,506 | 592 | 509 | 405 | 39% | 34% | 27% |
| 367 | Electronic Components and Accessories | 5,836 | 2,955 | 1,806 | 1,075 | 51% | 31% | 18% |
| 369 | Misc. Electrical Equipment and Supplies | 2,327 | 1,374 | 566 | 387 | 59% | 24% | 17% |
| 371 | Motor Vehicles and Equipment | 4,438 | 2,353 | 1,190 | 895 | 53% | 27% | 20% |
| 372 | Aircraft and Parts | 1,621 | 780 | 459 | 382 | 48% | 28% | 24% |
| 376 | Guided Missiles, Space Vehicles, Parts | 141 | 32 | 37 | 72 | 23% | 26% | 51% |
| 379 | Misc. Transportation Equipment | 1,118 | 754 | 263 | 101 | 67% | 24% | 9% |
| 382 | Search and Navigation Equipment | 1,064 | 576 | 263 | 245 | 53% | 24% | 23% |
| 382 | Measuring and Controlling Devices | 4,170 | 2,486 | 1,096 | 588 | 60% | 26% | 14% |
| 39 | Misc. Manufacturing Industries | 16,573 | 12,899 | 2,961 | 713 | 78% | 18% | 4% |
| 401 | Railroads - Maintenance | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 458 | Air Transport - Maintenance | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 753 | Auto Repair* | 98,930 | 96,947 | 1,960 | 23 | 96% | 2% | 0% |

* - The establishment data for SIC 753 applies only to establishments that operated the entire year; 15,671 establishments did not operate the entire year.
Misc. - Miscellaneous.
N/A - Not available.
n.e.c. - Not elsewhere classified.

NOTE: The total number of establishments for certain 3-digit SICs may differ from what was reported in Table 9-9 due to rounding errors in the source.

Sources: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Manufactures, 1987 Census of Service Industries.

TABLE 11. DISTRIBUTION OF REVENUE BY EMPLOYMENT-CLASS SIZE FOR THE INDUSTRIES USING DEGREASING EQUIPMENT, 1986

| SIC Code | Industry Name | Total Establish-ments | Distribution of Establishments by Employment-Size Class | | | Percent of Total Revenue (thousands of $) | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1-19 | 20-99 | 100+ | 1-19 | 20-99 | 100+ |
| 254 | Partitions and Fixtures | $5,536,200 | $713,400 | $2,076,500 | $2,746,400 | 13% | 38% | 50% |
| 259 | Misc. Furniture and Fixtures | $3,740,100 | $513,000 | $1,0986,900 | $2,131,000 | 14% | 29% | 57% |
| 332 | Iron and Steel Foundries | $10,627,700 | $209,900 | ND | ND | 2% | ND | ND |
| 335 | Nonferrous Rolling and Drawing | $33,282,200 | ND | ND | ND | ND | 29% | ND |
| 336 | Nonferrous Foundries (castings) | $6,315,200 | $455,000 | $1,825,000 | $4,034,400 | 7% | 42% | 64% |
| 339 | Misc. Primary Metal Products | $2,907,400 | $384,100 | $1,228,700 | $1,294,600 | 13% | | 45% |
| 342 | Cutlery, Handtools, and Hardware | $13,517,100 | $690,300 | $2,247,900 | $10,578,000 | 5% | 17% | 78% |
| 343 | Plumbing and heating, Except Electric | $5,282,700 | $291,500 | $965,900 | $4,025,300 | 6% | 18% | 76% |
| 344 | Fabricated Structural Metal Products | $40,390,600 | $4,973,100 | $16,348,400 | $19,069,100 | 12% | 40% | 47% |
| 345 | Screw Machine Products, Bolts, Etc. | $7,890,000 | $766,600 | $3,127,900 | $3,995,700 | 10% | 40% | 51% |
| 346 | Metal Forgings and Stampings | $28,409,800 | $1,230,900 | $5,893,600 | $21,285,300 | 4% | 21% | 75% |
| 347 | Metal Services, n.e.c. | $7,789,500 | $1,367,000 | $3,773,500 | $2,649,000 | 18% | 48% | 34% |
| 348 | Ordnance and Accessories, n.e.c. | $7,643,600 | ND | $167,800 | ND | ND | 2% | ND |
| 349 | Misc. Fabricated Metal Products | $24,401,100 | $2,457,000 | $7,658,700 | $14,285,400 | 10% | 31% | 59% |
| 351 | Engines and Turbines | $14,570,400 | $109,700 | $473,600 | $13,987,100 | 1% | 3% | 96% |
| 352 | Farm and Garden Machinery | $11,474,300 | $693,700 | $1,434,400 | $9,346,200 | 6% | 13% | 81% |
| 353 | Construction and Related Machinery | $24,627,300 | $1,422,500 | $4,692,500 | $18,512,300 | 6% | 19% | 75% |
| 354 | Metalworking Machinery | $22,019,300 | $3,404,900 | $7,761,700 | $10,852,700 | 15% | 35% | 49% |
| 355 | Special Industry Machinery | $17,096,600 | $1,547,300 | $5,161,700 | $10,387,600 | 9% | 30% | 61% |
| 356 | General Industrial Machinery | $24,120,500 | $1,310,000 | $5,711,000 | $17,099,500 | 5% | 24% | 71% |
| 357 | Computer and Office Equipment | $60,569,800 | ND | $3,254,900 | ND | ND | 5% | ND |
| 358 | Refrigeration and Service Machinery | $23,227,600 | $692,500 | $2,766,700 | $19,768,400 | 3% | 12% | 85% |
| 359 | Industrial Machinery, n.e.c. | $19,913,600 | $5,646,100 | $7,254,400 | $7,013,100 | 28% | 36% | 35% |

TABLE 11. (CONTINUED)

| SIC Code | Industry Name | Total Establish-ments | Distribution of Establishments by Employment-Size Class | | | Percent of Total Revenue (thousands of $) | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1-19 | 20-99 | 100+ | 1-19 | 20-99 | 100+ |
| 361 | Electric Distribution Equipment | $8,196,800 | $225,500 | $930,000 | $7,041,300 | 3% | 11% | 86% |
| 362 | Electrical Industrial Apparatus | $15,266,300 | $635,400 | $2,077,900 | $12,553,000 | 4% | 14% | 82% |
| 364 | Electric Lighting and Wiring Equipment | $18,004,000 | ND | $2,903,900 | ND | ND | 16% | ND |
| 366 | Communications Equipment | $34,000,700 | $354,100 | $2,168,000 | $31,478,600 | 1% | 6% | 93% |
| 367 | Electronic Components and Accessories | $50,257,600 | $1,296,000 | $5,445,900 | $43,515,700 | 3% | 11% | 87% |
| 369 | Misc. Electrical Equipment and Supplies | $21,213,600 | ND | $2,154,700 | ND | ND | 10% | ND |
| 371 | Motor Vehicles and Equipment | $205,861,900 | $1,690,300 | $5,849,700 | $198,321,900 | 1% | 3% | ND |
| 372 | Aircraft and Parts | $77,278,200 | $400,900 | $1,760,800 | $75,116,300 | 1% | 2% | 97% |
| 376 | Guided Missiles, Space Vehicles, Parts | $28,265,100 | ND | ND | ND | ND | ND | ND |
| 379 | Misc. Transportation Equipment | $6,032,700 | $383,400 | $1,069,600 | $4,579,700 | 6% | 18% | 76% |
| 382 | Search and Navigation Equipment | $36,266,800 | $261,700 | $856,100 | $35,149,000 | 1% | 2% | 97% |
| 382 | Measuring and Controlling Devices | $26,042,700 | $1,283,000 | $4236,600 | $20,523,100 | 5% | 16% | 79% |
| 39 | Misc. Manufacturing Industries | $32,012,000 | ND | ND | ND | ND | ND | ND |
| 401 | Railroads - Maintenance | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 458 | Air Transport - Maintenance | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 753 | Auto Repair* | $27,308,159 | $23,750,770 | $3,358,444 | $198,945 | 87% | 12% | 1% |

* - The revenue establishment data for SIC 753 applies only to establishments that operated the entire year; 15,671 establishments that did not operate year-round generated revenue of $1,356,022,000.

Misc. - Miscellaneous.
N/A - Not available.
ND - Not disclosed (in order to avoid reporting data for individual companies).
n.e.c. - Not elsewhere classified.

NOTE: The revenue figures may differ from those in Table 9-9 because certain revenue data was not disclosed, thus not included for certain SICs.

Sources: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Manufactures, 1987 Census of Service Industries.

TABLE 12. CAPACITY UTILIZATION RATES FOR THE INDUSTRIES USING DEGREASING EQUIPMENT, 1985-1988 (FROM THE FOURTH QUARTER OF EACH YEAR)

| SIC Code | Industry Name | 1988 | 1987 | 1986 | 1985 |
|---|---|---|---|---|---|
| 254 | Partitions and Fixtures | 65% | 63% | 62% | 57% |
| 259 | Misc. Furniture and Fixtures | 78% | 78% | 74% | 66% |
| 332 | Iron and Steel Foundries | 83% | 765 | 685 | 66% |
| 335 | Nonferrous Rolling and Drawing | 77% | 76% | 69% | 66% |
| 336 | Nonferrous Foundries (castings) | 74% | 54% | 68% | 64% |
| 339 | Misc. Primary Metal Products | 82% | 77% | 60% | 65% |
| 342 | Cutlery, Handtools, and Hardware | 77% | 75% | 80% | 77% |
| 343 | Plumbing and Heating, Except Electric | 78% | 77% | 74% | 71% |
| 344 | Fabricated Structural Metal Products | 66% | 65% | 62% | 64% |
| 345 | Screw Machine Products, Bolts, Etc. | 73% | 74% | 69% | 73% |
| 346 | Metal Forgings and Stampings | 45% | 73% | 48% | 70% |
| 347 | Metal Services, n.e.c. | 61% | 45% | 54% | 51% |
| 348 | Ordnance and Accessories, n.e.c. | 66% | 57% | 59% | 52% |
| 349 | Misc. Fabricated Metal Products | | 65% | | 60% |
| 351 | Engines and Turbines | 60% | 56% | 53% | 57% |
| 352 | Farm and Garden Machinery | 56% | 51% | 30% | 42% |
| 353 | Construction and Related Machinery | 58% | 56% | 41% | 51% |
| 354 | Metalworking Machinery | 76% | 65% | 63% | 68% |
| 355 | Special Industry Machinery | 71% | 61% | 56% | 50% |
| 356 | General Industrial Machinery | 68% | 60% | 56% | 56% |
| 357 | Computer and Office Equipment | 67% | 65% | 62% | 66% |
| 358 | Refrigeration and Service Machinery | 67% | 68% | 65% | 66% |
| 359 | Industrial Machinery, n.e.c. | 70% | 73% | 65% | 64% |
| 361 | Electric Distribution Equipment | 77% | 70% | 69% | 67% |
| 362 | Electrical Industrial Apparatus | 61% | 55% | 55% | 57% |
| 364 | Electric Lighting and Wiring Equipment | 64% | 66% | 64% | 65% |
| 366 | Communications Equipment | 68% | 68% | 73% | 71% |
| 367 | Electronic Components and Accessories | 72% | 69% | 63% | 62% |
| 369 | Misc. Electrical Equipment and Supplies | 65% | 69% | 69% | 69% |

TABLE 12. (CONTINUED)

| SIC Code | Industry Name | 1988 | 1987 | 1986 | 1985 |
|---|---|---|---|---|---|
| 371 | Motor Vehicles and Equipment | 81% | 77% | 74% | 76% |
| 372 | Aircraft and Parts | 63% | 66% | 70% | 63% |
| 376 | Guided Missiles, Space Vehicles, Parts | 60% | 64% | 64% | 60% |
| 379 | Misc. Transportation Equipment | 38% | 25% | 48% | N/A |
| 381 | Search and Navigation Equipment | N/A | N/A | N/A | N/A |
| 382 | Measuring and Controlling Devices | 59% | 57% | 59% | 61% |
| 39 | Misc. Manufacturing Industries | 61% | 58% | 59% | 63% |
| 401 | Railroads - Maintenance | N/A | N/A | N/A | N/A |
| 458 | Air Transport - Maintenance | N/A | N/A | N/A | N/A |
| 753 | Auto Repair | N/A | N/A | N/A | N/A |

Misc. - Miscellaneous.
N/A - Not available.
n.e.c. - Not elsewhere classified.

Sources: U.S. Department of Commerce, Bureau of the Census. Current Industrial Reports, 1988.

Exports, imports, and the balance of trade for each user industry are listed in Table 13. SIC 371, Motor Vehicles and Equipment, had a trade deficit of -$47.5 billion, the largest of any of the 39 industries. The largest trade surplus was $25.3 billion in SIC 372, Aircraft and Parts.

This industry's exports as a percentage of revenue, 42 percent, is the highest among the user industries (Table 14). At the other extreme, less than one percent of SIC 376's revenue came from exports.

Profitability data are not available at the 3-digit SIC level. Therefore, Table 15 lists the average after-tax income of the two-digit categories in which the user industries in manufacturing are contained. SIC industries 401, 458, and 753 are the only exceptions. The profitability data are survey data taken from Dun and Bradstreet's Industry Norms and Key Business Ratios as well as the Bureau of the Census' Quarterly Financial Report. For SICs 33 through 38 the average income after taxes is the average of the sum of quarterly ratios for 1990. The average income after taxes for each four-digit industry comprising SICs 25 and 753 were averaged to come up with a ratio for the two industries. The profitability ratios ranged from 6.6 percent in SIC 38, Instruments and Related Products, to 1.3 percent in SIC 37, Transportation Equipment.

Output forecasts for industries using degreasing equipment are presented in Table 16.[32] Average annual rates between 1992 and 1997 range from 0.39 percent in SIC 348, Ordnance and Accessories, n.e.c. to 9.64 percent in SIC 357, Computer and Office Equipment.

The growth rates in output underscore the diversity of industries engaged in degreasing operations. For

TABLE 13. EXPORT AND IMPORT DATA FOR THE INDUSTRIES USING DEGREASING EQUIPMENT, 1990

| SIC Code | Industry Name | Exports (thousands of $) | Imports (thousands of $) | Balance of Trade (thousands of $) |
|---|---|---|---|---|
| 254 | Partitions and Fixtures | N/A | N/A | N/A |
| 259 | Misc. Furniture and Fixtures | $1,555,277 | $5,198,877 | ($3,643,600) |
| 332 | Iron and Steel Foundries | $127,326 | $66,436 | $60,890 |
| 335 | Nonferrous Rolling and Drawing | $4,882,688 | $5,363,098 | ($480,410) |
| 336 | Nonferrous Foundries (castings) | $38,619 | $33,258 | $5,361 |
| 339 | Misc. Primary Metal Products | N/A | $179,323 | N/A |
| 342 | Cutlery, Handtools, and Hardware | $1,592,208 | $2,402,174 | ($809,966) |
| 343 | Plumbing and Heating, Except Electric | $293,092 | $268,264 | $24,828 |
| 344 | Fabricated Structural Metal Products | $1,163,891 | $623,214 | $540,677 |
| 345 | Screw Machine Products, Bolts, Etc. | $624,009 | $1,214,411 | ($590,402) |
| 346 | Metal Forgings and Stampings | $1,666,065 | $907,372 | $758,693 |
| 347 | Metal Services, n.e.c. | N/A | N/A | N/A |
| 348 | Ordnance and Accessories, n.e.c. | $2,334,571 | $455,962 | $1,878,609 |
| 349 | Misc. Fabricated Metal Products | $3,239,537 | $5,575,075 | $2,335,538) |
| 351 | Engines and Turbines | $3,608,607 | $2,190,853 | $1,417,754 |
| 352 | Farm and Garden Machinery | $4,076,108 | $2,742,288 | $1,333,820 |
| 353 | Construction and Related Machinery | $8,675,280 | $5,083,557 | $3,591,733 |
| 354 | Metalworking Machinery | $4,057,410 | $5,525,119 | ($1,467,709) |
| 355 | Special Industry Machinery | $5,230,157 | $5,938,599 | ($708,442) |
| 356 | General Industrial Machinery | $6,847,222 | $6,103,753 | $743,469 |
| 357 | Computer and Office Equipment | $23,007,309 | $23,619,036 | ($611,727) |
| 358 | Refrigeration and Service Machinery | $3,838,240 | $2,067,201 | $1,771,039 |
| 359 | Industrial Machinery, n.e.c. | $1,888,477 | $1,742,022 | $146,455 |

TABLE 13. (CONTINUED)

| SIC Code | Industry Name | Exports (thousands of $) | Imports (thousands of $) | Balance of Trade (thousands of $) |
|---|---|---|---|---|
| 361 | Electric Distribution Equipment | $504,698 | $790,454 | ($285,756) |
| 362 | Electrical Industrial Apparatus | $2,507,330 | $3,238,628 | ($731,298) |
| 364 | Electric Lighting and Wiring Equipment | $3,928,489 | $4,709,896 | ($781,407) |
| 366 | Communications Equipment | $5,115,295 | $8,561,495 | ($3,446,200) |
| 367 | Electronic Components and Accessories | N/A | $19,805,200 | N/A |
| 369 | Misc. Electrical Equipment and Supplies | $4,657,088 | $4,325,838 | $331,250 |
| 371 | Motor Vehicles and Equipment | $28,503,900 | $75,988,723 | ($47,484,823) |
| 372 | Aircraft and Parts | $36,479,978 | $11,227,386 | $25,252,592 |
| 376 | Guided Missiles, Space Vehicles, Parts | $50,047 | $4,984 | $45,063 |
| 379 | Misc. Transportation Equipment | $973,225 | $249,621 | $723,604 |
| 381 | Search and Navigation Equipment | $2,062,258 | $830,122 | $1,232,136 |
| 382 | Measuring and Controlling Devices | $7,725,884 | $4,239,526 | $3,486,358 |
| 39 | Misc. Manufacturing Industries | $4,295,835 | $20,090,473 | ($15,794,638) |
| 401 | Railroads - Maintenance | N/A | N/A | N/A |
| 458 | Air Transport - Maintenance | N/A | N/A | N/A |
| 753 | Auto Repair | N/A | N/A | N/A |

Misc. - Miscellaneous.
N/A - Not available.
n.e.c. - Not elsewhere classified.

Sources: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division. Reports EM 575 and IM 175, 1990.

TABLE 14. EXPORTS AS A PERCENTAGE OF REVENUE FOR THE INDUSTRIES USING DEGREASING EQUIPMENT, 1990

| SIC Code | Industry Name | Exports (thousands of $) | Revenue (thousands of 1990 $) | Exports As a Percentage of Revenue |
|---|---|---|---|---|
| 254 | Partitions and Fixtures | N/A | $6,201,664 | N/A |
| 259 | Misc. Furniture and Fixtures | $1,555,277 | $4,188,912 | 37% |
| 332 | Iron and Steel Foundries | $127,326 | $11,903,024 | 1% |
| 335 | Nonferrous Rolling and Drawing | $4,882,688 | $37,276,064 | 13% |
| 336 | Nonferrous Foundries (castings) | $38,619 | $7,073,024 | 1% |
| 339 | Misc. Primary Metal Products | N/A | $3,256,288 | N/A |
| 342 | Cutlery, Handtools, and Hardware | $1,592,208 | $15,098,272 | 11% |
| 343 | Plumbing and Heating, Except Electric | $293,092 | $5,916,624 | 5% |
| 344 | Fabricated Structural Metal Products | $1,163,891 | $45,266,032 | 3% |
| 345 | Screw Machine Products, Bolts, Etc. | $624,009 | $8,837,024 | 7% |
| 346 | Metal Forgings and Stampings | $1,666,065 | $31,818,976 | 5% |
| 347 | Metal Services, n.e.c. | N/A | $8,724,240 | N/A |
| 348 | Ordnance and Accessories, n.e.c. | $2,334,571 | $8,560,832 | 27% |
| 349 | Misc. Fabricated Metal Products | $3,239,537 | $27,260,688 | 12% |
| 351 | Engines and Turbines | $3,608,607 | $16,318,848 | 22% |
| 352 | Farm and Garden Machinery | $4,076,108 | $12,851,216 | 32% |
| 353 | Construction and Related Machinery | $8,675,290 | $27,576,976 | 31% |
| 354 | Metalworking Machinery | $4,057,410 | $24,643,920 | 16% |
| 355 | Special Industry Machinery | $5,230,157 | $19,147,632 | 27% |
| 356 | General Industrial Machinery | $6,847,222 | $27,014,960 | 25% |
| 357 | Computer and Office Equipment | $23,007,309 | $67,901,680 | 34% |
| 358 | Refrigeration and Service Machinery | $3,838,240 | $26,023,088 | 15% |
| 359 | Industrial Machinery, n.e.c. | $1,888,477 | $22,311,968 | 8% |
| 361 | Electric Distribution Equipment | $504,698 | $9,180,416 | 5% |
| 362 | Electrical Industrial Apparatus | $2,507,330 | $17,098,256 | 15% |
| 364 | Electric Lighting and Wiring Equipment | $3,928,489 | $20,164,480 | 19% |
| 366 | Communications Equipment | $5,115,295 | $38,080,672 | 13% |
| 367 | Electronic Components and Accessories | N/A | $56,288,624 | N/A |
| 369 | Misc. Electrical Equipment and Supplies | $4,657,088 | $23,777,936 | 20% |

TABLE 14. (CONTINUED)

| SIC Code | Industry Name | Exports (thousands of $) | Revenue (thousands of 1990 $) | Exports As a Percentage of Revenue |
|---|---|---|---|---|
| 371 | Motor Vehicles and Equipment | $28,503,900 | $230,633,872 | 12% |
| 372 | Aircraft and Parts | $36,479,978 | $86,580,592 | 42% |
| 376 | Guided Missiles, Space Vehicles, Parts | $50,047 | $29,439,424 | 0% |
| 379 | Misc. Transportation Equipment | $973,225 | $6,756,736 | 14% |
| 381 | Search and Navigation Equipment | $2,062,258 | $40,618,816 | 5% |
| 382 | Measuring and Controlling Devices | $7,725,884 | $29,167,040 | 26% |
| 39 | Misc. Manufacturing Industries | $4,295,835 | $35,853,440 | 12% |
| 401 | Railroads - Maintenance | N/A | $4,858,934 | N/A |
| 458 | Air Transport - Maintenance | N/A | $6,874,804 | N/A |
| 753 | Auto Repair | N/A | $32,103,883 | N/A |

Misc. - Miscellaneous.
N/A - Not available.
n.e.c. - Not elsewhere classified.

Sources: Air Transport Association of America. Air Transport 1989: The Annual Report of the U.S. Scheduled Airline Industry; Interstate Commerce Commission, Bureau of Accounts, Transportation Statistics in the United States (for the year ended December 31, 1987); U.S. Department of Commerce, Bureau of the Census. 1987 Census of Manufactures, 1987 Census of the Service Industries.

TABLE 15. AVERAGE AFTER-TAX PROFIT MARGIN IN THE INDUSTRIES USING DEGREASING EQUIPMENT: 1990

| SIC Code | Industry Name | Average After-Tax Profit Margin |
|---|---|---|
| 25 | Furniture and Fixtures | 4.8% |
| 33 | Primary Metals Industries | 2.6% |
| 34 | Fabricated Metal Products | 3.4% |
| 35 | Industrial Machinery and Equipment | 4.4% |
| 36 | Electronic and Other Electric Equipment | 3.0% |
| 37 | Transportation Equipment | 1.3% |
| 38 | Instruments and Related Products | 6.6% |
| 39 | Misc. Manufacturing Industries | N.A |
| 401 | Railroads - Maintenance | N/A |
| 458 | Air Transport - Maintenance | N/A |
| 753 | Auto Repair | 6.0% |

Misc. - Miscellaneous.
N/A - Not available.

Sources: Dun and Bradstreet Information Services. Industry Norms & Key Business Ratios 1990-1991; U.S. Department of Commerce, Bureau of the Census. Quarterly Financial Report, First Quarter 1991.

TABLE 16. OUTPUT FORECASTS OF INDUSTRIES USING DEGREASING EQUIPMENT

| SIC Code | Industry Name | Percent Change From Previous Year | | | | | | | | Average Annual Growth 1992-1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1990* | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
| 254 | Partitions and Fixtures | 0.98 | -5.50 | 9.31 | 5.58 | 5.23 | 3.90 | 2.91 | 3.29 | 4.18 |
| 259 | Misc. Furniture and Fixtures | 0.98 | -5.50 | 9.31 | 5.58 | 5.23 | 3.90 | 2.91 | 3.29 | 4.18 |
| 332 | Iron and Steel Foundries | -9.00 | -8.79 | 3.72 | 2.00 | 0.08 | 0.70 | 0.52 | 1.43 | 0.94 |
| 335 | Nonferrous Rolling and Drawing | -4.14 | -2.77 | 11.89 | 4.14 | 4.31 | 2.34 | 2.22 | 2.81 | 3.16 |
| 336 | Nonferrous Foundries (castings) | 3.17 | -2.77 | 11.89 | 4.14 | 4.31 | 2.34 | 2.22 | 2.18 | 3.16 |
| 339 | Misc. Primary Metal Products | -0.87 | -6.69 | 3.60 | 3.81 | 4.20 | 2.33 | 2.24 | 2.73 | 3.06 |
| 342 | Cutlery, Handtools, and Hardware | 3.71 | -5.27 | 9.07 | 3.88 | 4.36 | 2.76 | 1.52 | 2.29 | 2.96 |
| 343 | Plumbing and Heating, Except Electric | 0.35 | -2.42 | 6.09 | 3.08 | 3.88 | 2.36 | 1.74 | 1.99 | 2.61 |
| 344 | Fabricated Structural Metal Products | -3.49 | -5.98 | 2.91 | 1.66 | 3.26 | 3.79 | 3.64 | 3.44 | 3.15 |
| 345 | Screw Machine Products, Bolts, Etc. | -1.99 | -6.10 | 9.60 | 4.36 | 4.07 | 1.90 | 1.29 | 1.60 | 2.64 |
| 346 | Metal Forgings and Stampings | -1.99 | -6.10 | 9.60 | 4.36 | 4.07 | 1.90 | 1.29 | 1.60 | 2.64 |
| 347 | Metal Services, n.e.c. | -1.99 | -6.10 | 9.60 | 4.36 | 4.07 | 1.90 | 1.29 | 1.60 | 2.64 |
| 348 | Ordnance and Accessories, n.e.c. | -4.63 | -4.72 | -0.35 | -0.41 | 1.25 | 0.06 | 0.40 | 0.68 | 0.39 |
| 349 | Misc. Fabricated Metal Products | 0.35 | -2.42 | 6.09 | 3.08 | 3.88 | 2.36 | 1.74 | 1.99 | 2.61 |
| 351 | Engines and Turbines | 3.02 | -3.12 | 2.93 | 4.91 | 4.15 | 2.94 | 2.47 | 2.05 | 3.30 |
| 352 | Farm and Garden Machinery | 7.99 | -1.94 | 5.97 | 3.95 | 4.00 | 2.75 | 2.02 | 2.16 | 2.97 |
| 353 | Construction and Related Machinery | -1.48 | -3.49 | 6.19 | 6.06 | 5.76 | 4.60 | 3.46 | 3.40 | 4.65 |
| 354 | Metalworking Machinery | 1.90 | -1.32 | 11.04 | 6.98 | 6.51 | 5.36 | 4.16 | 4.66 | 5.53 |
| 355 | Special Industry Machinery | 2.51 | -7.76 | 7.23 | 7.11 | 7.21 | 4.95 | 3.87 | 3.48 | 5.31 |
| 356 | General Industrial Machinery | 3.21 | -6.53 | 5.35 | 5.76 | 5.42 | 4.40 | 4.27 | 3.72 | 4.71 |
| 357 | Computer and Office Equipment | 9.12 | 4.22 | 10.59 | 12.45 | 11.78 | 8.92 | 7.44 | 7.71 | 9.64 |
| 358 | Refrigeration and Service Machinery | -2.77 | -3.04 | 7.42 | 5.95 | 4.49 | 3.19 | 3.37 | 3.03 | 4.00 |
| 359 | Industrial Machinery, n.e.c. | 3.60 | -5.29 | 3.41 | 3.27 | 4.75 | 4.16 | 4.08 | 3.08 | 3.87 |

TABLE 16. (CONTINUED)

| SIC Code | Industry Name | Percent Change From Previous Year | | | | | | | | Average Annual Growth 1992-1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1990* | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
| 361 | Electric Distribution Equipment | -0.92 | -7.70 | 6.48 | 5.14 | 5.42 | 3.74 | 2.51 | 2.17 | 3.79 |
| 362 | Electrical Industrial Apparatus | -0.92 | -7.70 | 6.48 | 5.14 | 5.42 | 3.74 | 2.51 | 2.17 | 3.79 |
| 364 | Electric Lighting and Wiring Equipment | 1.05 | -4.38 | 8.82 | 3.68 | 3.72 | 2.11 | 1.59 | 1.46 | 2.50 |
| 366 | Communications Equipment | 3.20 | 3.11 | 6.75 | 8.76 | 6.50 | 4.31 | 4.16 | 4.19 | 5.57 |
| 367 | Electronic Components and Accessories | 4.80 | 2.16 | 10.63 | 10.31 | 12.00 | 7.96 | 5.78 | 6.33 | 8.45 |
| 369 | Misc. Electrical Equipment and Supplies | -3.28 | -4.14 | 9.28 | 4.31 | 4.24 | 3.40 | 3.23 | 2.83 | 3.60 |
| 371 | Motor Vehicles and Equipment | -7.46 | -5.04 | 15.07 | 5.01 | 4.97 | 1.51 | 1.63 | 0.50 | 2.71 |
| 372 | Aircraft and Parts | 3.93 | -4.21 | 2.71 | 2.31 | 1.31 | 2.36 | 2.96 | 3.65 | 2.48 |
| 376 | Guided Missiles, Space Vehicles, Parts | 2.81 | -3.04 | 5.50 | 1.81 | 1.21 | 3.20 | 3.26 | 2.64 | 2.42 |
| 379 | Misc. Transportation Equipment | 2.81 | -3.04 | 5.50 | 1.81 | 1.21 | 3.20 | 3.26 | 2.64 | 2.42 |
| 381 | Search and Navigation Equipment | 2.20 | 0.47 | 5.62 | 5.29 | 5.65 | 4.44 | 4.29 | 4.27 | 4.78 |
| 382 | Measuring and Controlling Devices | 2.20 | 0.47 | 5.62 | 5.29 | 5.65 | 4.44 | 4.29 | 4.27 | 4.78 |
| 39 | Misc. Manufacturing Industries | 4.20 | -1.19 | 4.37 | 2.16 | 3.13 | 3.74 | 3.88 | 3.91 | 3.36 |
| 401 | Railroads - Maintenance | 0.42 | -1.99 | 5.26 | 3.80 | 2.89 | 3.12 | 2.34 | 2.13 | 2.85 |
| 458 | Air Transport - Maintenance | 2.99 | 0.74 | 3.91 | 4.56 | 4.77 | 4.73 | 4.29 | 4.26 | 4.52 |
| 753 | Auto Repair | 3.89 | 2.21 | 2.96 | 2.65 | 2.78 | 2.87 | 2.82 | 2.75 | 2.77 |

*Actual

Notes on Forecasts
(a) Forecasts for SIC 254 and SIC 259 are combined.
(b) Forecasts for SIC 335 and SIC 336 are combined.
(c) Forecasts for SIC 339 are grouped with forecasts for SIC 334 (Secondary Smelting and Refining of Nonferrous Metals).
(d) Forecasts for SIC 343 and SIC 349 are combined.
(e) Forecasts for SIC 345, SIC 346 and SIC 347 are combined.
(f) Forecasts for SIC 361 and SIC 362 are combined.
(g) Forecasts for SIC 376 and SIC 379 are combined, and are grouped with Forecasts for SIC 375 (Motorcycles, Bicycles, and Parts).
(h) Forecasts for SIC 381 and SIC 382 are combined.
(i) This is a combined forecast for the major group SIC 40 (Railroad Transportation), SIC 474 (Rental of Railroad Cars) and SIC 4789 (Transportation Services, n.e.c.).

Misc. - Miscellaneous.
n.e.c. - Not elsewhere classified.
Source: Forecasts provided by Wharton Econometric Forecasting Associates, Bala Cynwyd, PA.

example, the range of annual averages in SIC 33, (Primary Metals Industry, SIC 34, Fabricated Metal Products, except Machinery and Transportation Equipment), and SIC 35 (Industrial and Commercial Machinery and Computer Equipment), is 0.94 percent to 3.16 percent, 0.39 percent to 3.15 percent, and 2.97 percent to 9.64 percent.

Industries with exceptionally high average growth rates are SIC 357 Electronic Components and Accessories, with a rate of 9.64 percent, and SIC 367, with a rate of 8.45 percent. Those with very low growth rates are SIC 332 Iron and Steel Foundries, with a rate of 0.94 percent, and SIC 348, Ordnance and Accessories, n.e.c., with a rate of 0.39 percent.

1.5 Automotive Repair Industry

Almost 50 percent of the establishments identified as users of degreasing equipment is accounted for by SIC 753, Automotive Repair Shops. The industry ranks fifth-highest in terms of employment. For these two reasons and the fact that auto repair shops are labor-intensive, low-margin operations, it may be that firms in this industry will experience disproportionate economic impacts. Thus, it necessary to profile the industry in order to assess the magnitude of the impacts resulting from the NESHAP.

SIC 753 is a heterogenous industry consisting of seven four-digit SIC industries. These industries are Top, Body, and Upholstery Repair Shops and Paint Shop (SIC 7532), Automotive Exhaust System Repair Shops (SIC 7533), Tire Retreading and Repair Shops (SIC 7534), Automotive Glass Replacement Shops (SIC 7536), Automotive Transmission Repair Shops (SIC 7537), General Automotive Repair Shops (SIC 7538), and Automotive Repair Shops, Not Elsewhere Classified (SIC 7539). Statistics concerning all seven four-digit industries are presented in Tables 17 through 20.

TABLE 17. DISTRIBUTION OF ESTABLISHMENTS AND FIRMS IN SIC 753 BY FOUR-DIGIT INDUSTRIES, 1987

| SIC Code | Industry Name | Establishments | Firms |
|---|---|---|---|
| 7532 | Top, Body, and Upholstery Repair Shops and Paint Shops | 32,951 | 32,233 |
| 7533 | Automotive Exhaust System Repair Shops | 4,910 | 3,654 |
| 7534 | Tire Retreading and Repair Shops | 1,930 | 1,763 |
| 7536 | Automotive Glass Replacement Shops | 3,534 | 2,510 |
| 7537 | Automotive Transmission Repair Shops | 6,335 | 6,131 |
| 7538 | General Automotive Repair Shops | 55,348 | 54,419 |
| 7539 | Automotive Repair Shops, Not Elsewhere Classified | 9,593 | 9,229 |
| 753 | Automotive Repair Shops | 114,601 | 109,939 |

Sources: Gale Research, Inc. Service Industries USA, Detroit, MI, 1992; U.S. Department of Commerce, Bureau of the Census. 1987 Census of Service Industries.

Of the seven industries, SIC 7538 accounted for the largest number of establishments (55,348) and the largest number of firms (55,419) in 1987 (Table 17). These figures represent 48.3 percent and 49.4 percent respectively of the totals for SIC 753. The next largest four-digit industry is SIC 7532 with 32,951 establishments operated by 32,233 firms. The smallest number of establishments (1,930) and firms (1,763) are in SIC 7534. Establishments are defined as the physical location at which business is conducted. Firms are business organizations or entities consisting of one or more establishments under common ownership.

The various types of firms in SIC 753 are presented in Table 18. Approximately 50 percent of all firms in SIC 753 were individual proprietorships in 1987. Corporations accounted for 42 percent of all firms, partnerships 7 percent, and other types of firms one percent.

As can be seen in Table 19, the largest number of personnel were employed in SIC 7538 in 1987. However, the average number of employees per establishment was highest in SIC 7534. SICs 7532 and 7538 accounted for 75 percent of total employment in SIC 753.

These two SIC industries also accounted for 74 percent of revenue in 1987 for SIC 753 (Table 20). The largest average revenue per establishment occurred in SIC 7534 where the figure was $572,021.

Though only SIC 753 was identified as an automotive repair industry using degreasing equipment, it is one of three industries identified by the Standard Industrial Classification Manual as performing automotive repair services. SIC 551, Motor Vehicles Dealers, New and Used, and SIC 554, Gasoline Service Stations, also do such work. These three industries, which in essence comprise the automotive repair industry, are part of the broader

TABLE 18. LEGAL FORMS OF FIRMS IN SIC 753, 1987

| SIC Code | Industry Name | Total Number of Firms | Corporations[a] | Individual Proprietorships[b] | Partnerships[c] | Other |
|---|---|---|---|---|---|---|
| 7532 | Top, Body, and Upholstery Repair Shops and Paint Shops | 32,233 | 13,380 | 16,595 | 2,234 | 24 |
| 7533 | Automotive Exhaust System Repair Shops | 3,654 | 2,185 | 1,230 | 235 | 4 |
| 7534 | Tire Retreading and Repair Shops | 1,763 | 1,083 | 578 | 101 | 1 |
| 7536 | Automotive Glass and Replacement Shops | 2,510 | 1,333 | 996 | 180 | 1 |
| 7537 | Automotive Transmission Repair Shops | 6,131 | 3,156 | 2,578 | 395 | 2 |
| 7538 | General Automotive Repair Shops | 54,419 | 21,225 | 29,094 | 4,056 | 44 |

TABLE 18. (CONTINUED)

| SIC Code | Industry Name | Total Number of Firms | Corporations[a] | Individual Proprietorships[b] | Partnerships[c] | Other |
|---|---|---|---|---|---|---|
| 7539 | Automotive Repair Shops, Not Elsewhere Classified | 9,229 | 4,303 | 4,271 | 655 | 0 |
| 753 | Automotive Repair Shops | 109,939 | 46,665 | 55,342 | 7,856 | 76 |

[a]Corporations are business firms that have the legal status of a fictional individual, which is owned by stockholders, and run by a set of elected officers and a board of directors.
[b]Proprietorships are business firms owned by a single person.
[c]Partnerships are business firms whose ownership is shared by a fixed number of proprietors.

Source: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Service Industries.

TABLE 19. DISTRIBUTION OF EMPLOYMENT IN SIC 753 BY FOUR-DIGIT INDUSTRIES, 1987

| SIC Code | Industry Name | Employment ($10^3$) | Average Number of Employees Per Establishment[a] |
|---|---|---|---|
| 7532 | Top, Body, and Upholstery Repair Shops and Paint Shops | 162.8 | 5 |
| 7533 | Automotive Exhaust System Repair Shops | 21.7 | 4 |
| 7534 | Tire Retreading and Repair Shops | 13.8 | 7 |
| 7536 | Automotive Glass Replacement Shops | 18.1 | 5 |
| 7537 | Automotive Transmission Repair Shops | 26.3 | 4 |
| 7538 | General Automotive Repair Shops | 202.6 | 4 |
| 7539 | Automotive Repair Shops, Not Elsewhere Classified | 40.3 | 4 |
| 753 | Automotive Repair Shops | 485.6 | 4 |

[a]Approximation.

Sources: Gale Research, Inc. Service Industries USA. Detroit, MI, 1992; U.S. Department of Commerce, Bureau of the Census. 1987 Census of Service Industries.

TABLE 20. DISTRIBUTION OF REVENUE IN SIC 753 BY FOUR-DIGIT INDUSTRIES, 1987

| SIC Code | Industry Name | Revenue ($10^6$$) | Average Revenue Per Establishment ($) |
|---|---|---|---|
| 7532 | Top, Body, and Upholstery Repair Shops and Paint Shops | 9,312.3 | 282,611 |
| 7533 | Automotive Exhaust System Repair Shops | 1,466.8 | 298,737 |
| 7534 | Tire Retreading and Repair Shops | 1,104.0 | 572,021 |
| 7536 | Automotive Glass Replacement Shops | 1,278.0 | 361,630 |
| 7537 | Automotive Transmission Repair Shops | 1,394.0 | 220,047 |
| 7538 | General Automotive Repair Shops | 11,872.5 | 214,506 |
| 7539 | Automotive Repair Shops, Not Elsewhere Classified | 2,236.7 | 233,160 |
| 753 | Automotive Repair Shops | 28,664.2 | 250,122 |

Sources: Gale Research Inc. Service Industry Analysis. Detroit, MI, 1992; U.S. Department of Commerce, Bureau of the Census. 1987 Census of Service Industries.

automotive aftermarket. The aftermarket consists of part-producing firms and outlets that service and repair the more than 180 million vehicles in the U.S. in 1992.[33] Data for all three industries are presented in Tables 21 through 9-24.

In Table 21, the number of establishments and firms in each industry is shown. The 114,601 automotive repair shops accounted for 58.9 percent of all establishments in the three industries in 1987. These establishments were owned by 109,939 firms. SIC 551 accounted for 14.6 percent of all establishments and SIC 554 26.5 percent.

The various legal forms of firms in the three industries are listed in Table 22. The majority of gasoline service stations and automotive repair shops were individual proprietorships. Eighty-eight percent of motor vehicle dealers were corporations. For SICs 554 and 753, corporations accounted for 33.7 percent and 42.4 percent of all firms.

As can be seen in Table 23, SIC 551 employed, approximately 1.9 times more personnel than SIC 753 in 1987; it employed 3.1 times more than SIC 554. These differences in part account for the larger average number of employees in SIC 551 in comparison to the other two industries.

Motor vehicle dealers also had much higher revenues in 1987 than the other two automotive service sectors (Table 24). In that year, revenue for SIC 551 was $280,529.2 million. It is important to note, however, that much of this revenue is attributable to motor vehicle sales. It is not known what percentage was accounted for by service operations. The same is true of gasoline service stations which derive income from gasoline sales.

More recent data concerning the average repair and service dollar volume earned in 1990 by selected parts of

TABLE 21. NUMBER OF ESTABLISHMENTS AND FIRMS IN SICS 551, 554, AND 753, 1987

| SIC Code | Industry Name | Establishments | Firms |
|---|---|---|---|
| 551 | Motor Vehicle Dealers (New and Used) | 28,320 | 26,997 |
| 554 | Gasoline Service Stations | 51,682[a] | N/A |
| 753 | Automotive Repair Shops | 114,601 | 109,939 |
| | Total | 194,603 | N/A |

[a]Includes only those establishments with automotive service bays. These establishments account for approximately 45 percent of the total number of gasoline service stations (114,748).

N/A - Not available.

Sources: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Retail Trade, 1987 Census of Service Industries.

TABLE 22. LEGAL FORMS OF FIRMS IN SICS 551, 554, AND 753, 1987

| SIC Code | Industry Name | Total Number of Firms | Corporations[a] | Individual Proprietorships[b] | Partnerships[c] | Other |
|---|---|---|---|---|---|---|
| 551 | Motor Vehicle Dealers (New and Used) | 26,997 | 23,626 | 2,365 | 660 | 346 |
| 554 | Gasoline Service Stations | 76,041* | 25,632* | 44,141* | 5,570* | 698* |
| 753 | Automotive Repair Shops | 109,939 | 46,665 | 55,342 | 7,856 | 76 |
| | Total | 212,977 | 95,923 | 101,848 | 14,086 | 1,120 |

*These figures apply to all establishments in SIC 554, regardless of whether or not they have an automotive service bay.

[a]Corporations are business firms that have the legal status of a fictional individual, which is owned by stockholders, and run by a set of elected officers and a board of directors.

[b]Proprietorships are business firms owned by a single person.

[c]Partnerships are business firms whose owenrship is shared by a fixed number of proprietors.

Sources: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Retail Trade, 1987 Census of Service Industries.

TABLE 23. EMPLOYMENT STATISTICS FOR SICS 551, 554 and 753, 1987

| SIC Code | Industry Name | Employment ($10^3$) | Average Number of Employees Per Establishment[a] |
|---|---|---|---|
| 551 | Motor Vehicle Dealers (New and Used) | 939.9 | 33 |
| 554 | Gasoline Service Stations | 307.2[a] | 6[a] |
| 753 | Auto Repair Shops | 485.6 | 4 |
| | Total | 2,172.2 | |

[a]These figures apply only to those gasoline service stations with automotive service bays.

Sources: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Retail Trade, 1987 Census of Service Industries.

TABLE 24. REVENUE STATISTICS FOR SICS 551, 554 and 753, 1987

| SIC Code | Industry Name | Revenue ($10^6$) | Average Revenue Per Establishment ($) |
|---|---|---|---|
| 551 | Motor Vehicle Dealers (New and Used) | 280,529.2[a] | 9,905,692[a] |
| 554 | Gasoline Service Stations | 37,939.1[a,b] | 734,087[a,b] |
| 753 | Auto Repair Shops | 28,664.2 | 250,122 |

[a]Not all revenue is attributable to motor vehicle servicing.
[b]These figures apply only to those gasoline service stations with automotive service bays.

Sources: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Retail Trade, 1987 Census of Service Industries.

TABLE 25. AVERAGE ANNUAL REPAIR AND SERVICE DOLLAR VOLUME AND AVERAGE NUMBER OF BAYS FOR SELECTED AUTOMOTIVE SERVICE INDUSTRIES

| Industry | Average Annual Repair and Service Dollar Volume, 1990 | Average Number of Bays, 1990 |
|---|---|---|
| Repair Shops | 300,000 | 5.2 |
| Service Stations | 151,000 | 2.8 |
| Body Shops | 359,000 | 8.8 |
| Car/Truck Dealerships | 1,640,000 | 17.2 |
| Tire Dealers | 195,000 | 3.9 |

Source: Service Station Management. October 1990, pp. 1-TAP - 34-TAP.

the service industry are contained in Table 9-25. Car/Truck Dealerships earned more than four times the service revenue of the second ranked industry, Body Shops. They almost had twice as many service bays on average as body shops. Repair shops, tire dealers, and service stations were ranked third, fourth, and fifth, respectively.

These statistics, however, do not address the market share controlled by each automotive service industry. The market share controlled by each industry is a function of both average revenue per establishment and the number of establishments in an industry. It should also be noted that some consumers do their own maintenance work. Standard and Poor's Corporation reported total service market shares for 1990 using a slightly different format for describing the industries. General and Specialty Repair Shops controlled 28 percent of the market, Service Stations 27 percent, New Car Dealers 21 percent, Auto Discount and Department Stores, 16 percent, and Tire Stores 8 percent.[34] So while the Car/Truck Dealership industry earns much more service revenue on average, it ranks only third in market share because it has less establishments than the other industries.

The automotive repair industry's output growth has historically followed the trend for the overall economy.[35] Factors influencing the industry's output include changes in disposable income, the number of miles driven, and the quality and durability of vehicles and their parts. Conventional wisdom holds that fewer vehicle sales result in increased aftermarket sales because consumers spend more on repair instead of new cars.[36] However, as the economy contracts, disposable income declines. Thus, consumers tend to delay scheduled and discretionary maintenance. This lengthening of the "repair cycle" has the effect of reducing the total number of service establishments.[37]

The aforementioned factors caused the growth in aftermarket sales to fall in 1991.[38] Many people delayed maintenance work due to the economic downturn. At the same time, there was a decline in the growth rate of the number of miles driven in 1991. However, the aftermarket is expected to return to its average annual growth rate of about two percent; the demand for scheduled repairs and maintenance is expected to improve.[39]

Beyond these business cycle effects, average annual growth in the aftermarket has slowed since 1980.[40] Three factors have contributed to this decline:

- A greater number of new vehicles are on the road, as the number of vehicles scrapped annually has been increasing.
- Original parts are increasingly well-designed and engineered, and are lasting longer.
- Specific diagnostic technologies more accurate;u identify parts that are likely to fail, reducing the practice of routine parts replacement.

Thus, average annual growth is not expected to exceed two percent in the 1990s.

The single largest growth potential for the aftermarket products and services is the "untapped" aftermarket according to the Motor and Equipment Manufacturers Association (MEMA).[41] The "untapped" market represents unperformed maintenance. Currently, it is estimated that $47.4 billion is the size of this market. Making consumers aware of the need for preventive vehicle maintenance should help open the market. However, this phenomonon has existed for decades, and cannot be expected to significantly alter growth rates in the industry.[42]

## 2.0 METHODOLOGY

### 2.1 Introduction

This section presents the methods for estimating the economic impacts of the degreasing NESHAP limiting halogenated solvent emissions from organic solvent cleaners (degreasers).

Degreasing equipment using the following solvents falls within the scope of the NESHAP: methylene chloride, perchloroethylene, 1,1,1 trichloroethane, and trichloroethylene. 1,1,1 trichloroethane is subject to regulation as an ozone depleter under the Montreal Protocol, and is assumed to be phased out before the degreasing NESHAP effect.

Degreasing equipment can be categorized into three broad types of cleaners: cold cleaners, open top vapor cleaners (OTVCs), and in-line (conveyorized) cleaners. Only the latter two are subject to the NESHAP, as cold cleaners are thought to be adequately controlled in the baseline.

Impacts will be calculated for two categories of degreasers: existing and new. New degreasers will be purchased over the course of compliance, both for replacement of old machines and as a result of industry growth. It is assumed that degreasers have, on average, a service life of 15 years. Thus, it follows that the current stock of degreasers will be replaced by new degreasers at a rate of one fifteenth, or 6.7 percent annually.

The most direct impact of the NESHAP will be on those facilities that manufacture products which require organic solvent cleaning. These facilities will experience changes in their costs resulting from the need to modify existing organic cleaning systems, or from the purchase of already modified systems (i.e. new degreasers).

There are 39 SIC classifications that contain facilities which are likely to be impacted. These industry groups were initially identified in a study performed by

Eureka Laboratories in 1976 of air emissions from organic solvent cleaning operations in California. The results of the study were extended to cover organic solvent cleaning operations throughout the United States. According to data collected for the industry profile, in 1987 these SICs included 255,499 establishments, generating just over $1 trillion in combined total revenue.

Because organic solvent cleaning spans so many industries, it is not within the scope of this analysis to identify all of the specific establishments and products that would be affected by a degreasing NESHAP. Therefore, organic solvent cleaning operations will be modelled generically.

Degreasing is an essential factor of production for those industry groups examined. Of particular importance for this analysis is the baseline cost of degreasing. If machines are retrofitted, degreasing costs will increase by the cost of the retrofit. The size of this cost increase will directly impact firm decisions regarding system modification, as well as industry prices, output levels, and employment. Section 2.2 outlines how baseline costs will be calculated for the model degreasers.

Cost increases stemming from compliance to the NESHAP will also be evaluated by the firm as they relate to the total production costs of affected facilities. This process requires creating model facilities with requisite economic, technological, and financial parameters. Section 2.3 delineates how model facilities are constructed.

Section 2.4 explains how impacts will be estimated at the facility level.

With an increase in compliance costs, firms will have the choice of retrofitting existing machines or installing alternative systems. Section 2.5 describes how impacts on the market for alternative systems will be evaluated.

Facilities which manufacture degreasing equipment will be affected as well. Section 2.6 discusses the nature of the analysis with respect to equipment manufacturers.

In addition, manufacturers of halogenated solvents will be impacted by compliance with the NESHAP. Section 2.7 focuses on the market adjustments that are likely to occur here.

Finally, Section 2.8 discusses small business impacts.

## 2.2 Estimating Baseline Degreasing Costs

The objective of this section is to demonstrate how baseline degreasing costs have been estimated for facilities operating degreasers. Because there are so many different types of degreasers, a model degreaser approach is used to capture the range of technical characteristics associated with degreasing. RADIAN Corp. has defined five types of model degreasers, based on their average solvent/air interface.* Model OTVCs have the designated sizes of small (4.5 sq. ft.), medium (8.6 sq. ft.), large (16 sq. ft.), and very large (38 sq. ft.). In-line cleaners have one designated size -- very large (38 sq. ft.). It is assumed that technical characteristics are the same for both existing and new model degreasers. The method by which costs are computed is composed of the following tasks:

1. Set the technical characteristics of the model degreasers in terms of fixed equipment and the most important variable inputs: These have been identified as capital costs, production labor, maintenance labor, solvent requirements, energy requirements, and additional miscellaneous costs.

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* For a detailed treatment of model cleaner selection and control costs see the RADIAN Corp. Memorandum entitled Summary of Costs and Cost Effectiveness Associated with Emission Reductions for Selected Control Techniques for Organic Solvent Cleaners, September 30, 1992.

2. Apply the Radian estimates of model degreaser total fixed (capital) costs, annualized by a capital recovery factor: This requires a straightforward application of the cost recovery formula:

$$CC_m = P_m \left(\frac{r(1+r)^t}{(1+r)^t - 1}\right) \quad (1)$$

where $CC_m$ is the annualized capital cost of model degreaser m, $P_m$ is the purchase price of degreaser m, r is an annual interest or discount rate, and t is the system's lifetime in years. Purchase prices of the model degreasers are as follows: small = $20,000; medium = $40,000; large = $70,000; very large = $140,000; in-line = $139,000.

3. Generate estimates of the annual quantities of the variable inputs for each of the model sizes: These estimates come from a combination of engineering data from RADIAN and from actual facility data collected by JACA. The estimates are calculated using the following assumptions and data: **Production labor** costs assume that labor is performed for 1464 hours annually with an hourly wage rate of $13.69. This number of hours is the total number of annual labor hours (1560) minus downtime for maintenance. **Maintenance labor**, which is utilized for cleaning the degreaser, is assumed to be performed once monthly for eight hours at a wage rate of $15.04. **Solvent requirements** are based on the actual amount of solvent used at Precision Tube Inc. for their 45 sq. ft. degreaser. Precision consumes 33,052

kg/yr. Given the amount of solvent and the size of the degreaser, and assuming a solvent price of $1.42/kg, the dollar value of solvent per sq. ft. is $1,035.63. This value is then applied to the five model degreasers to arrive at annual solvent cost. **Miscellaneous expenditures**, which include taxes, insurance, and administrative costs, have been estimated by RADIAN Corp. to be 4 percent of annualized capital cost. **Energy costs** are derived from the RADIAN approach for calculating energy costs associated with degreasing control equipment.

4. Combine total fixed costs and total variable costs to arrive at total baseline costs of the model degreasers. Table 26 shows the estimated fixed, variable, and total costs for the five model degreasers.

## 2.3 Model Facilities

Since compliance costs are provided for model degreasers only, it is necessary to allocate these costs among impacted facilities. This involves allocating compliance costs to user industries. While all facilities which perform organic solvent cleaning will be impacted in some way, the economic impact analysis will estimate only the worst-case impacts. Thus, cost allocations will be performed for the most costly regulatory alternative, and applied to facilities which will be impacted most severely.

Control costs for new and existing model degreasers are provided by the engineering contractor. For each model

TABLE 26. MODEL CLEANER BASELINE DEGREASING COSTS

| Model Degreaser | Annualized Capital Cost | Annual Production Labor Cost | Annual Solvent Cost | Annual Maintenance Labor Cost | Annual Energy Cost | Annual Miscellaneous Costs[a] | Total Annual Cleaning Cost |
|---|---|---|---|---|---|---|---|
| Small | $2,630 | $20,042 | $4,660 | $1,444 | $515 | $1,052 | $30,344 |
| Medium | $5,260 | $20,042 | $8,906 | $1,444 | $843 | $2,104 | $38,599 |
| Large | $9,205 | $20,042 | $16,570 | $1,444 | $848 | $3,682 | $51,791 |
| Very large | $18,410 | $27,161 | $39,354 | $1,444 | $1,060 | $7,364 | $94,793 |
| In line | $18,300 | $27,161 | $39,354 | $1,444 | $1,060 | $7,320 | $94,639 |

[a]Includes property tax, insurance, and administrative costs.

Sources: Calculated internally by JACA Corp. using data gathered from Precision Tubes, Inc. and Radian Corp. Memorandum, Summary of Costs and Cost Effectiveness Associated with Emission Reductions for Selected Control Techniques for Organic Solvent Cleaners, September 30, 1992.

degreaser, control costs are estimated for a range of regulatory alternatives. Regulatory alternatives relate to the level of emissions reduction. The model degreaser with the highest cost of control will be chosen from among the model degreasers and regulatory alternatives. Thus, two figures will be used as estimates of maximum control costs; one for existing cleaners and one for new cleaners.

When installing pollution control equipment, it is often the smaller facilities in an industry that are impacted the most severely. This prevalence, which can be referred to as diseconomies of scale in pollution control, directs the focus of the analysis to the development of model facilities which capture the economic, technological, and financial attributes of small facilities.

Small model facilities are developed for each of the 39 SIC codes which will experience impacts. Economic parameters for these facilities will be taken directly from the census of manufacturers. A small model facility is defined here as having between one and nineteen employees. The revenue basis attached to small model facilities is calculated as the total revenue generated by facilities with between one and nineteen employees, divided by the total number of establishments in that employment class.

The range in the number of degreasers per establishment is based on observations from site visits and the results of a survey conducted by Dow Chemical Co. in 1976.[43] Dow found the average number of open-top and conveyorized vapor degreasers to be 1.43 in facilities with from 20-100 employees, and 3.76 in facilities with 500 or more employees. It is likely that the majority of small model facilities employ only one degreaser. If they do indeed use two degreasers, they are probably not both small, as this would be redundant. Thus, worst case impacts will be estimated assuming small facilities use one degreaser.

A final step in defining model facilities is to estimate their total baseline production costs. This involves computing the percentage contribution of total costs to revenue, which equal one minus the profit rate. Before tax profit rates will be used, as pollution control costs are tax deductible. Profitability data is obtained from the Commerce Department's Quarterly Financial Report, and from RMAs' Annual Statement Studies, 1992.

2.4 Calculation of Impacts

Now that model facilities have been defined and baseline and control costs have been measured, it is possible to proceed with the calculation of impacts.

The analysis begins by computing the increase in degreasing costs above baseline degreasing costs. This increase is a useful measure of the incentive degreasing operators will have for switching to alternative systems. The greater the increase in degreasing costs, the greater is the incentive for substitution. In some cases, the incremental cost of compliance will be large enough to make the existing system "marginal," i.e. no longer the least cost method of cleaning. These calculations will be used in support of the substitution analysis that follows.

Increases in degreasing costs alone do not account for the entire range of impacts. Decisions as to whether to substitute or retrofit will also depend on the contribution of degreasing costs to total costs of production. The ratio of control costs to total costs will be used in conjunction with degreasing cost increases when analyzing the likelihood of substitution.

2.5 Substitution Opportunities

As an alternative to implementing controls and incurring compliance costs, regulated facilities have the option of substituting for their existing solvent cleaning systems. Substitution possibilities include using an alternative solvent, or using an alternative degreasing

system. Since the use of alternative solvents and systems is well established in degreasing, it is necessary to evaluate substitution opportunities.

The primary approaches to solvent substitution are the reformulation of halogenated solvents and the substitution of non-halogenated solvents.

In terms of reformulation, one example is in the automobile repair industry.** This industry has reformulated carburetor cleaner compound to exclude the use of TCA, which had typically been used in five percent concentrations with MC and cresylic acid.

Substitution possibilities include terpene cleaners and aqueous cleaners. Terpene cleaners are available commercially in neat form or as water solutions with surfactants, emulsifiers, rust inhibitors, and other additives, and can be utilized in cold cleaners. Terpenes have tested favorably as substitutes for halogenated solvents for removal of heavy greases, oily deposits, and carbonized oils. One reported disadvantage of terpenes is the inability to separate long-chain aliphatic oils for recycling of the cleaning solution.

Aqueous cleaners comprise a wide range of methods that use water, detergents, acids, and alkaline compounds to displace soil rather than dissolving it in organic solvent. Aqueous cleaning has been found to be a viable substitute for cold-cleaning operations currently using halogenated solvents. Its primary drawback is that parts are wet after cleaning, creating rust problems.

Non-halogenated solvents in some cases do not clean as efficiently as halogenated solvents. Thus, the necessity of meeting minimum cleaning standards in many applications

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** It should be noted that automobile repair shops will not be regulated by this NESHAP. This presentation is used merely as an example.

may preclude the use of an alternative non-halogenated solvent. Non-halogenated solvents can be substituted for halogenated solvents only to the extent that they satisfy the specific technical requirements of the applications. Since non-halogenated solvents are already used far more extensively in cold-cleaning operations, substitution where it is technically feasible and cost-effective may have already taken place.

In order to assess the extent of substitution generated by the NESHAP, three aspects of the market for alternatives will be analyzed. First, the magnitude of non-halogenated systems in the baseline will be identified. Second, the ability of organic solvent cleaning users to switch to alternative systems will be gauged. Third, the growth rate of alternative systems will be estimated.

2.6 Impacts on Manufacturers of Degreasing Equipment

The demand for degreasing equipment can be thought of as derived from the demand for degreasing equipment in end-use markets. Thus, if the cost of compliance for end users has the effect of shifting up the end users' market supply curve, the ensuing reduction in output will lead to a reduction in demand for inputs, which include degreasing equipment. This will not necessarily lead to a contraction in the degreasing equipment manufacturing industry. This industry could well be in the position to manufacture control equipment and install retrofits. In addition, end-users could well substitute alternative cleaning systems, e.g. aqueous systems, which are also produced by firms which manufacture halogenated-solvent systems. In sum, it is not at all clear that the impacts of the degreasing NESHAP on equipment manufacturers will be negative. In fact, a net gain could be realized.

Since demand for degreasing equipment is derived from the demand for "degreased products," the growth rate in this product market will have an impact on the size of the

equipment manufacturing industry. Thus, growth rates will be used to estimate changes in demand in this market. (Growth rates are provided in the Industry Profile.) In addition, increases in the manufacture of alternative systems will affect manufacturers. Trends in this market will be examined as they impact equipment manufacturers.

2.7 Impacts on Solvent Manufacturers

Four halogenated solvents will be affected by the degreasing NESHAP. They are: methylene chloride (MC), perchloroethylene (PCE), 1,1,1-Trichloroethane (TCA), and Trichloroethylene (TCE). Manufacturers of these solvents will be impacted by the degreasing NESHAP in a variety of ways. First, demand for solvents will decline as degreasing machines recover fugitive emissions of solvent and reduce their solvent consumption. Also, demand for solvents will decline as end-users substitute alternative cleaning systems, e.g. aqueous systems, and reduce their solvent consumption. In addition, it is possible that intra-industry impacts will result from the NESHAP. Since 1,1,1 TCA is being phased out, it is likely that at least some facilities will move into using another regulated solvent. This will have the affect of increasing demand for the other solvent, and possibly putting upward pressure on solvent prices.

Demand for all types of cleaning fluids, i.e. halogenated and non-halogenated is derived from the demand for "degreased" products. Thus, growth in demand for these products will drive growth in demand for cleaning fluids.

In addition, retrofitting existing machines will lead to a reduction in fugitive emissions as solvent is recovered. It is assumed here that solvent-recovery data can be obtained from the engineering contractor. This information will be incorporated into the market analysis of cleaning fluids.

## 2.8 Small Business Impacts

The economic impact analysis will discuss the extent to which small businesses will be disproportionally impacted. If a substantial number of small businesses are deemed to experience significant impacts, a regulatory flexibility analysis will be recommended.

The analysis of small business impacts for user industries will rely on a comparison of control costs between large model facilities and small model facilities. A determination will be made as to the significance of cost increases, and the cost increase differential between large and small model facilities.

# 3.0 ECONOMIC IMPACTS

## 3.1 Introduction

This section presents the economic impact analysis for the degreasing NESHAP limiting halogenated solvent emissions from organic solvent cleaners (degreasers).

Preliminary estimates of economic impacts appear to be small, so the following analysis presents impacts in worst-case scenarios only. Modelling worst-case scenarios could pre-empt the need for more extensive analysis, if the most severe conditions result in negligible effects. The method for modelling worst-case impacts is presented in the methodology section (section 2) of this document.

## 3.2 Control Costs

Control costs for each model degreaser and each regulatory option have been provided by the engineering contractor. The maximum annualized cost of control has been identified for existing and new cleaners. For existing cleaners, this maximum corresponds to a small model degreaser using methylene chloride, with an emissions reduction level of 60 percent. The net annualized control cost per year is $1,938. For new cleaners, the maximum corresponds to a small model degreaser using methylene

chloride, with an emissions reduction level of 60 percent. The net annualized control cost per year is **$1,812.**

3.3 Economic Parameters of Model Facilities

Economic parameters of the model facilities for estimating worst-case economic impacts have been developed and are presented in Table 27. Each model facility is assumed to operate one small degreaser. Model facility revenues range from $346,222 for SIC 348 to $34,817,810 for SIC 376. However, data for SIC 376 can be considered an outlier in this analysis as it deviates greatly from the other averages. Impacts on SIC 376 are extremely small, and will not be analyzed here. Thus, the revenue for SIC 335, which is $1,412,769 is representative of the upper bound of average facility revenue. Employment per facility is fairly clustered, ranging from 5.2 employees to 8.2 employees. This clustering is to be expected, as the sample includes only facilities with from one to nineteen employees. Operating costs are estimated from industry profitability data, and are computed as facility revenue minus facility before-tax net income.

3.4 Impacts

3.4.1 Full-Cost Absorption. For calculating worst-case impacts it is assumed that facilities will have to absorb the entire incremental cost of control above the baseline. This conservative scenario posits that facilities will not be able to recover control costs through price increases. For the broad range of industries that will be impacted, actual price increases are difficult to predict. Assuming full-cost absorption assures that impacts will not be understated.

TABLE 27. ECONOMIC PARAMETERS OF SMALL MODEL PLANTS

| SIC Code | Industry Name | Number of Facilities | Average Per-Facility Revenue | Average Per-Facility Employees | Average Per-Facility Operating Costs |
|---|---|---|---|---|---|
| 254 | Partitions and Fixtures | 1,602 | $494,844 | 7.1 | $489,277 |
| 259 | Misc. Furniture and Fixtures | 1,592 | $377,665 | 5.2 | $373,416 |
| 332 | Iron and Steel Foundries | 448 | $516,213 | 7.4 | $503,888 |
| 335[a] | Nonferrous Rolling and Drawing | 311 | $1,479,169 | 7.6 | $1,443,854 |
| 336 | Nonferrous Foundries (castings) | 899 | $593,904 | 7.8 | $579,724 |
| 339 | Misc. Primary Metal Products | 584 | $724,601 | 8.2 | $707,302 |
| 342 | Cutlery, Handtools, and Hardware | 1,369 | $574,228 | 6.9 | $552,121 |
| 343 | Plumbing and Heating, Except Electric | 511 | $670,002 | 6.2 | $644,207 |
| 344 | Fabricated Structural Metal Products | 7,828 | $731,459 | 7.3 | $703,298 |
| 345 | Screw Machine Products, Bolts, Etc. | 1,466 | $586,022 | 8.2 | $563,460 |
| 346 | Metal Forgings and Stampings | 2,129 | $638,895 | 7.7 | $614,297 |
| 347 | Metal Services, n.e.c. | 3,606 | $418,882 | 7.1 | $402,755 |
| 348[a] | Ordnance and Accessories, n.e.c. | 217 | $368,778 | 6.0 | $354,580 |
| 349 | Misc. Fabricated Metal Products | 4,902 | $581,304 | 6.6 | $558,924 |
| 351 | Engines and Turbines | 167 | $745,153 | 6.3 | $717,583 |
| 352 | Farm and Garden Machinery | 1,254 | $609,716 | 6.5 | $587,157 |
| 353 | Construction and Related Machinery | 2,057 | $765,755 | 7.4 | $737,422 |
| 354 | Metalworking Machinery | 8,548 | $483,276 | 6.7 | $465,395 |
| 355 | Special Industry Machinery | 2,931 | $591,647 | 6.9 | $569,756 |
| 356 | General Industrial Machinery | 2,047 | $735,248 | 7.4 | $708,428 |
| 357[a] | Computer and Office Equipment | 1,113 | $808,336 | 6.2 | $650,085 |
| 358 | Refrigeration and Service Machinery | 1,142 | $675,062 | 6.7 | $313,504 |
| 359 | Industrial Machinery, n.e.c. | 18,983 | $325,549 | 5.6 | $315,504 |

TABLE 27. (CONTINUED)

| SIC Code | Industry Name | Number of Facilities | Average Per-Facility Revenue | Average Per-Facility Employees | Average Per-Facility Operating Costs |
|---|---|---|---|---|---|
| 361 | Electric Distribution Equipment | 350 | $741,772 | 6.9 | $723,413 |
| 362 | Electrical Industrial Apparatus | 1,295 | $551,695 | 6.3 | $538,041 |
| 364[a] | Electric Lighting and Wiring Equipment | 969 | $646,045 | 7.1 | $630,055 |
| 366 | Communications Equipment | 592 | $621,258 | 7.3 | $605,882 |
| 367 | Electronic Components and Accessories | 2,955 | $448,410 | 6.5 | $437,312 |
| 369[a] | Misc. Electrical Equipment and Supplies | 1,374 | $523,622 | 6.2 | $510,662 |
| 371 | Motor Vehicles and Equipment | 2,353 | $762,919 | 6.9 | $746,135 |
| 372 | Aircraft and Parts | 780 | $588,471 | 6.3 | $575,524 |
| 376[a] | Guided Missiles, Space Vehicles, Parts | 32 | $36,872,061 | 7.9 | $36,060,875 |
| 379 | Misc. Transportation Equipment | 754 | $545,848 | 5.7 | $533,840 |
| 381 | Search and Navigation Equipment | 576 | $508,252 | 5.9 | $492,497 |
| 382 | Measuring and Controlling Devices | 2,486 | $559,422 | 6.2 | $542,080 |
| 39[a] | Misc. Manufacturing Industries | 12,899 | $414,737 | 5.0 | $388,859 |

[a]Estimate, interpolated from existing Bureau of Census data.

Source: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Manufactures, 1987 Census of Service Industries.

To measure full-cost absorption impacts, annualized control costs are divided into average total revenue for each facility. Table 28 presents these quotients, in percentage terms, for existing and new degreasers.

As shown, control costs as a percentage of facility revenue are uniformly higher for existing degreasers than for new degreasers. Control costs for existing degreasers range from .13 percent (SIC 335) to .59 percent (SIC 359) of total facility revenue. Control costs for new degreasers range from .12 percent (SIC 335) to .56 percent (SIC 369) of total facility revenue. Since control costs lead to such small cost increases, impacts based on control costs as a percent of total facility revenue appear to be negligible.

3.5.2 Earnings Impacts

While it appears that facilities will be faced with modest compliance cost burdens, those facilities with small profit margins in the baseline could still be adversely impacted if they are unable to achieve price increases to offset control costs. It is assumed that threshold for significant earnings impacts is a level of annualized control costs that exceeds twenty percent of before-tax net income.

Table 29 lists annualized control costs as a percent of before-tax net income. For SICs 254 and 259, earnings impacts appear to be significant. In all other cases, they fall below the twenty percent threshold.

It is important to point out that significant earnings impacts alone do not necessarily imply closure of those facilities. All impacts are based on worst-case assumptions. Recall that the percent cost increases for SICs 254 and 259 are 0.23% and 0.26%, respectively. These are small indeed, and it is quite possible that such modest costs can be recovered through small price increases. Nevertheless, if there are meaningful impacts resulting from

TABLE 28. ANNUALIZED CONTROL COSTS AND PERCENT COST ABSORPTION FOR SMALL MODEL PLANTS

| SIC Code | Industry Name | Existing Degreasers | | New Degreasers | |
|---|---|---|---|---|---|
| | | Annualized Control Cost | Percent Cost Absorption[a] | Annualized Control Cost | Percent Cost Absorption[a] |
| 254 | Partitions and Fixtures | $1,928 | 0.39% | $1,812 | 0.37% |
| 259 | Misc. Furniture and Fixtures | $1,928 | 0.51% | $1,812 | 0.48% |
| 332 | Iron and Steel Foundries | $1,928 | 0.37% | $1,812 | 0.35% |
| 335 | Nonferrous Rolling and Drawing | $1,928 | 0.13% | $1,812 | 0.12% |
| 336 | Nonferrous Foundries (castings) | $1,928 | 0.32% | $1,812 | 0.31% |
| 339 | Misc. Primary Metal Products | $1,928 | 0.27% | $1,812 | 0.25% |
| 342 | Cutlery, Handtools, and Hardware | $1,928 | 0.34% | $1,812 | 0.32% |
| 343 | Plumbing and Heating, Except Electric | $1,928 | 0.29% | $1,812 | 0.27% |
| 344 | Fabricated Structural Metal Products | $1,928 | 0.26% | $1,812 | 0.25% |
| 345 | Screw Machine Products, Bolts, Etc. | $1,928 | 0.33% | $1,812 | 0.31% |
| 346 | Metal Forgings and Stampings | $1,928 | 0.30% | $1,812 | 0.28% |
| 347 | Metal Services, n.e.c. | $1,928 | 0.46% | $1,812 | 0.43% |
| 348 | Ordnance and Accessories, n.e.c. | $1,928 | 0.52% | $1,812 | 0.49% |
| 349 | Misc. Fabricated Metal Products | $1,928 | 0.33% | $1,812 | 0.31% |
| 351 | Engines and Turbines | $1,928 | 0.26% | $1,812 | 0.24% |
| 352 | Farm and Garden Machinery | $1,928 | 0.32% | $1,812 | 0.30% |
| 353 | Construction and Related Machinery | $1,928 | 0.25% | $1,812 | 0.24% |
| 354 | Metalworking Machinery | $1,928 | 0.40% | $1,812 | 0.37% |
| 355 | Special Industry Machinery | $1,928 | 0.33% | $1,812 | 0.31% |
| 356 | General Industrial Machinery | $1,928 | 0.26% | $1,812 | 0.25% |
| 357 | Computer and Office Equipment | $1,928 | 0.24% | $1,812 | 0.22% |
| 358 | Refrigeration and Service Machinery | $1,928 | 0.29% | $1,812 | 0.27% |
| 359 | Industrial Machinery, n.e.c. | $1,928 | 0.59% | $1,812 | 0.56% |

TABLE 28. (CONTINUED)

| SIC Code | Industry Name | Existing Degreasers | | New Degreasers | |
|---|---|---|---|---|---|
| | | Annualized Control Cost | Percent Cost Absorption[a] | Annualized Control Cost | Percent Cost Absorption[a] |
| 361 | Electric Distribution Equipment | $1,928 | 0.26% | $1,812 | 0.24% |
| 362 | Electrical Industrial Apparatus | $1,928 | 0.35% | $1,812 | 0.33% |
| 364 | Electric Lighting and Wiring Equipment | $1,928 | 0.30% | $1,812 | 0.28% |
| 366 | Communications Equipment | $1,928 | 0.31% | $1,812 | 0.29% |
| 367 | Electronic Components and Accessories | $1,928 | 0.43% | $1,812 | 0.40% |
| 369 | Misc. Electrical Equipment and Supplies | $1,928 | 0.37% | $1,812 | 0.35% |
| 371 | Motor Vehicles and Equipment | $1,928 | 0.25% | $1,812 | 0.24% |
| 372 | Aircraft and Parts | $1,928 | 0.33% | $1,812 | 0.31% |
| 376 | Guided Missiles, Space Vehicles, Parts | $1,928 | 0.02% | $1,812 | 0.00% |
| 379 | Misc. Transportation Equipment | $1,928 | 0.35% | $1,812 | 0.33% |
| 381 | Search and Navigation Equipment | $1,928 | 0.38% | $1,812 | 0.36% |
| 382 | Measuring and Controlling Devices | $1,928 | 0.34% | $1,812 | 0.32% |
| 39 | Misc. Manufacturing Industries | $1,928 | 0.46% | $1,812 | 0.44% |

[a]Annualized control costs as a percent of average per-facility revenue.

TABLE 29. IMPACT OF CONTROL COSTS ON EARNINGS

| SIC Code | Industry Name | Annualized Control Costs as a Percent of Before-Tax Net Income | |
|---|---|---|---|
| | | Existing Cleaners | New Cleaners |
| 254 | Partitions and Fixtures | 34.63% | 32.55% |
| 259 | Misc. Furniture and Fixtures | 45.38% | 42.65% |
| 332 | Iron and Steel Foundries | 15.64% | 14.70% |
| 335 | Nonferrous Rolling and Drawing | 5.46% | 5.13% |
| 336 | Nonferrous Foundries (castings) | 13.60% | 12.78% |
| 339 | Misc. Primary Metal Products | 11.14% | 10.47% |
| 342 | Cutlery, Handtools, and Hardware | 8.72% | 8.20% |
| 343 | Plumbing and Heating, Except Electric | 7.47% | 7.02% |
| 344 | Fabricated Structural Metal Products | 6.85% | 6.43% |
| 345 | Screw Machine Products, Bolts, Etc. | 8.55% | 8.03% |
| 346 | Metal Forgings and Stampings | 7.84% | 7.37% |
| 347 | Metal Services, n.e.c. | 11.96% | 11.24% |
| 348 | Ordnance and Accessories, n.e.c. | 13.58% | 12.76% |
| 349 | Misc. Fabricated Metal Products | 8.61% | 8.10% |
| 351 | Engines and Turbines | 6.99% | 6.57% |
| 352 | Farm and Garden Machinery | 8.55% | 8.03% |
| 353 | Construction and Related Machinery | 6.80% | 6.40% |
| 354 | Metalworking Machinery | 10.78% | 10.13% |
| 355 | Special Industry Machinery | 8.81% | 8.28% |
| 356 | General Industrial Machinery | 7.09% | 6.66% |
| 357 | Computer and Office Equipment | 6.45% | 6.06% |
| 358 | Refrigeration and Service Machinery | 7.72% | 7.25% |
| 359 | Industrial Machinery, n.e.c. | 16.01% | 15.04% |
| 361 | Electric Distribution Equipment | 10.50% | 9.87% |
| 362 | Electrical Industrial Apparatus | 14.12% | 13.27% |
| 364 | Electric Lighting and Wiring Equipment | 12.06% | 11.33% |
| 366 | Communications Equipment | 12.54% | 11.78% |
| 367 | Electronic Components and Accessories | 17.37% | 16.33% |
| 369 | Misc. Electrical Equipment and Supplies | 14.88% | 13.98% |

TABLE 29. (CONTINUED)

| SIC Code | Industry Name | Annualized Control Costs as a Percent of Before-Tax Net Income | |
|---|---|---|---|
| | | Existing Cleaners | New Cleaners |
| 371 | Motor Vehicles and Equipment | 11.49% | 10.80% |
| 372 | Aircraft and Parts | 14.89% | 14.00% |
| 376 | Guided Missiles, Space Vehicles, Parts | 0.24% | 0.22% |
| 379 | Misc. Transportation Equipment | 16.06% | 15.09% |
| 381 | Search and Navigation Equipment | 12.24% | 11.50% |
| 382 | Measuring and Controlling Devices | 11.12% | 10.45% |
| 39 | Misc. Manufacturing Industries | 12.96% | 12.18% |

this NESHAP, they are likely to occur within these two industries.

3.5.3 Substitution Opportunities In this section, the likelihood of substituting alternative solvents and/or processes, rather than retrofitting existing ones, will be assessed. Substitution away from halogenated solvents is not mandated by the Clean Air Act, nor is it a regulatory option. Facilities can comply by simply retrofitting their machines with emission control devices. However, the trend of substituting away from organic solvent use is well established. Costs associated with the degreasing NESHAP, although modest, are certain to provide further incentive for the development of alternative cleaning methods.

The primary approaches to solvent substitution are the reformulation of halogenated solvents and the substitution of non-halogenated solvents. In terms of reformulation, most of the applications have been to cold cleaners. In terms of OTVCs, alternatives have generally been in the form of non-halogenated solvents -- primarily aqueous.

Aqueous systems have already made significant inroads into cleaning operations in recent years. In a 1976 survey, Dow Chemical Corp. found that 56 percent of metalworking establishments with twenty or more employees use an alkaline wash system.[44] By 1987, another study indicated that aqueous systems were being used in 89 percent of 116 four-digit SIC industries that have metal cleaning operations.[45] Catalogues from each of ten equipment manufacturers received offer off-the-shelf and customized aqueous systems.

Environmental regulations at the local, state and federal level have been the primary impetus behind the advent of aqueous systems, and is appropriate to assume that the degreasing NESHAP will foster continued growth in the market for aqueous-based cleaners.

An important factor in choosing a solvent and/or process is costs. For a given level and quality of output, firms will tend to choose the lowest cost combination of inputs. Table 30 presents baseline cleaning costs as a percent of total costs of production, the increase in cleaning costs over baseline cleaning costs, and the increase in cleaning costs as a percentage of total costs of production for small model degreasers. In all cases, baseline cleaning costs as a percent of production costs is below ten percent. Since degreasing costs occupy a fairly small share of total production costs (for small model facilities), the incentive for substitution is not likely to be great. As shown, the percentage change in cleaning costs is identical across SIC codes, as the same model degreaser and control costs are used for each SIC code. The increase in cleaning costs as a percentage of production costs varies with each model facility's level of operating costs. The percentage change in cleaning costs is 6.4 percent for existing degreasers, and 6.0 percent for new degreasers. The increase in production costs is no higher than .61 percent (SIC 359). Thus, based on cost alone, the increase in costs resulting from the degreasing NESHAP do not appear to provide significant stimulus for substitution. Nevertheless, since substitution has already occurred in those industries which perform degreasing, further examination is warranted.

In degreasing, technical considerations, such as degree of cleanliness, material compatibility, and space restrictions, are paramount in choosing a cleaning system. Costs factor in only after technical requirements are met. If parts cannot be cleaned adequately by a chosen system, its dollar cost is irrelevant.

With the use of aqueous systems comes the need for process changes. Aqueous solvents cannot be used with

TABLE 30. IMPACT OF CONTROL COSTS ON TOTAL COSTS OF PRODUCTION

| SIC Code | Industry Name | Baseline Cleaning Costs as a Percent of Operating Costs | Control Costs as a Percent of Baseline Cleaning Costs | | Control as a Percent of Total Costs of Production | |
|---|---|---|---|---|---|---|
| | | | Existing Cleaners | New Cleaners | Existing Cleaners | New Cleaners |
| 254 | Partitions and Fixtures | 6.2% | 6.4% | 6.0% | 0.39% | 0.37% |
| 259 | Misc. Furniture and Fixtures | 8.1% | 6.4% | 6.0% | 0.52% | 0.49% |
| 332 | Iron and Steel Foundries | 6.0% | 6.4% | 6.0% | 0.38% | 0.36% |
| 335 | Nonferrous Rolling and Drawing | 2.1% | 6.4% | 6.0% | 0.13% | 0.13% |
| 336 | Nonferrous Foundries (castings) | 5.2% | 6.4% | 6.0% | 0.33% | 0.31% |
| 339 | Misc. Primary Metal Products | 4.3% | 6.4% | 6.0% | 0.27% | 0.26% |
| 342 | Cutlery, Handtools, and Hardware | 5.5% | 6.4% | 6.0% | 0.35% | 0.33% |
| 343 | Plumbing and heating, Except Electric | 4.7% | 6.4% | 6.0% | 0.30% | 0.28% |
| 344 | Fabricated Structural Metal Products | 4.3% | 6.4% | 6.0% | 0.27% | 0.26% |
| 345 | Screw Machine Products, Bolts, Etc. | 5.4% | 6.4% | 6.0% | 0.34% | 0.32% |
| 346 | Metal Forgings and Stampings | 4.9% | 6.4% | 6.0% | 0.31% | 0.29% |
| 347 | Metal Services, n.e.c. | 7.5% | 6.4% | 6.0% | 0.48% | 0.45% |
| 348 | Ordnance and Accessories, n.e.c. | 8.6% | 6.4% | 6.05 | 0.54% | 0.51% |
| 349 | Misc. Fabricated Metal Products | 5.4% | 6.4% | 6.0% | 0.34% | 0.32% |
| 351 | Engines and Turbines | 4.2% | 6.4% | 6.0% | 0.27% | 0.25% |
| 352 | Farm and Garden Machinery | 5.2% | 6.4% | 6.0% | 0.33% | 0.31% |
| 353 | Construction and Related Machinery | 4.1% | 6.4% | 6.0% | 0.26% | 0.25% |
| 354 | Metalworking Machinery | 6.5% | 6.4% | 6.0% | 0.41% | 0.39% |
| 355 | Special Industry Machinery | 5.3% | 6.4% | 6.0% | 0.34% | 0.32% |
| 356 | General Industrial Machinery | 4.3% | 6.4% | 6.0% | 0.27% | 0.26% |
| 357 | Computer and Office Equipment | 3.9% | 6.4% | 6.0% | 0.25% | 0.23% |
| 358 | Refrigeration and Service Machinery | 4.7% | 6.4% | 6.0% | 0.30% | 0.28% |
| 359 | Industrial Machinery, n.e.c. | 9.7% | 6.4% | 6.0% | 0.61% | 0.58% |

TABLE 30. (CONTINUED)

| SIC Code | Industry Name | Baseline Cleaning Costs as a Percent of Operating Costs | Control Costs as a Percent of Baseline Cleaning Costs | | Control as a Percent of Total Costs of Production | |
|---|---|---|---|---|---|---|
| | | | Existing Cleaners | New Cleaners | Existing Cleaners | New Cleaners |
| 361 | Electric Distribution Equipment | 4.2% | 6.4% | 6.0% | 0.27% | 0.25% |
| 362 | Electrical Industrial Apparatus | 5.6% | 6.4% | 6.0% | 0.36% | 0.34% |
| 364 | Electric Lighting and Wiring Equipment | 4.8% | 6.4% | 6.0% | 0.31% | 0.29% |
| 366 | Communications Equipment | 5.0% | 6.4% | 6.0% | 0.32% | 0.30% |
| 367 | Electronic Components and Accessories | 6.9% | 6.4% | 6.0% | 0.44% | 0.41% |
| 369 | Misc. Electrical Equipment and Supplies | 5.9% | 6.4% | 6.0% | 0.38% | 0.35% |
| 371 | Motor Vehicles and Equipment | 4.1% | 6.4% | 6.0% | 0.26% | 0.24% |
| 372 | Aircraft and Parts | 5.3% | 6.4% | 6.0% | 0.33% | 0.31% |
| 376 | Guided Missiles, Space Vehicles, Parts | 0.1% | 6.4% | 6.0% | 0.02% | 0.01% |
| 379 | Misc. Transportation Equipment | 5.7% | 6.4% | 6.0% | 0.36% | 0.34% |
| 382 | Search and Navigation Equipment | 6.2% | 6.4% | 6.0% | 0.39% | 0.37% |
| 382 | Measuring and Controlling Devices | 5.6% | 6.4% | 6.0% | 0.36% | 0.33% |
| 39 | Misc. Manufacturing Industries | 7.6% | 6.4% | 6.0% | 0.48% | 0.45% |

existing organic solvent cleaners. A completely new cleaning system is required. For those firms that have not already switched to aqueous systems, the transition will be encumbered by technical and cost considerations, which are outlined below.

- **Rust** - For cleaning steel parts, aqueous systems are subject to rust, which does not occur when organic solvents are used.
- **Tarnish** - Brass, bronze and copper parts can in some cases tarnish when cleaned with aqueous systems. Again, this is not a problem with organic solvent cleaning.
- **Military Specifications** - In some cases, aqueous compounds leave residues which don't conform to military specifications.
- **Space** - Aqueous cleaning systems require a three to four stage cleaning setup. These stages include cleaning, rinsing, and in some cases a rust preventative and/or drying stage. These multi-stage cleaning systems require substantially more floor space than traditional organic-solvent based systems.
- **Energy requirements** - Organic solvents have specific heats which can be as little as twenty percent of that of water. Thus, aqueous systems usually require much higher energy inputs for heating than do organic-solvent based systems.
- **Research and Development** - In many cases, the use of aqueous systems requires a significant amount of research and development to assure that technical requirements are being met.

These are not the only determining factors in the choice of cleaning systems. They are, however, some of the most important considerations when choosing to move away from halogenated solvent use.

Due to the impediments stemming from technical and cost considerations, substitution away from organic solvent cleaning will difficult. Those most likely to do so are larger firms with the ability to shoulder the required short-run cost increases, and which don't exhibit the space limitations that small facilities tend to have.

3.5.4 Capital Availability. Sections 3.5.1, 3.5.2, and 3.5.3 have expressed, respectively, that impacts on revenue and earnings will for the most part be small, and that there will be minimal substitution into aqueous alternatives. While costs as a percentage of revenue seem moderate, it still might be necessary to finance the capital costs associated with the installation of control equipment. Thus, it is necessary to evaluate the availability of capital. Financial profiles of small model facilities have been compiled to facilitate capital availability impacts. These profiles, which include before-tax profit margins, before-tax net income, total assets, and total liabilities, are presented in Table 31.

Capital availability impacts are captured in Table 9-32. Capital costs for small model degreasers total $11,219, and are the same for both existing and new cleaners. Shown in Table 32 are the ratio of capital costs to before-tax net income (BTNI), and the ratio of capital costs to total assets. Before-tax net income is used as a proxy for cash flow before taxes, which can be used to service debt. The ratio of capital costs to BTNI gives an indication of the extent to which capital costs can be financed from one year's cash flow. Of course, capital costs do not have to be paid from cash flow, but the ability to do so in one year suggests that either external financing is not needed, or will not be difficult to obtain. If the

TABLE 31. FINANCIAL PROFILES OF SMALL MODEL FACILITIES

| SIC Code | Industry Name | Profit Margin[a] | Per-Facility Before-Tax Net Income | Per-Facility Total Assets | Per-Facility Total Liabilities |
|---|---|---|---|---|---|
| 254 | Partitions and Fixtures | 1.13% | $5,567 | $262,776 | $167,914 |
| 259 | Misc. Furniture and Fixtures | 1.13% | $4,249 | $200,551 | $128,152 |
| 332 | Iron and Steel Foundries | 2.39% | $12,325 | $240,302 | $134,533 |
| 335 | Nonferrous Rolling and Drawing | 2.39% | $35,315 | $688,568 | $385,494 |
| 336 | Nonferrous Foundries (castings) | 2.39% | $14,179 | $276,468 | $154,780 |
| 339 | Misc. Primary Metal Products | 2.39% | $17,300 | $337,309 | $188,842 |
| 342 | Cutlery, Handtools, and Hardware | 3.85% | $22,108 | $290,269 | $151,744 |
| 343 | Plumbing and Heating, Except Electric | 3.85% | $25,795 | $338,682 | $177,053 |
| 344 | Fabricated Structural Metal Products | 3.85% | $28,161 | $369,749 | $193,294 |
| 345 | Screw Machine Products, Bolts, Etc. | 3.85% | $22,562 | $296,231 | $154,861 |
| 346 | Metal Forgings and Stampings | 3.85% | $24,597 | $322,958 | $168,833 |
| 347 | Metal Services, n.e.c. | 3.85% | $16,127 | $211,743 | $110,693 |
| 348 | Ordnance and Accessories, n.e.c. | 3.85% | $14,198 | $186,415 | $97,453 |
| 349 | Misc. Fabricated Metal Products | 3.85% | $22,380 | $293,846 | $153,614 |
| 351 | Engines and Turbines | 3.70% | $27,571 | $428,807 | $231,880 |
| 352 | Farm and Garden Machinery | 3.70% | $22,559 | $350,868 | $189,734 |
| 353 | Construction and Related Machinery | 3.70% | $28,333 | $440,663 | $238,291 |
| 354 | Metalworking Machinery | 3.70% | $17,881 | $278,107 | $150,388 |
| 355 | Special Industry Machinery | 3.70% | $21,891 | $340,470 | $184,111 |
| 356 | General Industrial Machinery | 3.70% | $27,204 | $423,107 | $228,798 |
| 357 | Computer and Office Equipment | 3.70% | $29,908 | $465,166 | $251,542 |
| 358 | Refrigeration and Service Machinery | 3.70% | $24,977 | $388,472 | $210,069 |
| 359 | Industrial Machinery, n.e.c. | 3.70% | $12,045 | $187,341 | $101,306 |
| 361 | Electric Distribution Equipment | 2.48% | $18,359 | $400,428 | $219,161 |
| 362 | Electrical Industrial Apparatus | 2.48% | $13,654 | $297,820 | $163,001 |
| 364 | Electric Lighting and Wiring Equipment | 2.48% | $15,990 | $348,752 | $190,877 |
| 366 | Communications Equipment | 2.48% | $15,376 | $335,372 | $183,554 |
| 367 | Electronic Components and Accessories | 2.48% | $11,098 | $242,064 | $132,485 |
| 369 | Misc. Electrical Equipment and Supplies | 2.48% | $12,960 | $282,665 | $154,707 |

TABLE 31. (CONTINUED)

| SIC Code | Industry Name | Profit Margin[a] | Per-Facility Before-Tax Net Income | Per-Facility Total Assets | Per-Facility Total Liabilities |
|---|---|---|---|---|---|
| 371 | Motor Vehicles and Equipment | 2.20% | $16,784 | $394,077 | $243,514 |
| 372 | Aircraft and Parts | 2.20% | $12,946 | $303,968 | $187,832 |
| 376 | Guided Missiles, Space Vehicles, Parts | 2.20% | $811,185 | $19,045,848 | $11,769,064 |
| 379 | Misc. Transportation Equipment | 2.20% | $12,009 | $281,952 | $174,227 |
| 381 | Search and Navigation Equipment | 3.10% | $15,756 | $298,971 | $128,775 |
| 382 | Measuring and Controlling Devices | 3.10% | $17,342 | $329,071 | $141,740 |
| 39 | Misc. Manufacturing Industries | 3.59% | $14,879 | $187,378 | $96,197 |

[a]As a percent of average per-facility revenue.

Sources: U.S. Department of Commerce, Bureau of the Census. 1987 Census of Manufactures, Quarterly Financial Report, For Manufacturing, Mining, and Trade Corporations, Second Quarter, 1992; RMA Annual Statement Studies, 1992.

TABLE 32. PER-FACILITY CAPITAL COSTS AS A PERCENT OF NET INCOME AND TOTAL ASSETS

| SIC Code | Industry Name | Capital Costs as a Percent of Net Income | Capital Costs as a Percent of Total Assets |
|---|---|---|---|
| 254 | Partitions and Fixtures | 201.5% | 4.3% |
| 259 | Misc. Furniture and Fixtures | 264.1% | 5.6% |
| 332 | Iron and Steel Foundries | 91.0% | 4.7% |
| 335 | Nonferrous Rolling and Drawing | 31.8% | 1.6% |
| 336 | Nonferrous Foundries (castings) | 79.1% | 4.1% |
| 339 | Misc. Primary Metal Products | 64.9% | 3.3% |
| 342 | Cutlery, Handtools, and Hardware | 50.7% | 3.9% |
| 343 | Plumbing and Heating, Except Electric | 43.5% | 3.3% |
| 344 | Fabricated Structural Metal Products | 39.8% | 3.0% |
| 345 | Screw Machine Products, Bolts, Etc. | 49.7% | 3.8% |
| 346 | Metal Forgings and Stampings | 45.6% | 3.5% |
| 347 | Metal Services, n.e.c. | 69.6% | 5.3% |
| 348 | Ordnance and Accessories, n.e.c. | 79.0% | 6.0% |
| 349 | Misc. Fabricated Metal Products | 50.1% | 3.8% |
| 351 | Engines and Turbines | 40.7% | 2.6% |
| 352 | Farm and Garden Machinery | 49.7% | 3.2% |
| 353 | Construction and Related Machinery | 39.6% | 2.5% |
| 354 | Metalworking Machinery | 62.7% | 4.0% |
| 355 | Special Industry Machinery | 51.2% | 3.3% |
| 356 | General Industrial Machinery | 41.2% | 2.7% |
| 357 | Computer and Office Equipment | 37.5% | 2.4% |
| 358 | Refrigeration and Service Machinery | 44.9% | 2.9% |
| 359 | Industrial Machinery, n.e.c. | 93.1% | 6.0% |
| 361 | Electric Distribution Equipment | 61.1% | 2.8% |
| 362 | Electrical Industrial Apparatus | 82.2% | 3.8% |
| 364 | Electric Lighting and Wiring Equipment | 70.2% | 3.2% |
| 366 | Communications Equipment | 73.0% | 3.3% |
| 367 | Electronic Components and Accessories | 101.1% | 4.6% |
| 369 | Misc. Electrical Equipment and Supplies | 86.6% | 4.0% |

TABLE 32. (CONTINUED)

| SIC Code | Industry Name | Capital Costs as a Percent of Net Income | Capital Costs as a Percent of Total Assets |
|---|---|---|---|
| 371 | Motor Vehicles and Equipment | 66.8% | 2.8% |
| 372 | Aircraft and Parts | 86.7% | 3.7% |
| 376 | Guided Missiles, Space Vehicles, Parts | 1.4% | 0.1% |
| 379 | Misc. Transportation Equipment | 93.4% | 4.0% |
| 381 | Search and Navigation Equipment | 71.2% | 3.8% |
| 382 | Measuring and Controlling Devices | 64.7% | 3.4% |
| 39 | Misc. Manufacturing Industries | 75.4% | 6.0% |

ratio exceeds 100 percent, it is possible that debt will have to be issued. Ratios in excess of 100 percent do not, however, necessarily indicate that capital costs are unwieldy. For example, a ratio of 500 percent simply signifies that it would take five years of cash flow to finance the capital costs. A ratio of 100 percent is used as a conservative threshold of the potential need for external financing.

The ratio of capital costs to total assets is also the ratio of the change in liabilities (i.e. the additional liability of purchasing pollution control equipment) to total assets. In this case, the total asset base is assumed to be constant. Implied by a constant asset base is that the purchase of pollution control equipment is a non-productive investment. Since the installation of control equipment can in some cases lead to net savings as emissions are reduced, control equipment does in some cases add to the firms productive capacity. However, only those situations in which annualized control costs are positive will be examined here.

The ratio of capital costs to total assets gauge the impact on a facility's capital structure. If the ratio of capital costs to total assets is greater than 10 percent, it may be difficult to obtain financing for at least some facilities. Clearly, there will be some highly leveraged firms which will be limited to expanding liabilities by this much, and others which can take on even greater amounts of debt. However, 10 percent is assumed here to be an appropriate average where some facilities have difficulty obtaining external financing.

As shown, facilities in SICs 254, 259, and 367 have ratios of capital costs to BTNI in excess of 100 percent. For each of these facilities, the ratio of capital costs to total assets is less than 10 percent (in fact, it is less than six percent). Thus, it is concluded here that the

average small facility will not be inhibited from obtaining the external financing necessary to cover capital costs.

3.5.5 Impacts on Manufacturers of Degreasing Equipment. In contrast to the negligible impact the degreasing NESHAP will have on degreasing user industries, the impacts on degreasing equipment be more significant. In all likelihood, degreasing equipment manufacturers will experience increases in demand for their products as a result of the NESHAP.

Demand for degreasing equipment will come in three areas. First, demand for organic solvent cleaners, (i.e. OTVCs and in-line cleaners) will remain as users replace old machinery and as firms enter user industries. These cleaners will differ from many cleaners currently in use in that they are already equipped with emissions control devices. While this replacement demand is probably no larger than the demand that would exist in the absence of the regulation, the machines have more value-added than older machines. The second market niche for equipment manufacturers is in the need for add-on control equipment. Firms with existing equipment not in compliance will have to retrofit. The third area of growth for equipment manufacturers is in alternative systems -- primarily aqueous. Alternative systems can be thought of as replacement demand as well. However, the replacement of an organic-solvent system with an aqueous system signifies a movement from a one-stage system to a three to four stage system. The senior engineer at Precision tubes estimated that replacing their forty-five square foot organic solvent cleaner with an aqueous system would cost approximately one million dollars. For these reasons, demand for degreasing equipment is apt to grow at rates faster than the demand for degreasing users products.

Control equipment manufacturers may actually be hard pressed to meet the increased demand for control equipment.

In a telephone survey conducted by JACA Corp. in 1987, two major suppliers of degreasing equipment who also manufacture control equipment were both found to be operating at more than 80 percent of control equipment capacity. One of the respondents said they could accommodate a "gradual switch" to controlling degreasing equipment. If current capacity is not sufficient to meet a sudden increased demand for control equipment, additional capacity will have to be added, which could take one or two years.[45]

3.5.6 Impacts on Solvent Manufacturers. While the net effect of the degreasing NESHAP on equipment manufacturers will be positive, the impact on solvent manufacturers is less clear.

It is apparent at the outset that the demand for organic solvents should decrease, all else equal, since emissions will be reduced. However, all else is not equal.

It first must be noted that demand for the regulated solvents is only in part derived from degreasing end-users' products. For TCE, TCA, MC, and PCE, degreasing end-uses account for 90 percent, 52 percent, 15 percent, and 13 percent of total solvent consumption, respectively. Thus, if demand for each of these solvents were reduced by the same percentage, TCE would be the most adversely affected. Several factors temper such a conclusion.

1,1,1, trichloroethane (TCA) is being phased out under the Montreal Protocol, and will not be available for use in degreasers. Thus, it can be said that the degreasing NESHAP will have no impact on the TCA market, as it will not be available in the baseline.

Trichloroethylene (TCE), due to its reliance on degreasing end-uses, will indeed experience reduced demand by users already consuming TCE. Already, TCE has been experiencing declining growth of about two percent annually in vapor degreasing. However, due to its chemical

similarity to TCA (e.g. similar specific gravities, similar boiling points), TCE is the most likely halogenated solvent candidate to replace TCA in existing degreasers. In addition, TCE is being used as a feedstock for CFC alternatives, which could also boost TCE growth. Also, increased demand for TCE could lead to upward price pressure. Thus, TCE can be expected to experience renewed growth by the mid-1990s.

The extent of this growth will be determined largely by the substitution choices made by the user industries. A portion will surely move away from halogenated solvent use altogether and into aqueous systems. In a survey conducted by the Alliance of Metal Working Industries, the National Screw Machine Products Association reported that their members were already moving towards aqueous use in favor of halogenated solvents. Of those firms with less than $5 million in annual sales, eighty-four percent had indicated they were investigating alternatives to halogenated solvents (sixty percent were looking to aqueous systems). For firms earning over $5 million in annual sales, eighty-three percent were looking at alternatives (seventy-seven percent aqueous).[47]

As with the other regulated solvents, methylene chloride will exhibit diminished growth stemming from reduced emissions. Unlike TCE, MC is not seen as an effective substitute for TCA. However, discussions with Precision Tube Inc. indicate that they plan to replace their Freon based cleaner with MC. Thus, there could be some substitution into the MC market as a result of the Montreal protocol. Nonetheless, in most end-uses, MC demand is shrinking. The degreasing NESHAP is likely to accelerate this trend to some extent.

Perchloroethylene (PCE) is the least dependent of the regulated solvents on degreasing end-uses. Again,

degreasing end-uses will be reduced as a result of emissions reduction. However, unlike MC, PCE does have end-uses that should exhibit growth by mid-decade, most notably as a feedstock for CFC replacement. Reduced demand for degreasing consumption could be offset by increased demand for CFC feedstock consumption. In addition, PCE holds more than 75 percent of the market for solvent use in dry cleaning. Therefore, on the whole PCE demand is likely to remain relatively strong.

3.5.7 Small Business Impacts. The RFA (Public Law (96-354, September 19, 1980) requires Federal agencies to give special consideration to the impact of regulation on small businesses. The RFA specifies that a regulatory flexibility analysis must be prepared if a proposed regulation will have (1) a significant economic impact on (2) a substantial number of small entities. Regulatory impacts are considered significant if:

- Annual compliance costs increase total costs of production by more than 5 percent
- Annual compliance costs as a percent of sales are at least 10 percent (percentage points) higher for small entities
- Capital cost of compliance represent a significant portion of capital available to small entities
- The requirements of the regulation are likely to result in closures of small entities

A "substantial number" of small entities is generally considered to be more than 20 percent of the small entities in the affected industry. Since this analysis deals only with small entities, conclusions can be drawn from the above sections. Each of the criteria for significant impacts will be considered in turn.

Table 30 in section 3.5.3 presented control costs as a percent of total costs of production for impacted facilities in the relevant SICs. Recall that the largest cost increase

was 0.61 percent for SIC 359. This figure is well below the significant-impact threshold of five percent.

Assessing the differential impacts, measured by a comparison of compliance costs as a percent of sales for small and large entities, is more problematical as large model facilities were not modelled in this analysis. Treatment of this small business impacts criterion involves creating two large model facilities and employing the data from Precision Tubes Inc. to serve as a third, "actual" case.

If it is assumed that large facilities use large degreasers, than compliance costs for large facilities are actually savings, as estimated by RADIAN Corp. To be conservative, it is assumed here that large model facilities possess five very large degreasers, so that a "maximum savings" case is modelled. This case is important as it models the maximum cost differential between large and small entities. The selection of five degreasers as a conservative number is based on the 1976 Dow Chemical study referenced earlier, which found that the average number of open-top and conveyorized degreasers in facilities with 500 or more employees was 3.76.

Large model facilities were created for SICs 359 and 254. SIC 359 was chosen because the small model facilities in this group experience the highest cost absorption impact when compared with other small model facilities. In SIC 254, firms with greater than 100 employees had the smallest average per-facility revenue when compared with firms of greater than 100 employees in other SICs. Thus, if firms in SIC 254 incur the same dollar- value of savings as other large firms in other SICs, their savings as a percent of avergae per-facility revenue will be the higher than the

TABLE 33. COMPARISON OF COST ABSORPTION[a] FOR SMALL AND LARGE MODEL FACILITIES

| SIC Code | Industry Name | Large Model Facility/ Average Per Facility Revenue | Small Model Facility: Percent Cost Absorption | Large Model Facility: Percent Cost Absorption | Cost Absorption Percentage Point Differential |
|---|---|---|---|---|---|
| 254 | Partitions and Fixtures | $18,495,976 | 0.26% | (0.29%) | 0.55 |
| 335 | Nonferrous Rolling and Drawing | $18,000,000[b] | 0.09% | (0.06%) | 0.15 |
| 359 | Industrial Machinery, N.E.L. | $27,513,017 | 0.39% | (0.20%) | 0.59 |

[a]Compliance costs as a percent of average per-facility revenue.

[b]Actual Precision Tubes Inc. revenue.

other large firms. Finally, the actual case of Precision Tubes Inc. is used. Precision tubes reports to SIC 335.

Table 33 displays the comparison of cost absorption for small and large model facilities. Presented are the average per-facility revenues, the percent cost absorption (negative for the large facilities as they incur savings), and thepercentage point differential of cost absorption between small and large facilities. As shown, the cost differentials are in no case larger than one percentage point, much less ten percentage points. Thus, by this criterion, small business impacts are not deemed significant.

The third criterion alludes to the amount of capital available to small businesses. This analysis does not calculate the amount of capital available to impacted facilities. It does, however, calculate the ability of facilities to obtain capital if needed in section 3.5.4. It was concluded that the assets of small facilities will not be so adversely affected as to prohibit the procurement of outside financing. It is assumed, then, that capital availability will not be an obstacle for small entities in complying with the regulation.

Criteria number four stipulates that small business impacts are significant if compliance leads to closure. The only implication of closure in this analysis is found in section 3.5.2 concerning earnings impacts. Here it was found that, under worst-case assumptions, closures might occur in SICs 254 and 259, given their low rate of profitability in the baseline. If this indeed occurs, the question of whether or not these closures make up a substantial portion of small facilities must be addressed.

The total number of facilities in each of the 39 potentially impacted SICs is known, but the number of firms which have uncontrolled degreasers in each SIC is not known. One way to estimate the percentage of impacted small

facilities is to assume that all SICs are affected in the same proportion (i.e. equal proportions of the facilities in each SIC will be impacted by the NESHAP.) Given this assumption, a proxy for the share of impacted small facilities in SICs 254 and 259 is the total number of small facilities in these SICs as a share of the total number of small facilities in all 39 SICs. SICs 254 and 259 hold a combined 3,194 small facilities. All 39 SICs hold a total of 93,121 small facilities. Thus, SICs 254 and 359 make up 3.4 percent of the total number of small facilities. Therefore, in the extreme case that some closures result, the number of closures is estimated to be far less than the amount required for substantial number of impacted firms (recall that a substantial number is 20 percent.)

In conclusion, it seems highly unlikely that the impact of the degreasing NESHAP will be significant for a substantial number of small entities.

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## Appendix A: Aggregate Changes In the Industries Using Degreasing Equipment

In 1987, the SIC classification system was reorganized, and eleven of the 3-digit industries using degreasing equipment changed in aggregate terms. The eleven industries were SICs 354, 355, 356, 357, 359, 362, 364, 366, 369, 381, and 382.

The changes were as follows. What was formerly SIC 3623, Welding Apparatus, Electric, was added to SIC 354, Metalworking Machinery. SIC 355, Special Industry Machinery, now includes two 4-digit industries formerly identified as SICs 3549, Metalworking Machinery, Not Elsewhere Classified, and 3636, Sewing Machines. SIC 356, General Industrial Machinery, now includes the former SIC 3551, Food Products Machinery. Computer and Office Equipment, SIC 357, added the former SIC 3661, Telephone and Telegraph Apparatus, and SIC 3662, Radio and Television Communication Equipment. The former SIC 3561, Pumps and Pumping Equipment, and SIC 3563, Air and Gas Compressors, are now part of SIC 359, Industrial Machinery, Not Elsewhere Classified. Electrical Industrial Apparatus, SIC 362, picked up the former SIC 3613, Switchgear and Switchboard Apparatus. SIC 364, Electric Lighting and Wiring Equipment, acquired the old 3699, Electrical Equipment and Supplies. The former 3573, Electronic Computing Equipment, was added to SIC 366, Communications Equipment. SIC 369, Miscellaneous Electrical Equipment and Supplies, added four old 4-digit industries including 3573, Electronic Computing Equipment, 3679, Electronic Components, Not Elsewhere Classified, 3549, Metalworking Machinery, Not Elsewhere Classified, and 3662, Radio and Television Communication Equipment. SIC 3662 was also added to SICs 381 and 382. SIC 382 also includes the former 3811, Engineering and Scientific Instruments, and 3832, Optical Instruments an Lenses.

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16. ABSTRACT

Under authority of the 1990 Clean Air Act Amendments, a National Emission Standard of Hazardous Air Pollutants (NESHAP) is being proposed to control methylene chloride, perchloroethylene, Trichloroethylene, trichloroethane, and CFC-113 emissions from facilities with halogenated solvent cleaners. Thirty-eight (38) 3-digit and one (1) 2-digit SIC industries were evaluated. This report analyzes economic and financial impacts at the selected regulatory alternatives for facilities with positive costs as a result of complying with the proposed standard.

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