



National Emission Standards for Hazardous Air Pollutants (NESHAP) for Source Category: Surface Coating of Metal Cans

Background Information for Proposed Standards

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**National Emission Standards for
Hazardous Air Pollutants (NESHAP)
for Source Category:
Surface Coating of Metal Cans**

**U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Standards Division
Research Triangle Park, North Carolina**

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LIST OF ABBREVIATIONS, ACRONYMS, AND UNITS OF MEASURE

ACT	alternative control techniques
APCD	air pollution control device
AQMD	Air Quality Management District
BID	background information document
CO	carbon monoxide
CO ₂	carbon dioxide
CTC	control technology center
CTG	control techniques guidelines
EB	electron beam
EGBE	ethylene glycol butyl ether
EPA	U. S. Environmental Protection Agency
ft ³ /min	cubic feet per minute
gal	gallon(s)
HAP	hazardous air pollutant
ICR	information collection request
L	liter
lbs	pounds
LEL	lower explosive limit
MACT	maximum achievable control technology
MEK	methyl ethyl ketone
Mg	megagram
MRI	Midwest Research Institute
m ³ /min	cubic meters per minute
NESHAP	national emission standards for hazardous air pollutants
NO _x	nitrogen oxides
NSPS	new source performance standards
OAQPS	Office of Air Quality Planning and Standards
OSHA	Occupational Safety and Health Administration
ppm	part(s) per million
RACT	reasonably available control technology
RTO	regenerative thermal oxidizer
SO _x	sulfur oxides
TAC	total annualized cost or total annual cost
THC	total hydrocarbon(s)
TRI	Toxic Chemical Release Inventory
TTN	Technology Transfer Network
UV	ultraviolet
VOC	volatile organic compound
VOHAP	volatile organic hazardous air pollutant

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Chapter 1

Introduction

1.0 OVERVIEW

Section 112 of the Clean Air Act (CAA) requires the U. S. Environmental Protection Agency (EPA) to establish emission standards for all categories of sources of hazardous air pollutants. These national emission standards for hazardous air pollutants (NESHAP) must represent the maximum achievable control technology (MACT) for all major sources. The CAA defines a major source as:

“... any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants.”

In July 1992, the Documentation for Developing the Initial Source Category List was published.¹ “Metal Can Manufacturing (Surface Coating)” was included as a source category. The Metal Can Manufacturing (Surface Coating) Industry NESHAP project establishes air emission standards for major sources in this source category.

The purpose of this document is to summarize the background information gathered during the development of the Metal Can Manufacturing (Surface Coating) Industry NESHAP. The following sections provide additional details on the background of the metal can source category, a summary of existing Federal/State/local regulations, and a brief summary of the project history.

1.1 BACKGROUND

Metal cans are used to store a wide variety of products, including beverages, foods, aerosol products, paints, medicines, and many other products. The metal can industry may be divided by manufacturing process, coating operation, and can contents. The main can manufacturing processes for the metal can industry are three-piece and two-piece can body manufacturing and can end manufacturing. Breakouts of these categories would include the draw-and-iron and two-piece draw/redraw processes. The draw-and-iron process is used to manufacture both one- and two-piece cans.

Decorative tins and metal crowns and closures manufacturing/coating operations are similar to can manufacturing and are sometimes coated on the same lines as traditional cans. Because of the similarities and co-location with can coating, the EPA is including the coating of decorative tins and metal crowns and closures as part of the metal can source category.

Coating operations are performed on both the exterior and interior of a metal can. The exterior coatings in use are base coat, inks, overvarnishes, rim coat, bottom coat, side seam stripe, and repair coatings. The interior coatings in use are sheet-applied protective coatings, inside sprays, side seam stripe, and end seal compound. Further explanation of the can manufacturing process and the coating operations are provided in Chapter 2.

Organic hazardous air pollutants (HAP) are present in many of the inks, coatings, primers and adhesives applied to metal cans during the coating operations. Many of the same HAP are also present in some of the materials used for cleaning associated with surface coating operations. Glycol ethers make up the majority of the HAP used and emitted by the metal can manufacturing industry. Additional details on HAP use associated with various can coating technologies and industry segments are further discussed in Chapter 2.

1.2 SUMMARY OF EXISTING FEDERAL/STATE/LOCAL REGULATIONS

The EPA published a control techniques guidelines document (CTG) for “Control of Volatile Organic Emissions from Existing Stationary Sources--Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks” (EPA-450/2-77-008) in 1977 to provide guidance to states in controlling volatile organic compounds (VOC) emissions from can manufacturing operations.³ The CTG recommended emission limits for all coating operations based on reasonably available control technology (RACT). Table 1-1 summarizes these limits, which are expressed in pounds of VOC emitted per gallon of coating applied, subtracting the volume percent of water in the coating. These limits can be achieved by either using coatings with VOC content equal to or less than the limits or by reducing the level of VOC actually emitted to these levels using add-on controls.

Table 1-1. 1977 Metal Can CTG (RACT) VOC Limits³

Affected operations	VOC limit, kg VOC/L coating - water
Sheet basecoat and overvarnish	0.34
Two-piece can exterior	0.34
Two- and three-piece can interior body spray, two-piece can end	0.51
Three-piece can side seam spray	0.66
End seal compound	0.44

Most State VOC rules are at exactly these levels, at least for nonattainment areas within the State. However, a few local and regional agencies, such as California’s Bay Area and South Coast air quality management districts (AQMDs) have adopted stricter standards.^{4,5} The South Coast AQMD limits also affect manufacturers of pails, 55-gallon drums, and decorative tins, which are regulated as miscellaneous metal parts in some States. Table 1-2 summarizes the Bay Area and South Coast AQMD VOC limits. In addition to limits from coating operations, both the Bay Area and South Coast AQMDs regulate cleaning operations. For example, metal can

Table 1-2. Summary of California AQMD VOC Limits

Affected operations	VOC limit, kg VOC/L coating - water	
	Bay Area AQMD	South Coast AQMD ^a
Sheet basecoat and overvarnish	0.225	0.225
Two-piece can exterior base coat & varnish	0.25	0.25
Two- piece can interior body spray	0.51	0.51
Three-piece can interior body spray	0.51	0.44
Two-piece can exterior end	0.51	--
Three-piece can side seam spray	0.66	0.66
Inks	0.3	0.3
End seal compound: food/beverage cans	0.44	0.44
Nonfood	--	--

^aSouth Coast AQMD also has a list of “exempt” solvents that may be subtracted from the VOC total.

coating operations in the South Coast AQMD are subject to Rule 1171, which limits the vapor pressure of solvents used and the cleaning methods that can be used, requires the use of covered nonporous containers, and prohibits the use of propellants. Rule 1171 also allows facilities to use add-on controls that achieve at least 90 percent capture and 95 percent destruction efficiencies as an alternative to work practices. The Bay Area rule requires the following work practices: (1) closed containers must be used for storage or disposal of cloth or paper used for solvent surface preparation and cleanup; (2) fresh or spent solvent must be stored in closed containers; and (3) the use of organic compounds for the cleanup of spray equipment including paint lines is prohibited unless equipment for collecting the cleaning compounds and minimizing their evaporation to the atmosphere is used.

In addition to VOC regulations, many States have their own list of air toxics (many of which are also designated as HAP under the CAA) and air toxics rules that may apply to metal can coating facilities. These regulations typically regulate a large number of chemical compounds. These air toxics regulations typically specify allowable fenceline concentrations for the individual air toxics. If a facility’s annual emissions of a regulated compound exceed a specified level, the

State may require facility to perform dispersion modeling to determine whether the allowable concentration is exceeded at any point beyond the fenceline. The decision to require modeling depends on several factors, including the toxicity of the pollutant, its status as a VOC or HAP, the National Ambient Air Quality Standards (NAAQS) attainment status of the facility location, and other considerations. If the actual or modeled emissions at the fenceline exceed the allowable concentration, the facility must reduce its air toxic emissions.

In 1983, EPA promulgated a new source performance standard (NSPS) for two-piece beverage can surface coating (40 CFR 60, subpart WW).⁶ The NSPS emission limits are more stringent than the CTG VOC emission limits, and are expressed in terms of mass (kilograms [kg]) of VOC emitted per volume (liter [L]) of coating solids used. As an example, the NSPS limit for two-piece can exterior base coatings is 0.29 kg of VOC per L of coating solids (0.46 kg VOC/L of coating solids for clear base coats), whereas the applicable CTG limit is equivalent to 0.53 kg VOC/L of coating solids. Table 1-3 summarizes the NSPS emission limits. These limits apply to new sources nationwide, regardless of nonattainment status.

Table 1-3. Two-Piece Beverage Can NSPS VOC Emission Limits⁶

Coating operation	VOC emission limit, kg VOC/L coating solids applied
Exterior base coat (except clear base coat)	0.29
Clear base coat and overvarnish	0.46
Inside spray	0.89

1.3 PROJECT HISTORY

1.3.1 Data Gathering

In 1998, an information collection request (ICR)⁷ was developed by EPA to determine HAP usage, controls, and emissions associated with the metal can manufacturing industry. The ICR was sent to 37 U.S. can manufacturing companies in July of 1998. Responses were received from 211 facilities representing 32 companies.

In addition to information obtained from these questionnaires, several site visits were made to metal can manufacturing facilities with surface coating operations. Also, the EPA has met with multiple trade organizations and industry representatives over the past 5 years.

Based on data obtained from the Can Manufacturers Institute (CMI), industry meetings, and TRI data, the total number of can manufacturing facilities in the United States is estimated to be between 210 and 220. However, the ICR responses represent facilities producing more than 98 percent of the total number of cans manufactured/shipped in the United States.

1.3.2 Emissions and Control Data

The available emissions and control information for the metal can manufacturing industry has been summarized in Chapters 2 and 3. Most of the information collected is based on calendar year 1997, and is representative of current practices. In some segments of the industry, coating operations shifted away from HAP to non-HAP VOC and waterborne materials. Control efficiency data are relevant to current conditions for the purpose of MACT determination.

1.4 REFERENCES

1. U. S. Environmental Protection Agency. Documentation for Developing the Initial Source Category List: Final Report. Publication No. EPA-450/3-91-030. Research Triangle Park, NC. July 1992.
2. U. S. Environmental Protection Agency. Preliminary Industry Characterization: Metal Can Manufacturing--Surface Coating. Research Triangle Park, NC. September 1998.
3. U. S. Environmental Protection Agency. OAQPS Guidelines. Control of Volatile Organic Emissions from Existing Stationary Sources - Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks. Publication No. EPA-450/2-77-008. Research Triangle Park, NC. May 1977.
4. Bay Area (California) Air Quality Management District Regulation 8, Organic Compounds, Rule 11 - Metal Container, Closure, and Coil Coating. December 20, 1995.
5. California South Coast Air Quality Management District Rule 1171: Solvent Cleaning Operations. June 13, 1997.

6. U. S. Environmental Protection Agency. New Source Performance Standards for the Beverage Can Surface Coating Industry. 48 FR 38737. Washington, D.C. U. S. Government Printing Office. August 25, 1983.
7. U. S. Environmental Protection Agency. Information Collection Request for the Metal Can Manufacturing Industry. July 22, 1998. [Docket A-98-41, Item II-C-15]

Chapter 2

Metal Can Manufacturing— Surface Coating Source Category

This chapter characterizes the metal can manufacturing industry, including facilities, products, manufacturing and coating processes, sources of HAP emissions, and emission reduction techniques. The information in this chapter comes from readily available sources including the literature, industry representatives, and State and local air pollution control agencies.

2.0 INDUSTRY PROFILE

A can is defined in the dictionary as “a usually cylindrical metal container.” However, government agencies and industry groups use different criteria to determine what is a can, such as shape, capacity, materials used for its construction, the phase of the product contained (solid, liquid, or gas), and the material thickness or gauge.

Metal cans are used to contain a wide variety of products, including beverages, foods, aerosol products, paints, medicines, and many other products. Metal cans and can parts are made from aluminum or steel. Although most cans are cylindrical in shape, cans may be manufactured in other shapes, including rectangular cans such those used to contain gasoline or paint thinner and oblong cans used for packing hams and other meats.

Decorative tins (for example, potato chip and popcorn tins), and metal crowns and closures (for example, metal bottle caps and jar lids) are similar to traditional can ends and are sometimes coated on the same lines as traditional metal cans and ends. Because of these similarities and the

co-location with the coating of traditional cans, the EPA is including the coating of decorative tins and metal crowns and closures as part of the metal can source category.

The Standard Industrial Classification (SIC) code for the manufacturing of metal cans is 3411. However, coating of metal sheets used to make cans may be performed by sheet coating facilities, which are included in SIC code 3479. Metal crowns and closures appear under SIC code 3466.

The coating of some can parts is done on metal coil coating lines. A separate NESHAP is under development for metal coil surface coating, which is examining all metal coil coating, regardless of the product manufactured from the coil. So the metal can NESHAP will not examine the coil coating of can parts. Also, some can parts or labels are not metal. Examples include the paper labels on most food cans and the cardboard bodies of composite cans (for example, frozen concentrate fruit juice cans). These nonmetal materials or products are not included as part of the metal can manufacturing (surface coating) source category, but may be regulated under another source category, such as paper and other web coating, or printing and publishing.

It is estimated that 220 plants in the United States are engaged in one or more can manufacturing processes, as identified by SIC code 3411. Figure 2-1 presents the distribution across the country of the 208 metal can plants identified in the project database. As Figure 2-1 indicates, can manufacturing plants are concentrated in California, Texas, and several States in the East and Midwest. To minimize shipping distance, the distribution of can plants tends to be clustered around agricultural regions or areas of dense human population, depending on the cans' end use.

The operations performed by can manufacturing facilities vary from plant to plant. Many of these plants operate complete can manufacturing processes. However, some plants perform only sheet printing and coating, sending finished sheets to other facilities that complete the can manufacturing process. Other plants produce only can ends from coils or sheets that may be purchased precoated or coated on site. Still other plants operate can manufacturing processes

and produce other container products such as metal crowns and closures. In addition, some metal can manufacturing facilities are co-located with food packaging plants.



Figure 2-1. Number of can manufacturing plants by State.

Most metal cans produced today are two-piece cans and three-piece cans. Table 2-1 summarizes the different variations of two- and three-piece cans and typical uses. As Table 2-1 shows, two-piece draw-and-iron aluminum cans typically hold beverages but may also hold food and nonfood products. Cans containing nonfood products are called general line cans. Another type of aluminum draw-and-iron can is the one-piece aluminum can, which is used for aerosol and pumped applications for pharmaceutical products (e.g., saline solution), cosmetics (e.g., perfume, hair spray, and air freshener), as well as nonpropelled products such as fuel additives. The one-piece can is so called because the aerosol or pump valve is attached directly onto the top of the can (that is, no top end piece is required). Some industry representatives refer to one-piece aluminum cans as bottles. Two-piece steel draw-and-iron cans are used to contain food items.

Table 2-1. Types of Cans and Their Uses

This manufacturing process . . .	Uses this material . . .	To hold . . .
Three-piece	Steel	Food, juices, spices, aspirin, & other non-food items such as paints and glues (includes decorative tins); includes aerosols
Draw and iron	Aluminum (one- and two-piece)	<u>Two-piece</u> : primarily beer, carbonated beverages, juices <u>One-piece</u> : aerosol & pump products (perfume, air freshener, hair spray, saline solution); fuel additives
	Steel (two-piece only)	Food, other nonfood items
Two-piece draw/redraw	Steel, aluminum	Food, shoe polish, sterno fuel, car wax, other non-food items
Ends	Steel, aluminum	Food and nonfood items
Crowns and closures	Steel	Food and nonfood items

Figure 2-2 presents 1997 through 1999 shipments of the various types of cans produced in the United States, broken down by end use. As Figure 2-2 indicates, the vast majority of cans are used to contain food and beverage products, whereas nonfood packaging accounts for only about 3 percent of metal can production.

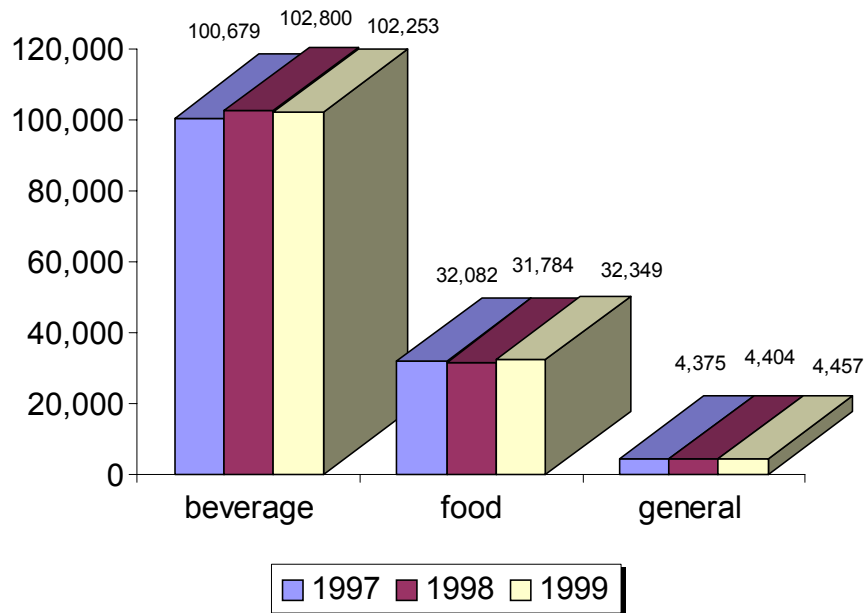


Figure 2-2. Metal can shipments by end use, 1997-1999 (millions of cans).

Figure 2-3 presents 1997 shipments and market share for two- and three-piece cans. As Figure 2-3 shows, current production is dominated by two-piece cans, which accounted for 83 percent of cans shipped in 1997. The number of one-piece cans is less than 0.1 percent of the cans manufactured and thus is not included in Figure 2-3.

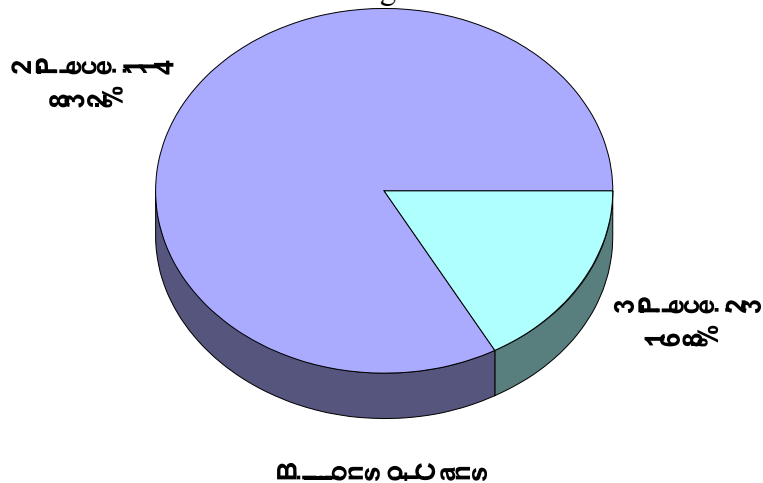


Figure 2-3. 1997 metal can shipments by manufacturing process.²

Two-piece steel and aluminum draw-redraw cans, which are shallower than draw-and-iron cans, are used for food products (such as pet foods, tuna, salmon, and snack foods) and nonfood products (such as car wax, shoe polish, and Sterno fuel). Can ends, used for all types of cans, include the standard ends and several types of easy-open ends. They also include metal ends for composite can bodies, such as frozen fruit juice cans, which have bodies made of cardboard or other nonmetal materials.

2.1 METAL CAN MANUFACTURING AND COATING PROCESSES

Can body manufacturing and can end manufacturing involve three-piece, two-piece, and one-piece processing. The three-piece manufacturing process is relatively simple and involves forming and welding of the can body. Two-piece processing includes cans manufactured by the draw-and-iron and draw-redraw processes. The manufacture of one-piece cans is discussed under the draw-and-iron process description for two-piece cans. The can and end manufacturing processes are described in detail in Sections 2.1.1 through 2.1.3.

2.1.1 Three-Piece Can Bodies

Three-piece can bodies are made from flat sheets cut from coils of tin-plated or tin-free steel, depending on the end use. The tin plating is applied to prevent rust. Tin-free steel is electrocoated with a layer of metallic chromium covered by a layer of chromium oxide.

Before the bodies are formed, coatings are usually applied to the interior and exterior surfaces with a roller onto the flat sheet. Three-piece interior and exterior coatings are discussed briefly below. Section 2.2 contains a detailed discussion of the coatings used in can manufacturing.

Interior coatings protect the can from corrosion by the contents and/or protect the contents from being contaminated by dissolved metal from the can. Occasionally, however, pigmented interior coatings enhance the visual appearance of the inside of the can. After the can is fabricated, some facilities spray the interior with additional coating to cover any defects in the roller-applied

coating. End seal compounds (explained in Section 2.2.3) and interior side seam striping (explained below) are also interior coatings.

Exterior coatings are applied for decoration, to protect the can from corrosion, to protect the printed designs from marring or abrasion, or to reduce friction on the bottom of the can to facilitate handling. Typical exterior coating operations are base coating, size coating, decorative ink and overvarnish application, bottom coating, side seam stripe application, and repair coating. Exterior coatings are usually applied with direct-roll coaters except for side seam and repair coatings, which are applied with a spray. Most roller-applied coatings (except for printing inks and overvarnishes) can be applied using the same coating equipment, and many facilities use the same equipment to apply a variety of coatings to can bodies, ends, crowns and closures, and decorative tins.

Figure 2-4 shows how sheets are coated on one side. Steel sheets feed onto a conveyor that transfers them to a coater that applies the coating to the sheets. After passing horizontally through a short flashoff area, the sheets are picked up by wickets and conveyed through a wicket oven. The sheets are typically run through an additional coating process to coat the opposite side. For this the sheets are flipped, stacked, and returned to the front of the coating line, returned directly to the front of coating line, or flipped and sent to another coating line. The curing oven operates at temperatures of up to 425°F, often with multiple heating zones for proper curing of coatings. The heating zones are followed by a cooling zone that reduces the temperature of the sheet using ambient air from inside or outside the plant. Line speeds range from 60 to 110 sheets per minute depending on the design and age of equipment, and the type of coating, the 60 sheet-per-minute line speed is for lithography printing and varnish, which run more slowly than other sheet coating operations. Oven exhaust rates usually vary between 2,000 and 14,000 standard cubic feet per minute.

Decorations on three-piece cans may be printed on the can body or on paper labels that are then glued onto the can. As noted previously, paper label printing and gluing is not included in this source category. Inks applied using the offset lithography process are illustrated in Figure 2-5.

Inks are applied by a series of rollers transferring the design from the plate cylinder to a blanket cylinder, then onto the metal sheet. Decorative inks are usually applied over an exterior base coat but may be applied directly to the metal. The transfer of inks is influenced by environmental

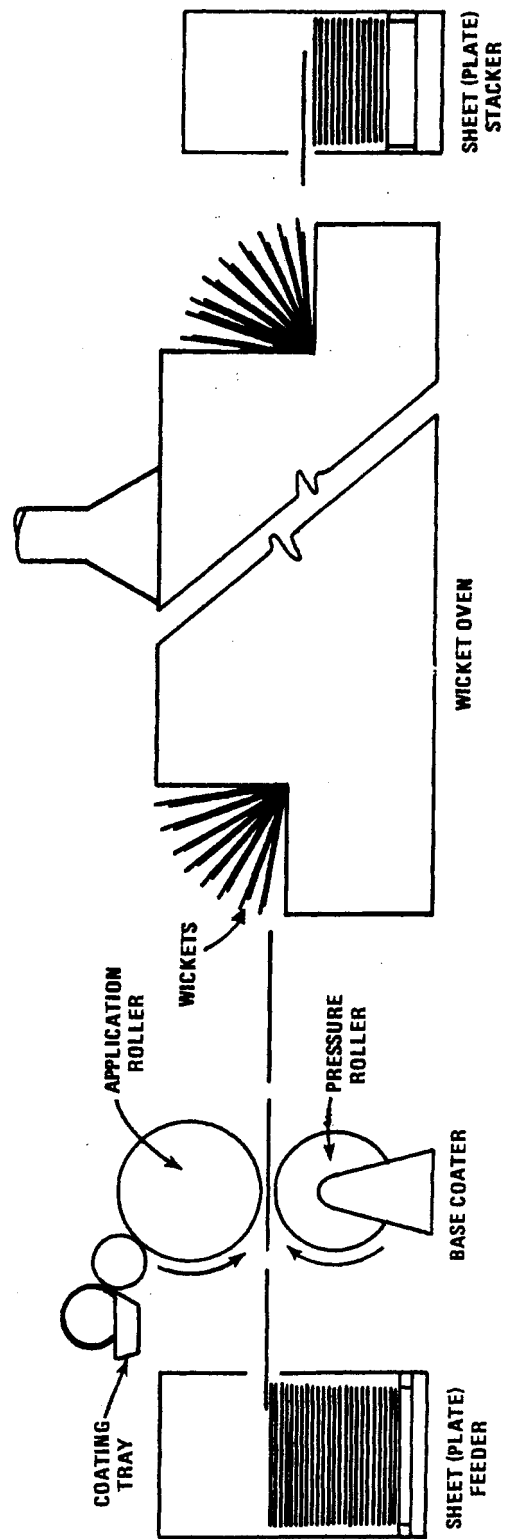


Figure 2-4. Three-piece can sheet base coating operation.³

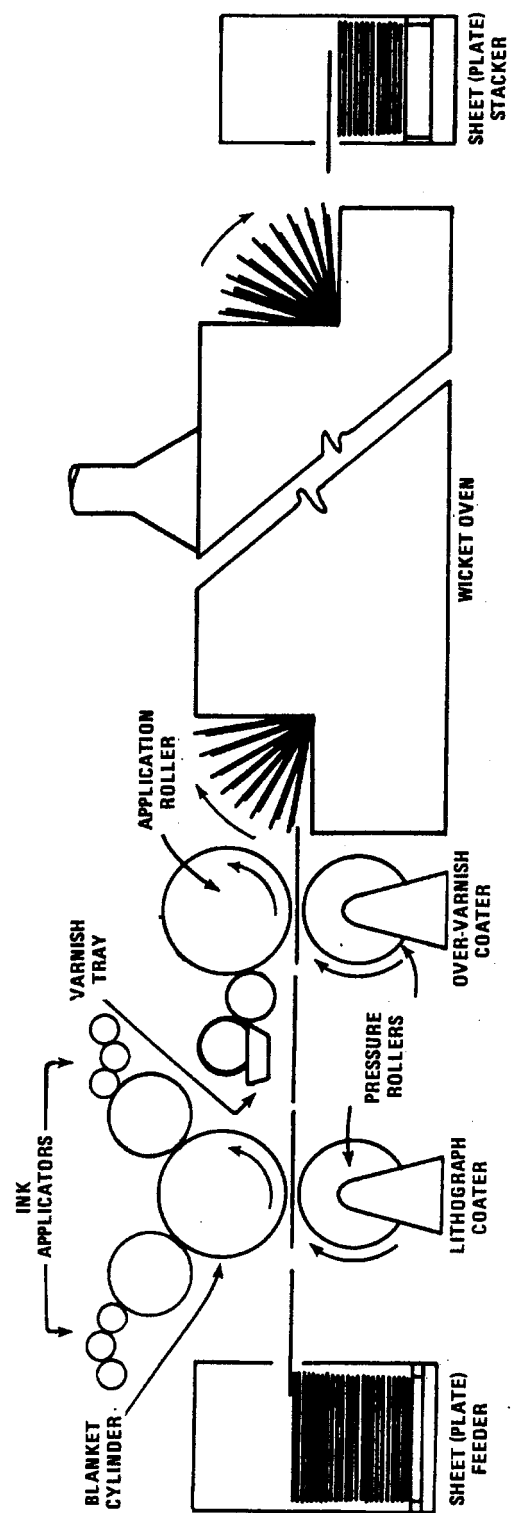


Figure 2-5. Sheet printing operation.³

factors such as temperature, draft, and humidity because the inks can become emulsified in the presence of water. An overvarnish is applied on top of the decoration by a direct roll coater while the inks are still wet. The inks and overvarnish cure in a wicket oven similar to, but usually smaller than, the base coat oven. Exhaust rates range from 1,500 to 8,000 scfm. If the required design has more than two colors, the first set of inks is dried in an oven. Another set of inks is then applied, followed by an overvarnish and baking in an oven. At least 100 existing three-piece printing lines are known to use ultraviolet-radiation-cured (UV-cured) printing inks and more than 30 lines also use UV overvarnishes. These coatings are applied in the same manner as solventborne or waterborne coatings, but are cured by exposure to ultraviolet radiation rather than heat. Consequently, these coatings do not need to pass through a drying oven.

After the coatings are applied, the sheets are transported to the fabrication process, as illustrated in Figure 2-6. The sheets are unloaded from a stacker to a conveyor and transported to the slitter, which cuts the sheet into body blanks. The body blanks enter the body maker where each blank is formed into a cylinder and the seam is welded or cemented, then sprayed with a coating called a “side seam stripe” to protect exposed metal along the seam. The coating may be applied to the inside of the can, the outside, or both sides depending on customers’ concerns about rust on the outside of the can or chemical reaction between the metal and the product on the inside. The side seam stripe is cured in an electric or gas-fired oven, or by exposure to a direct-flame burner. The cylinders are flanged in preparation for the attachment of ends, and are sometimes necked down to reduce the size of the ends, which reduces the amount of material required to make the ends.

In addition to protective interior coatings that are roll-coated onto flat sheets before forming, some facilities apply inside sprays after the body has been formed, especially for larger size cans (22 ounces and larger) to cover flaws in the sheet coating and ensure that no metal is exposed. The spray coating is cured or baked in a single pass vertical or horizontal oven at temperatures of up to 425°F. The typical oven exhaust rate is approximately 2,000 scfm.

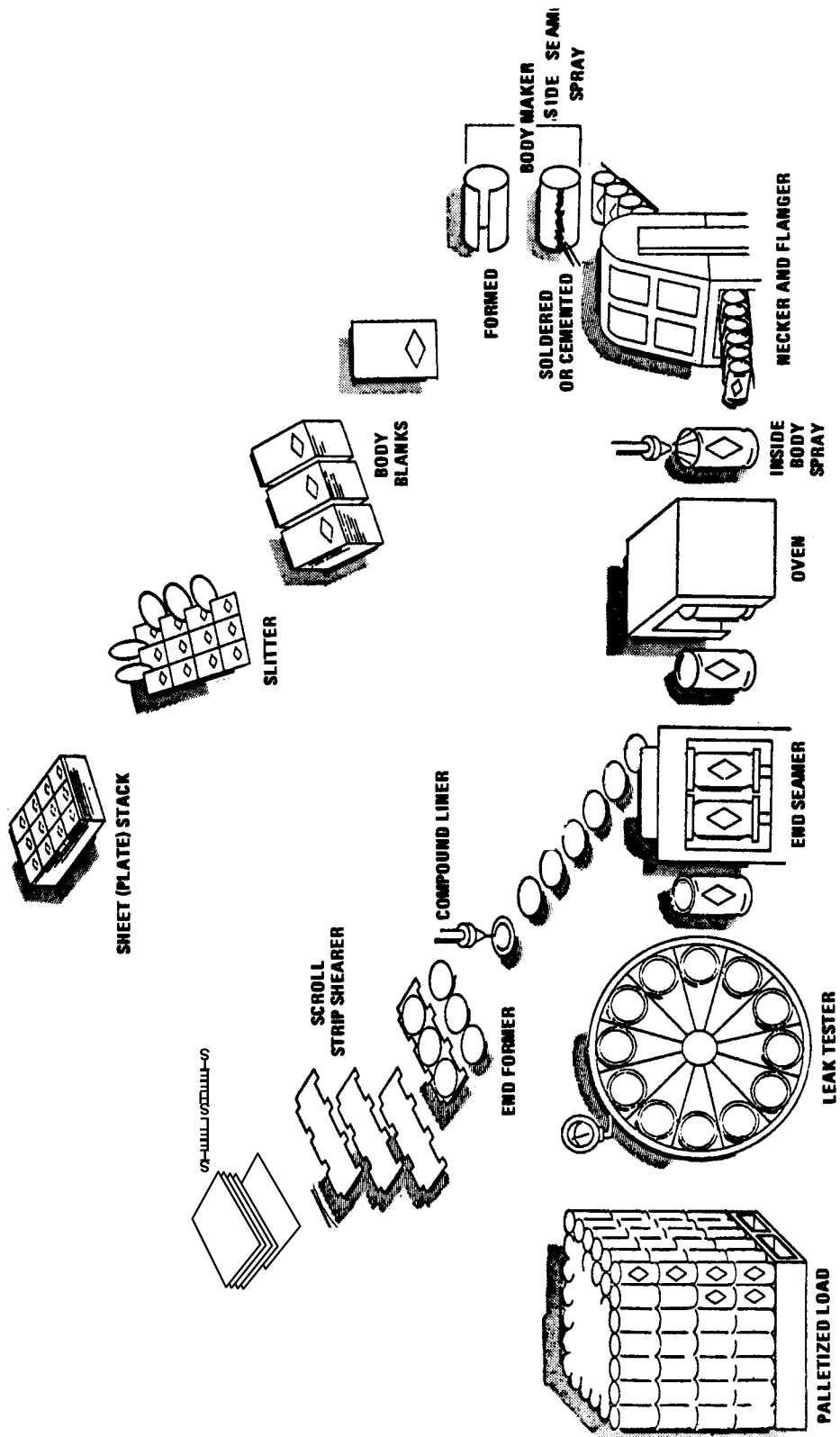


Figure 2-6. Three-piece can fabrication process.³

Some cans pass through a beader that forms ridges on the can to provide additional axial and panel strength. Next, one end is applied to each can in the double seamer, where the edges of the can body and end are folded together, then folded again to form a seal. The finished cans are checked for leaks, and then are stacked on pallets for storage. Line speeds for three-piece can manufacturing range from 350 to 800 cans per minute.

2.1.2 Two-Piece Can Bodies

Two-piece cans are made by forming a cup-shaped container with one piece of aluminum or steel and attaching an end to it. Two-piece cans are manufactured either by the draw-and-iron process or the draw-redraw process. After the fabrication process, various coatings are applied and cured. These processes are described in detail below.

2.1.2.1 Draw-and-Iron Process

Aluminum Beverage Cans and One-Piece Cans. Figure 2-7 illustrates the aluminum draw-and iron can manufacturing process. Metal coil is continuously fed into a cupper that stamps shallow metal cups from the coil. In the draw-and-iron process, each cup is stamped, placed on a cylinder, and forced through a series of rings of decreasing annular space, which further draw out the wall of the can and iron out folds in the metal.

After the draw-and-iron step, the can bodies are trimmed to the desired length and washed to remove lubricants used in the draw-and-iron step. Beverage cans are typically conveyed directly to the printing and varnishing area after washing; however, about 10 percent of beverage cans first receive an exterior base coat due to customer preference. The base coat is transferred from a feed tray through a series of rollers and onto the can, which rotates on a mandrel. The base coat cures at 350°F to 400°F in single or multi-pass continuous, high production ovens at a rate of 500 to 2,000 cans per minute.

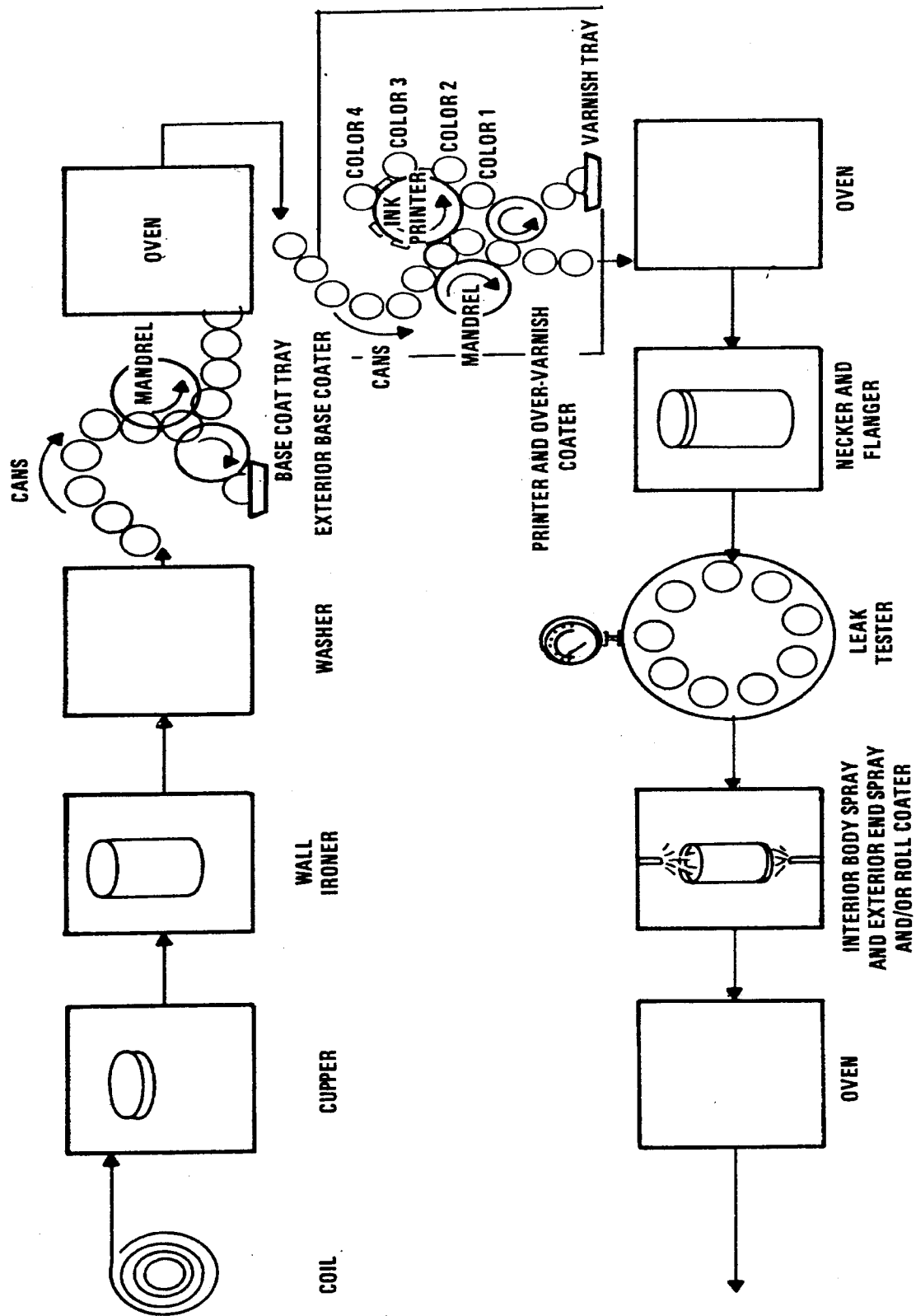


Figure 2-7. Two-piece draw-and-iron aluminum beverage can manufacturing process.³

The decorative coating process consists of a lithographic printing step and an overvarnish application step. Four to eight colors of ink are applied to printing blankets on a lithographic printer that transfers the designs and lettering to the can as it rotates on a mandrel. Rollers apply an overvarnish while the inks are still wet, then, in some instances, a rim coat is applied with a roller to the bottom of the can to facilitate handling. The cans then pass through a drying oven at 325°F to 400°F to cure the inks and overvarnish.

One manufacturer of two-piece aluminum beverage cans uses UV-cured printing inks and overvarnishes. These coatings are applied the same way as solventborne or waterborne coatings, but are cured by exposure to ultraviolet radiation rather than heat and do not need to pass through a drying oven.

The inside spray coating is then applied to the interior surface of the can and a rim coat is applied, if required. The thickness of the coating depends on the aggressiveness of the contents; cans containing very aggressive products may require a thicker initial coating or a second coating. The cans then pass through an oven to cure the inside spray. The open end of the can is necked and flanged. One-piece cans are subjected to more severe necking than beverage cans because the valve is placed directly on the can (i.e., there is no end piece); therefore, more durable coatings are required. Then the cans are tested for leaks using pressure or light, and tested for acceptable coating thickness by electrical resistance. Cans that fail either test are automatically removed from the process for recycling. Cans that pass are stacked in cartons or on pallets for storage.

Two-Piece Draw-and-Iron Steel Food Cans. The two-piece draw-and-iron steel food can manufacturing process is similar to the aluminum beverage can process except that food cans are typically decorated with paper labels so the printing and overvarnish steps are unnecessary. Instead, a “wash coat” is applied to protect the can from corrosion. The wash coat is applied after the washing process, but before drying. The cans are inverted and the wash coat is poured over the exterior surface. The cans then pass through a drying oven to cure the wash coat.

Food cans are made from steel because they are usually vacuum-packed. To provide additional axial and panel strength, the cans pass through a beader that forms three radial creases in the metal (called “beads”) after the wash coat is applied. Wash coatings are formulated to withstand this fabrication process.

2.1.2.2 Draw-Redraw Process

As in the draw-and-iron process, aluminum or steel coil is continuously fed into a cupper that stamps shallow metal cups from the coil. Shallow cans may be stamped only once, whereas deeper cans may require one or two additional stamps. The cans are then stacked on pallets for storage.

Draw-redraw cans are typically produced from precoated coils; if so, there are no additional coating steps in the manufacturing process (coil coating for draw-redraw cans is covered under the coil coating source category). However, some can manufacturers purchase uncoated coils and perform sheet coating at the plant in a manner similar to the three-piece can coating operation. Most draw-redraw cans are labeled with printed paper; however, a new process called distortion printing has been developed in which the design is printed on the can prior to forming. The design stretches to its intended dimensions when the can is formed.

2.1.3 Can Ends

2.1.3.1 Aluminum Beverage Can Ends

Aluminum beverage can ends are made exclusively from precoated coil. Beverage can ends are stamped from coils in a reciprocating press. After stamping, the ends are scored in an oval pattern and a tab is attached to form an “easy open” end. These steps are performed after the end piece has been coated and therefore damage the coating. Repair coatings are applied after these steps to restore the integrity of the coatings.

Because they are flat, can ends must be thicker than bodies to resist pressure. Aluminum beverage cans are usually necked down to reduce the amount of material used to make a can by reducing the diameter of the ends.

After stamping, scoring, and tab attachment, the ends are transported to a curler which forms a trough or “curl” on the perimeter of the can end. A bead of a liquid polymer dispersion called an end seal compound is applied in the curl to create a hermetic seal when the end is attached to a can by the double seamer. Solvent-based end seal compounds are usually air dried and water-based compounds are dried in electric or gas-fired ovens at approximately 110°F. The oven exhaust rate is about 300 scfm. The ovens can be part of a coating line or stand-alone installations, depending on the facility.

2.1.3.2 Food Can and Other Sheet-Coated Ends

Ends for food cans are typically coated on metal sheets rather than coils. Can end sheet coatings are applied by direct-roll coaters similar to those used in sheet coating operations for three-piece can bodies, and some facilities use the same coating lines to coat can bodies and ends. Because both the interior and exterior surfaces are usually coated, each sheet is subjected to two separate application and drying steps. If UV-cured exterior coatings are used, these coatings are applied first. The UV coating is set by passing the sheets under a bank of UV drying lamps. The sheets are then collected and turned over by wickets in preparation for the interior coating application, which is applied by a direct-roll coater. The sheets then pass through a drying oven to cure the interior coatings and complete the cure of the exterior UV-cured coating. Can ends are then formed in processes similar to those used to produce aluminum beverage can ends. The end seal compound application step is also similar to that used in aluminum beverage can manufacturing.

Sheet-coated easy-open can ends require additional fabrication steps such as when the metal is scored and when a tab is attached. These steps are performed after the end piece has been coated and therefore damage the coating. Repair coatings are applied after these steps to restore the integrity of the coatings.

2.2 COATINGS

Can manufacturing processes include several coating application steps, as described in Section 2.2. Table 2-2 summarizes the different types of coating formulations applied to cans and their specific uses.

Section 2.2.1 introduces the general types of coatings used in can manufacturing; Section 2.2.2 describes the required properties and formulations of can coatings based on the application process and the end use of the can.

Table 2-2. Coatings and Their Purposes

Coating application type	Purpose
Exterior:	
Base coat, size coat	To protect metal; also a base for printing inks
Inks	Decoration and information; also minor use to ID cans and indicate pasteurization
Overvarnishes	Protection of printed design and base coat
Rim coat	Applied to bottom rim of can to reduce friction for improved handling
Bottom coat	Protect can from abrasion and rust
Side seam stripe	Protect seam from abrasion and rust
Repair	Repair coatings damaged during fabrication or handling
Interior:	
Sheet-applied protective coatings	Protect metal from contents and vice versa (three-piece cans)
Inside sprays	Protect metal from contents and vice versa (two-piece cans; some three-piece cans)
Side seam stripe	Protect seam and surrounding bare metal from corrosion by contents
End seal compound	Provide hermetic seal between can and end pieces

2.2.1 Coating Technologies

In the past, most coatings used in can manufacturing contained a high concentration of solvents, resulting in significant emissions of volatile organic compounds (VOC). However, in the 1970s, clean air regulations created demand for coatings with lower VOC content, which led to the development of alternative can coating formulations and technologies such as high(er)-solids, waterborne, UV-cured, and powder coatings. While some can coating operations still use conventional solventborne coatings, newer coating technologies have gained acceptance from

industry for many applications. Suppliers of coatings to the can industry, through the Can Manufacturers Institute (CMI), provided the EPA with a summary of the range of VOC and HAP content in formulations used in different coating processes. This information is shown in Table 2-3. The VOC information in Table 2-3 is not directly related to the development of the MACT standards for HAP, however, it is included on Table 2-3 and the following discussion because many HAP are VOC and also as additional background information. The VOC and HAP content were reported in different units and the EPA does not have the information to accurately convert the data to common units; so they cannot be directly compared. Note that the HAP content data reflect as-applied values, which in some cases, such as three-piece can fabrication, includes addition of thinning materials that may contain HAP.

According to Table 2-3, conventional solventborne coatings have high concentrations of VOC, typically 70 to 75 percent by volume or 4.0 to 6.6 pounds of VOC per gallon of coating, minus water (lb VOC/lb gal coating minus water). The VOC component may consist of a single compound or a mixture of volatile ethers, acetates, aromatics, glycol ethers, and aliphatic hydrocarbons. The HAP content of conventional solventborne coatings ranges from 0.06 to 1.6 lb HAP/lb solids applied.

Some of the advantages of conventional solventborne coatings are good abrasion resistance, good performance for a wide range of applications, and easy application. However, because most can manufacturers are subject to regulations limiting VOC emissions, low-VOC coatings are being developed as replacements for conventional solventborne coatings in many applications. Conventional solventborne coatings are still used for three-piece exterior sheet coating processes where high abrasion resistance is required or where the metal is subsequently subjected to fabrication steps (e.g., can ends, beaded three-piece cans, and draw-redraw cans). In addition, conventional solventborne inks are used in three-piece steel can lithographic printing. Current conventional solventborne three-piece can inks are alkyd-based and do not contain HAP, but do contain VOC. Conventional solventborne coatings are also used as interior coatings (including sheet coatings, inside sprays, and side seam stripe coatings) for cans containing certain foods and nonfood products (e.g., paints and varnishes) for which no suitable low-VOC

coatings have been developed. Conventional solventborne coatings have been eliminated from two-piece beverage can coating and are expected to be eliminated from two-piece draw-and-iron food can manufacturing by 1999.

More recent and alternative can coating formulations and technologies such as

- high solids coatings
- waterborne formulations
- ultraviolet (UV)-curable finishes
- powder coatings

are also mentioned in Table 2-3 and are considered to be pollution prevention technologies.

These technologies are further discussed in terms of general background information and their applicability to metal can manufacturing surface coating operations in Chapter 3 (Section 3.3).

Table 2-3. Coating Technologies: VOC/HAP Content and Uses^a

Coating technology	VOC content, lb VOC/gal coating minus water	Range of HAP content, lb HAP/lb solids applied	Main industry uses	Comments
ALUMINUM BEVERAGE CANS				
Waterborne epoxy	2.8 - 3.6	0.20 - 0.30	Inside spray	
Waterborne white polyester, acrylic	1.4 - 2.1	0.06 - 0.20	Exterior base coat	
Waterborne varnish polyester, acrylic	1.4 - 2.1	0.06 - 0.20	Exterior overvarnish and bottom rim coat	
UV varnish	<0.01	<0.01	Exterior overvarnish and bottom rim coat	UV is only an option for less demanding uses
STEEL FOOD CAN COATINGS				
Solventborne aluminum pigmented epoxy	5.5 - 6.0	1.0 - 1.5	Inside spray for draw-and-iron pet food cans	Expected to convert fully to waterborne in 1999
Waterborne epoxy	2.4 - 3.3	0.2 - 0.5	Inside spray for draw-and-iron food cans	
Waterborne topcoat epoxy and acrylic	2.8 - 3.2	0.2 - 0.4	three-piece can inside spray	
Waterborne washcoat	1.7 - 2.2	0.1 - 0.2	Wash coat for draw-and-iron food cans	
INTERIOR SHEET COATINGS				
Solventborne epoxies (includes pigmented, whites, buff, gray)	4.8 - 6.0	0.3 - 1.6	three-piece cans: - Fruits & vegetables - Soups & pastas - Meat & fish - Pet food - Paint & aerosol	Solvent reformulation will increase cost & VOC content. Waterborne and high-solids coatings are not viable for paint and aerosol products.
Waterborne epoxy	1.7 - 2.0	0.04 - 0.10	three-piece cans: - Fruits & vegetables - Soups & pastas	Waterborne creates operational inefficiencies if coaters cannot be dedicated. Pigmented types not yet developed.

Table 2-3. (continued)

Coating technology	VOC content, lb VOC/gal coating minus water	Range of HAP content, lb HAP/lb solids applied	Main industry uses	Comments
Vinyl organosol (includes pigmented)	4.6 - 6.5	0.3 - 1.5	High flexibility: - Drawn cans - Easy-open ends	Reformulation will increase cost & VOC content
High solids vinyl organosol (includes pigmented)	3.2 - 4.0	0.2 - 0.3	Good flexibility: - Shallow drawn cans - Easy-open end - three-piece cans - Meat, fish, pet food - Tomatoes, juices	Expanding usage in recent years
Oleoresinous	1.2 - 3.5	0 - 0.1	three-piece cans: - Mild foods only (corn)	Limited product resistance
EXTERIOR SHEET COATINGS				
Solventborne - Varnish - White	4.0 - 6.0 4.0 - 5.0	0.15 - 0.70 0.06 - 0.40	High process ^b /flexible decorated bodies: - Beaded food cans - Draw-redraw cans	UV not an option for whites
High solids varnish -White	2.6 - 3.0 2.3 - 3.0	0.1 - 0.2 0.1 - 0.2	Low-process decorated three-piece bodies: - Tomato products - Aerosol and general line cans	UV not an option for whites
UV overvarnish	<0.01	<0.01	Decorated three-piece bodies - Low-process foods - Aerosol and general line	
Solventborne clear and gold epoxies	4.8 - 6.0	0.8 - 1.6	High abrasion/flexibility needs - Food can ends - Draw/redraw cans	Waterborne or UV are options only for less demanding uses
Waterborne clear and gold epoxies	1.8 - 2.2	0.04 - 0.25	Food ends	
High-performance UV	<0.01	<0.01	Food ends	
Vinyl organosol	4.5 - 6.5	0.3 - 0.6	Draw/redraw cans	Vinyl is unsuitable for some retorting equipment
High-solids vinyl organosol	3.2 - 4.0	0.2 - 0.3	Draw/redraw cans	

Table 2-3. (continued)

Coating technology	VOC content, lb VOC/gal coating minus water	Range of HAP content, lb HAP/lb solids applied	Main industry uses	Comments
END SEAL COMPOUNDS				
High-solids solventborne, waterbase	0 - 3.7	0 - 0.36	Beer/beverage	
High-solids solventborne, waterbase	0 - 3.7	0 - 0.44	Food: - High-fat - Sanitary (nonaseptic) - Sanitary (aseptic)	Reformulation is required to eliminate HAP from high-solids solventbase sealants Waterbase end seal compounds have limited commercial use on aseptic packs
Waterbase	0	0	Aerosol	
Waterbase	0	0	General Line	
SIDE SEAM STRIPE COATINGS				
Epoxy and/or acrylic	4.5 - 6.6	0.02 - 1.2	Thin film requirements - Seam exteriors - Interior for mild foods and decorative tins	Mostly replaced by high-solids coatings in recent years
Vinyl organosol	5.0 - 6.5	0.7 - 1.2	Medium film weight requirements: - Interior for most foods	Gradually moving to high-solids coatings in recent years (see below)
High-solids vinyl organosols	3.5 - 5.0	0.5 - 0.7	Medium film weight requirements: - Interior for most foods	Expanding commercial use; proven technology
Waterborne coatings	2.3 - 3.0	0.2 - 0.3	Thin and medium film weight applications	- Early development state - No dedicated commercial lines - Will require extensive testing and customer approval to expand use

Table 2-3. (continued)

Coating technology	VOC content, lb VOC/gal coating minus water	Range of HAP content, lb HAP/lb solids applied	Main industry uses	Comments
Powder coatings	<0.01	<0.01	Thick film requirements: - Acid foods - Latex paints	Not practical for lower film weight requirements

^a Source: Supplier Coating Matrix submitted by CMI at the July 17, 1997 meeting between CMI and EPA.

^b “High process” means cans are subjected to heat cycles such as retort or pasteurization after the coatings are applied; therefore coatings must be able to withstand these cycles.

2.2.2 Characteristics of Interior and Exterior Coatings

Metal can coatings must possess certain physical and/or chemical properties to perform properly. In general, coatings must exhibit resistance to chemicals, flexibility, and adhesion to the metal surface. Coatings for beer and certain beverage cans must be able to survive an aqueous pasteurization cycle of 20 to 30 minutes at temperatures ranging from 140°F to 160°F, and coatings for foods cooked in the can must be able to withstand conditions of 250°F and 15 pounds per square inch (psi) steam pressure for up to 90 minutes. In addition, coatings applied using different methods (e.g., sheet, coil, or spray application) must meet different requirements for viscosity and other parameters that affect the quality of the coating. Also, coatings applied prior to fabrication processes, such as coatings for ends and two-piece draw-redraw cans, must be able to withstand these processes. Finally, the end use of the can also affects the coating formulations that can be used.

2.2.2.1 Interior Coatings

The primary purpose of the interior coating is to form a barrier between the can and its contents. Specifically, interior coatings must protect the metal from corrosive contents and must not stain on contact with the contents, affect the color, flavor, odor, or appearance of foods, or otherwise contaminate the contents.

Metal cans contain a wide variety of products. The formulation of the interior coating depends on the can fabrication and product canning processes involved as well as the chemical properties of the contents. Interior coating formulations are typically categorized as food and nonfood coatings due to differences in required properties and regulations affecting their formulation. All interior coatings for cans containing edible products must meet Food and Drug Administration (FDA) regulations, whereas interior coatings for nonfood products do not. The FDA requirements limit the variety of solvents and resins that can be used in coating formulations for food cans. However, because of the unique requirements of different products contained in cans, a wide variety of interior coating formulations are used. The different types of interior coating formulations used in metal can manufacturing are discussed in the following sections according to the application process.

Sheet-Applied Interior Coatings. Three-piece can bodies are sheet coated (rather than coil coated) because bare margins are required to apply the weld or cement. Sheet-applied coatings are also used to coat two- and three-piece steel can ends that are used to contain products for which no suitable coil-applied interior coatings have been developed, such as chemically aggressive foods (e.g., tomatoes) and non-food products (e.g., paints and varnishes). These products require resin systems such as oleoresins, epoxy-esters, epoxy-phenolic resins, and alkyds, which cannot be cured in the high-speed ovens used in coil coating processes.

Interior sheet coatings are typically conventional or high-solids solventborne coatings, or waterborne coatings. The formulation of interior coatings varies greatly with the end use of the can. Conventional solventborne coatings are used for cans containing certain foods and non-food products (e.g., paints and varnishes) for which no suitable low-VOC coatings have been developed.

Inside Sprays. As described in Section 2.1, inside sprays are applied to all two-piece beverage and food cans, and a few three-piece steel food cans. Most inside spray coatings are waterborne epoxy or acrylic formulations; some manufacturers of large three-piece cans and three-piece pet food cans use solventborne coatings but are expected to convert to waterborne coatings in the near future. Waterborne coating formulations for beverage cans vary only slightly for most applications and contents. However, the application rate may vary widely because some beverages, such as Gatorade® and other sports beverages, are more aggressive and thus require a thicker coating.

The formulations of inside sprays for food cans, like sheet coatings for food cans, vary significantly according to the type of product contained. The thickness of coating applied to the interior of food cans is approximately twice the thickness applied to beverage cans.⁷ The application rate is higher for food cans because the contents are typically more chemically reactive than beverages and because consumers expect canned foods to have a longer shelf life than beverages.

Interior Side Seam Stripe Coatings. The side seam stripe is applied to the seams of three-piece cans after welding to protect the exposed metal from the contents of the can. Most interior side seam stripe coatings are either conventional or high-solids solventborne coatings, although powder coatings are sometimes used when high film weights are required, such as for containing latex paints and highly acidic foods. Because powder coating technology is not conducive to low film weights, powder coatings are only used when a thick film weight is acceptable.

The resin base for most interior side seam stripe applications is a vinyl organosol, although epoxy and acrylic resins are sometimes used for mild foods and decorative tins. Waterborne coatings are currently in development, but extensive testing is required before they are accepted for commercial use.

End Seal Compounds. End seal compounds are applied to the rims of can ends to provide a hermetic seal when the end is attached to the can. End seal compounds are typically vinyl organosol or plastisol formulations.

End seal compound formulations vary widely in VOC and HAP content due to the wide variety of products that are packaged in cans. End seals with no-VOC and no-HAP content have been developed for aerosol and general line cans, two-piece beer and beverage cans, and certain food products. However, no-VOC end seal compounds are not suitable for some other food products. Nevertheless, coating manufacturers are continuing to reduce the amount of VOCs and HAPs in end seal compounds. High solids and waterborne formulations are now available for products that formerly required compounds with VOC content in the range of conventional solventborne coatings.

2.2.2.2 Exterior Coatings

There are no FDA requirements for exterior coatings. As a result, manufacturers can use a wider variety of coating formulations for exterior coatings than for interior coatings. However, exterior coatings must be durable and coatings for cans containing food or pasteurized beverages must withstand exposure to heat during the retort or pasteurization process.

Most exterior coatings are applied by rollers to sheets or preformed cans. Coating operations in this category include the two- and three-piece can base coating and size coating, steel food can end coating, and application of decorative inks, overvarnishes, rim coats, and bottom coats. Other exterior coating operations are wash coating for two-piece steel cans, in which the coating is poured over the exterior surface of the can, and application of repair coatings, which may be applied by either conventional or electrostatic spraying techniques. Coating formulation considerations for each type of coating application are discussed below.

Overvarnishes and Rim Coats. Three-piece can overvarnishes are typically solvent-based coatings containing polyester resins. However, UV coatings may be used with conventional or UV inks.

Two-piece beverage can overvarnishes and rim coats are typically waterborne acrylic or polyester coatings similar to those used for two-piece beverage can exterior base coats; however, one two-piece beverage can facility that uses UV printing inks also uses UV overvarnish coatings.

Wash coatings and exterior coatings for draw-redraw cans.

Two-piece draw-and-iron food can wash coatings are typically waterborne epoxy or acrylic coatings similar to two-piece food can inside sprays. Exterior coatings for two-piece draw-redraw cans must be flexible and durable to withstand fabrication processes. Vinyl, vinyl organosol, and epoxy formulations are typically used.

Can End Coatings. Aluminum beverage can coatings are coil-coated alkyds, alkyd melamines, waterborne acrylic epoxies, or polyesters. Food can ends are typically epoxy coatings; where high flexibility and abrasion resistance are required, solventborne formulations are required. Waterborne epoxy or UV coatings are used for general line cans and foods not requiring pasteurization or retort.

Exterior Side Seam Stripe Coatings. Exterior side seam stripe coating formulations may be solventborne, high-solids solventborne, water borne, or powder type coatings. These coatings typically use either vinyl organosol, epoxy, or acrylic resins, similar to interior side seam stripe coatings. A wider variety of resins may be used for exterior side seam stripe coatings because FDA requirements do not apply to exterior coatings.

2.3 CHARACTERIZATION OF HAP EMISSIONS FROM METAL CAN SURFACE COATING FACILITIES

2.3.1 HAP Emissions

2.3.1.1 1995 Toxic Release Inventory Data

Table 2-4 presents total HAP emissions from the 177 can manufacturing facilities (i.e., facilities that reported SIC code 3411, “Metal Cans,” as their primary SIC code) and two dedicated crown manufacturing facilities (SIC code 3466) that responded to the 1995 Toxic Release Inventory (TRI) survey. (Note that other can coating facilities emitting significant quantities of air toxics may have reported under SIC code 3479, “Metal Coating and Allied Services.”) The TRI data indicate that many metal can manufacturing facilities emit significant quantities of HAP. Of these 177 facilities, 135 could be considered major sources based on their reported actual HAP emissions (not considering the facilities’ potential to emit).

As Table 2-4 shows, glycol ethers represent 71 percent of reported HAP emissions from these facilities. Ethylene glycol monobutyl ether (EGBE), a type of glycol ether, is the primary solvent used in waterborne beverage can coatings, and accounted for 84 percent of total HAP emissions associated with metal can production in 1995. N-hexane, which represents approximately 10 percent of reported HAP emissions, is used primarily in end seal compounds for beverage and food cans. According to industry representatives, end seal compounds for many food cans are being reformulated substituting heptane (a nonHAP compound) for n-hexane. Waterbased end seal compounds for beverage cans contain no HAP. However, there are still some solventborne compounds in use that contain n-hexane.

Table 2-4. HAP Emissions From Can Manufacturing Facilities

HAP compound	Annual emissions, ton/yr
Certain glycol ethers	6,861
Xylene (mixed isomers)	1,123
n-hexane	922
Methyl isobutyl ketone	296
Methyl ethyl ketone	243
Ethylbenzene	105
Toluene	97
Trichloroethylene	32
Methanol	12
1,1,1-trichloroethane	10
Tetrachloroethylene	8
Hydrogen fluoride	5
Ethylene glycol	3
Naphthalene	2
Total:	9,720

Source: 1995 TRI database (177 facilities under SIC code 3411 and 2 facilities under SIC code 3466).

2.3.1.2 ICR Data

Table 2-5 presents the specific HAP breakout of the total organic HAP emissions from the 208 facilities in the source category that responded to the information collection request (ICR). This data is based on 1997 emissions from the source category as reported in Form-A of the ICR. Of the 208 facilities, 150 are considered major sources based on potential to emit and 8 are synthetic minor sources (leaving 142 major source facilities that are subject to the NESHAP). As Table 2-5 shows, glycol ethers represent 71 percent of the reported HAP emissions; EGBE accounted for the majority of glycol ethers; and xylenes and hexane accounted for 10 and 9 percent, respectively.

The baseline emissions for the overall metal can manufacturing source category are estimated to be approximately 9,775 tons per year from the estimated 220 facilities (based on the reported data from the 208 facilities in the database) . The few missing facilities not included in the project database are assumed to be single facility companies with relatively small production capacities and HAP emissions.

Table 2-5. HAP Emissions From Metal Can (Surface Coating) Facilities

Organic HAP compound	Annual emissions, ton/yr* (entire database, 208 facilities)	Annual emissions, ton/yr* (major sources, 150 facilities)
Glycol ethers	6,906	6,775
Xylenes (isomers and mixture)	933	910
Hexane	868	847
Methyl ethyl ketone	339	324
Methyl isobutyl ketone	306	297
Ethyl benzene	122	119
Isophorone	82	82
Formaldehyde	67	66
Toluene	75	61
Trichloroethylene	40	39
Napthalene	21	20
Methanol	5	3
Cumene	3	2
Diethanolomine	3	3
Methylene chloride	3	3
Total	9,775	9,559

* Does not include HAP < 1 ton/yr

2.3.2 HAP Emission Sources and Emission Reduction Techniques

The majority of HAP emissions from metal can surface coating facilities are from the coating application and curing processes. Other potential sources of HAP emissions are coating equipment cleaning operations, coating mixing and thinning operations, storage of coatings and solvents, and can washing operations. These emission sources and the associated emission reduction techniques are described below.

2.3.2.1 Coating Operations

Emissions from coating operations occur during coating application, flashoff (the evaporation of solvents that occurs as the cans or sheets are transported from the application area to the oven), and curing. The majority of these emissions occur in the drying or curing process, ranging from 50 to 80 percent depending on the type of coating and other site-specific factors. Conventional coatings for the interior and exterior can body and end surfaces are cured in ovens which are vented either to a control device or directly to the atmosphere. Ultraviolet radiation-cured coatings do not contain significant amounts of HAP; therefore, no capture device is necessary. The UV coatings are cured in open air under banks of UV lights. Emissions from side seam stripe and end seal compound application operations may be vented to a control device but are typically uncontrolled. Industry representatives maintain that controlling emissions from these operations is not cost-effective because the captured emission streams would have a very low solvent concentration.

Emissions of HAP can vary widely depending on the HAP content of the coating formulations used. Low-HAP solventborne and waterborne coating formulations, UV-cured coatings, and powder coatings can significantly reduce emissions from coating operations.

As will be discussed in Chapter 3, the predominant method of add-on control used to control emissions from can coating operations is capture and incineration of the solvent vapors. Capture devices used for the application and flashoff areas include floor sweeps, close-capture hoods (hoods that capture emissions close to the point of generation), canopy hoods, partial enclosures, (i.e., enclosures that do not meet the criteria specified in EPA Method 204), and permanent total enclosures (i.e., enclosures that meet the criteria specified in EPA Method 204). Types of incinerators are recuperative or regenerative thermal and catalytic oxidizers.

2.3.2.2 Cleaning Operations

Coating equipment and tools require periodic cleaning to remove buildup of coatings and dirt. Cleaning activities may take place at the equipment location or parts may be removed and taken to a cleaning station. Many facilities use water-based cleaning solutions, but solvent-based

solutions are required for most three-piece can manufacturing facilities because the roller material is not compatible with water-based solutions. The most common technique for reducing emissions from cleaning operations in which solvents are used is through work practices designed to minimize emissions. Examples of work practices are the use of covered containers for storing solvent-laden rags and for dispensing solvents, avoidance or restriction of the use of atomizing sprays, and the selection of low-vapor-pressure solvents where possible. Emissions from dedicated cleaning stations and on-line cleaning are sometimes routed to incinerators.

2.3.2.3 Can Washing Operations

The draw-and-iron step in draw-and-iron can manufacturing requires the use of lubricants which must be removed before coatings are applied. Can washing operations typically use solutions of either sulfuric, hydrochloric, or hydrofluoric acid to etch the can surface to promote ink/overvarnish adhesion. Facility wide air emissions of acids from can washing operations are typically much less than 1 ton per year and are typically uncontrolled.

2.3.2.4 Mixing Operations

Most can manufacturing facilities purchase premixed coatings, and for these facilities no mixing operations are required. However, some premixed coatings are thinned with solvents on-site to obtain the proper viscosity. Emissions from mixing vessels may be uncontrolled or vented to incinerators used to control emissions from coating operations.

2.3.2.5 Coating/Solvent Storage

Coatings may be stored in 55-gallon drums, totes, or in fixed tanks. At least one facility maintains its coating storage at constant temperature to maintain the viscosity level needed for application, eliminating breathing losses. The same facility eliminates emissions during filling by using a vapor return system.

2.3.2.6 Wastewater

Based on EPA's current information, the major source of wastewater from can manufacturing is washing operations at draw-and-iron can manufacturing facilities. If hydrofluoric or some other

acid is used in can washing, these streams may contain very low concentrations of hydrofluoric acid; however they are not expected to be large sources of air emissions.

2.4 REFERENCES

1. Can Manufacturers Website: <http://www.cancentral.com/mcs.htm>.
2. Can Manufacturers Website: <http://www.cancentral.com/mcsmt.htm>.
3. U. S. Environmental Protection Agency. OAQPS Guidelines. Control of Volatile Organic Emissions from Existing Stationary Sources - Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks. Publication No. EPA-450/2-77-008. Research Triangle Park, NC. May 1977.
4. Letter dated July 18, 1997 from Zilke, R., Akzo Nobel Coatings Inc., to M. Wiggins, MRI. [Docket Number A-98-41. Item Number II-D-6]

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Chapter 3

Emission Control Techniques

This chapter discusses organic HAP and volatile organic compound (VOC) emission control techniques that are currently being used for surface coating operations in metal can manufacturing facilities. There are two approaches to limiting HAP emissions resulting from surface coating operations in the metal can manufacturing industry:

- Capture and control
- Pollution prevention

The first approach utilizes capture systems and add on control devices to destroy or remove the HAP from the air stream. Capture and control are discussed separately in this chapter. The second approach, focusing on pollution prevention, is to substitute low HAP or HAP-free materials for materials (coatings, inks, cleaning solvents, etc.) presently in use. This second approach also includes the use of more recent coating technologies such as powder coatings and ultraviolet (UV) radiation-cured coatings which do not contain significant amounts of HAP.

Table 3-1 summarizes available information on the emission reduction techniques used in the coating operations at metal can manufacturing facilities. The information was obtained from a survey of can manufacturers conducted by CMI in 1997, except where footnoted. The two major factors that influence the emission reduction technique used are: (1) the applicability of Federal, State, or local regulations affecting metal can surface coating operations; and (2) the availability of “compliant” coatings (i.e., coatings with VOC and/or organic HAP content below applicable emission limits) for the end use of cans that are produced by a facility. For example, the data in Table 3-1 indicate that many sheet coating lines reduce emissions through add-on capture and incineration, presumably because there are many food products for which acceptable low-VOC

Table 3-1. Emission Reduction Techniques Used by Coating Process/End Use^a

Coating process/end use	Number of lines using emission reduction technique							
	UV ^b	Powder	Non-HAP waterborne	Non-HAP solvent-borne	Waterborne coatings + capture/incineration	HAP-containing solvent-borne coatings + capture/incineration	HAP-containing waterborne coatings	HAP-containing solvent-borne coatings (no emission reduction)
SHEET COATING								
Three-piece printing	100	0	0	63	0	0	0	0
Three-piece can overvarnish	30	0	0	0	0	26	0	34
Three-piece sheet base coating	3	0	0	0	3	106	4	9
Two-piece draw-redraw base coating	0	0	0	0	0	2	0	0
END SEAL COMPOUNDS								
Food	0	0	0	0	0	9	0	53
Sanitary food	0	0	24	0	0	2	0	110
Aseptic food	0	0	0	0	0	0	0	3
Two-piece aluminum beverage	0	0	58	34	0	0	0	75
General line	0	0	0	0	0	0	1	14
Aerosol	0	0	26	0	0	0	0	0
"Compound" (end use not specified)	0	0	113	0	0	0	0	21
INSIDE SPRAYS								
Two-piece aluminum beverage	0	0	0	0	74	0	109	0
Steel draw-and-iron food cans	0	0	0	0	9	0	7	0
Three-piece steel food cans	0	0	0	0	0	1	0	0
TWO-PIECE DRAW & IRON CAN EXTERIOR COATINGS								
Base coat	0	0	0	0	15	0	28	0
Beverage can printing	5	0	0	0	37	0	68	0
Beverage can overvarnish	5	0	0	0	49	0	128	0
Rim coat	20	NK ^c	NK	NK	NK	NK	NK	NK
Steel food can wash coat	0	0	0	0	2	0	5	0

Table 3-1. (continued)

Coating process/end use	Number of lines using emission reduction technique							
	UV ^b	Powder	Non-HAP waterborne	Non-HAP solvent-borne	Waterborne coatings + capture/incineration	HAP-containing solvent-borne coatings + capture/incineration	HAP-containing waterborne coatings	HAP-containing solvent-borne coatings (no emission reduction)
SIDE SEAM STRIPE								
Overall	0	6	0	0	0	1 ^d	0	227

^a With the exception of the data for side seam stripe operations, these data are from the 1997 survey of can manufacturers conducted by CMI. Information on some non-members, especially smaller companies, is not represented. The survey results presented to EPA did not allow EPA to identify data from specific facilities. Therefore, information from other sources was not included unless it could be determined that the data were not double-counted.

^b Information on the number of lines using UV coatings provided by Radtech International North America.

^c "NK" = not known.

coatings have not been developed. Conversely, most two-piece beverage can facilities use waterborne coatings without control because coatings have been developed that allow facilities to meet existing (VOC) regulations in most areas without add-on controls.

3.1 CAPTURE SYSTEMS

Capture systems are designed to collect solvent laden air and direct it to a control device. In most can coating operations, solvent is removed from the thousands of cans coated each minute by evaporation in and around the coating applicator and in the subsequent curing oven. The exhaust from the applicators and ovens is then vented either to a control device or directly to the atmosphere. Some coatings, such as end seal compounds, can take up to 48 hours to fully cure and the associated air emissions are only partially captured and typically not controlled.

Differences in capture efficiency contribute much more to the variation in overall efficiencies than the choice of control device. Reported capture efficiencies in Table 3-2 ranged from estimates of less than 50 percent to the 100 percent capture which is assumed for systems meeting the requirements of permanent total enclosures. Test procedures are available to determine capture efficiency and to confirm the presence of permanent total enclosures.^{1,2}

Capture systems can be improved by extending the system to collect additional solvent laden air from other coating and cleaning operations and through constructing additional hooding and enclosures. In theory, capture can improve to (nearly) 100 percent for any given line or group of lines by retrofitting walls and increasing ventilation to meet the requirements of permanent total enclosures. In practice, it may be prohibitively expensive to retrofit some existing facilities.

3.2 ADD-ON CONTROL DEVICES

Add-on control devices are addressed within two categories: combustion control devices and recovery devices. Combustion control devices are defined as those devices used to destroy the contaminants, converting them primarily to carbon dioxide (CO₂) and water. The combustion control devices evaluated within this section include thermal incineration with recuperative and regenerative heat recovery and catalytic incineration.

**Table 3-2. Add-On Control Efficiencies Currently Achieved
by Coating Process/End Use^a**

Coating process/end use	(1) Range of CE achieved, % ^b	(2) Range of DE achieved, % ^c	Best OCE achieved by a particular line, % ^d		
			(3) CE	(4) DE	(5) OCE [(3) X (4)]
SHEET COATING					
Three-piece printing	60 - 100	90 - 95	100	95	95
Three-piece can overvarnish	60 - 100	90 - 95	100	95	95
Three-piece sheet base coating	60 - 100	90 - 95	100	95	95
Two-piece draw-redraw base coating ^e	95.2	99.3	95.2	99.3	94.5
END SEAL COMPOUNDS					
Food ^{f,g}	90	93.2	90	93.2	83.9
Sanitary Food ^{f,g}	70	90	70	90	63
Aseptic Food	0	0	0	0	0
Two-piece aluminum beverage	0	0	0	0	0
General Line (non-food)	0	0	0	0	0
Aerosol	0	0	0	0	0
INSIDE SPRAYS					
Aluminum beer & beverage cans	50 - 93	90 - 98.5	91.4	98.5	90
Steel draw-and-iron food cans	90	93.4	90	93.4	84
Three-piece steel food cans	77 - 97.5	91.6 - 92	97.5	92	89.7
TWO-PIECE DRAW & IRON CAN EXTERIOR COATINGS					
Base coat	50 - 92.2	95	90	95	85.5
Printing & Overvarnish	50 - 91.4	90 - 98.5	91.4	98.5	90
Steel food can wash coat	90	93.4 - 95	90	95	85.5
SIDE SEAM STRIPE ^h					
Overall	90 ^h	92.5	90 ^h	92.5	83.3

^a With the exception of the data for side seam stripe operations, these data are from the 1997 survey of can manufacturers conducted by CMI. Information on some non-members, especially smaller companies, is not represented. The survey results presented to EPA did not allow EPA to identify data from specific facilities. Therefore, information from other sources was not included unless it could be determined that the data were not double-counted.

^b "CE" means capture efficiency.

^c "DE" means destruction efficiency

^d "OCE" means overall control efficiency (CE x DE).

^e Information was only available for one facility.

^f Some industry representatives question the accuracy of capture efficiency for end seal compound application because unless baked in an oven, flashoff from end seams continues for several hours after application.

^g For food and sanitary food cans, only one facility in each category reported control of emissions from end seal compound application.

^h Industry representative from Can Corporation of America estimated 90% for their one facility.

Recovery devices are used to collect organic HAP/VOC prior to their final disposition, which may include organic HAP/VOC reuse, destruction, or disposal. One recovery device that is addressed in this section is carbon adsorption in conjunction with regeneration of the carbon bed by steam or hot air. Another system discussed is a proprietary system that uses oxidant-ozone counterflow wet scrubbing and granular-activated carbon adsorption with cold oxidation regeneration. Also within the recovery devices section, information regarding carbon adsorption with final destruction of organic HAP/VOC by incineration is provided.

As reported by the ICR respondents, the metal can industry has 147 add-on control devices at 73 facilities. Of those control devices, 142 are combustion control devices and 5 are recovery devices. It should be noted that the 5 recovery devices are all located at one facility.

3.2.1 Combustion Control Devices

Combustion is a rapid, high-temperature, gas-phase reaction in which organic HAP and/or VOC are oxidized to CO₂, water, sulfur oxides (SO_x), and nitrogen oxides (NO_x). If combustion is not complete, partial oxidation products, which may be as undesirable as the initial organic HAP and/or VOC, could be released. In order to avoid such occurrences, excess air (above the stoichiometric requirement) is used.¹ More complete process descriptions are provided below for each type of combustion control device.

3.2.1.1 Thermal Incineration

Thermal incineration is a process by which waste gas is brought to adequate temperature, and held at that temperature for a sufficient residence time for the organic compounds in the waste gas to oxidize. The constituents of the waste streams generated by metal can manufacturing surface coating operations will be converted to CO₂ and water in the presence of heat and sufficient oxygen.

A schematic diagram of a typical thermal incineration unit is provided in Figure 3-1. Primary components of the thermal incineration unit include a fan, a heat recovery device, the combustion chamber, and the exhaust stack. The heat recovery device is used to preheat the

incoming waste stream so that less auxiliary fuel is required in the combustion chamber. This type of heat recovery is known as primary heat recovery and can generally be described as either recuperative or regenerative. If the exhaust stream is of sufficient temperature and/or heating value so that little or no auxiliary fuel is needed, heat recovery may not be cost effective and thus may not be implemented. However, when auxiliary fuel is required, heat recovery can be used to minimize energy costs. Each type of heat recovery is discussed in more detail later in this section.

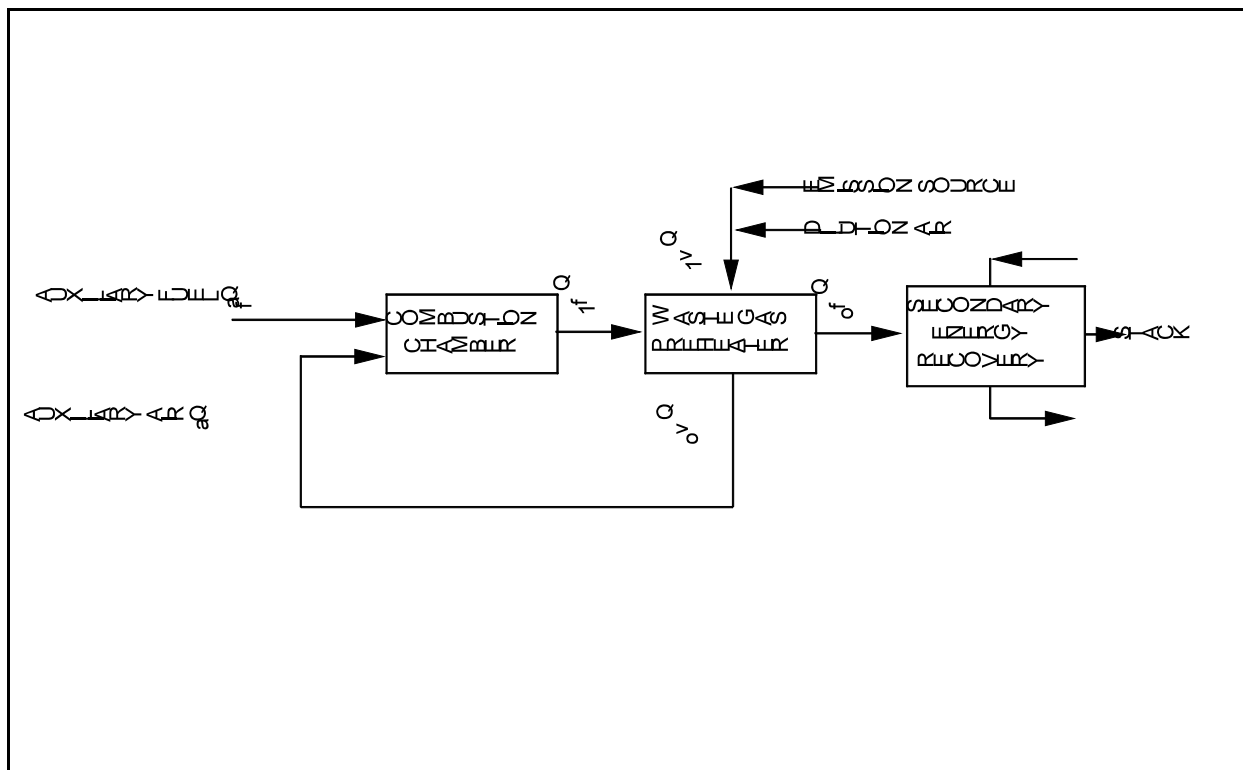


Figure 3-1. Thermal incinerator--general case.

In order for the thermal incinerator to achieve the desired destruction efficiency, certain key parameters must be controlled. These parameters include the combustion airflow rate, the waste stream flow rate, auxiliary fuel requirements, residence time, combustion chamber operating temperature, and the degree of turbulence between the air and combustible materials. Residence time is the time required for the initiation and completion of the oxidation reactions. Operating temperature is a function of the residence time, the oxygen concentration, the type and concentration of the contaminant involved, the type and amount of auxiliary fuel, and the degree

of mixing. The destruction efficiency for a particular contaminant is a function of the operating temperature and residence time at that temperature. A temperature above 816°C (1500°F) will destroy most organic vapors and aerosols. Turbulence, or the mechanically induced mixing of oxygen and combustible material, can be increased by the use of refractory baffles and orifices to force adequate mixing in the combustion chamber. Alternatively, mixing can be enhanced by the use of over-fire air, the injection of air into the combustion zone at a high velocity, or by a forced air draft.¹

Standard Operating Conditions for Thermal Incinerators. Thermal incinerators generally operate at a temperature ranging between 650° and 870°C (1200° and 1600°F) and require a minimum residence time of 0.3 seconds in the combustion zone.¹ Most thermal units are designed to provide no more than 1 second of residence time to the waste gas in the combustion chambers.³ The average operating temperature reported in the ICR responses was 773°C (1425°F) with nominal residence times of 0.5 to 1.5 seconds.

Thermal incinerators can be designed to control flow rates in excess of 2,832 cubic meters per minute (m³/min) (100,000 cubic feet per minute [ft³/min]). The organic HAP/VOC concentration of waste streams controlled via thermal incineration can be from the part per million (ppm) range to 25 percent of the lower explosive limit (LEL). The organic HAP/VOC concentrations typically cannot exceed 25 percent LEL for safety and insurance reasons.

Heat Recovery in Thermal Incinerators. Heat recovery reduces the incinerator's or other process' energy consumption. Primary heat recovery means preheating the incoming waste stream to the incinerator by transferring heat from the incinerator exhaust so the combustion chamber requires less auxiliary fuel. Secondary heat recovery means exchanging heat in the exhaust and leaving the primary device for heat recovery to some other medium used in plant processes.

Recuperative or regenerative devices can be used for primary heat recovery. The waste gas preheater shown in Figure 3-1 could be a recuperative heat exchanger. As shown in this figure, a

heat exchanger transfers heat to the incoming waste stream from the incinerator exhaust stream. In a recuperative heat exchanger, the incinerator's effluent continuously heats the incoming stream in a steady-state process. Typical heat exchangers for recuperative heat recovery include plate-to-plate and shell-and-tube. Choosing a type of heat exchanger depends on the waste gas flow rate, the desired heat exchange efficiency, the temperature of the incinerator exhaust stream (used for preheat), and economics. Recuperative heat exchangers can recover 70 percent of the energy in the incinerator exhaust gas, thereby reducing fuel, the primary operating cost, by 70 percent.⁴

An incinerator employing regenerative heat recovery is presented in Figure 3-2. Figure 3-2 illustrates a two-chamber design in which process exhaust air is purified in a conventional combustion chamber but uses two beds of ceramic material to recover thermal energy. The

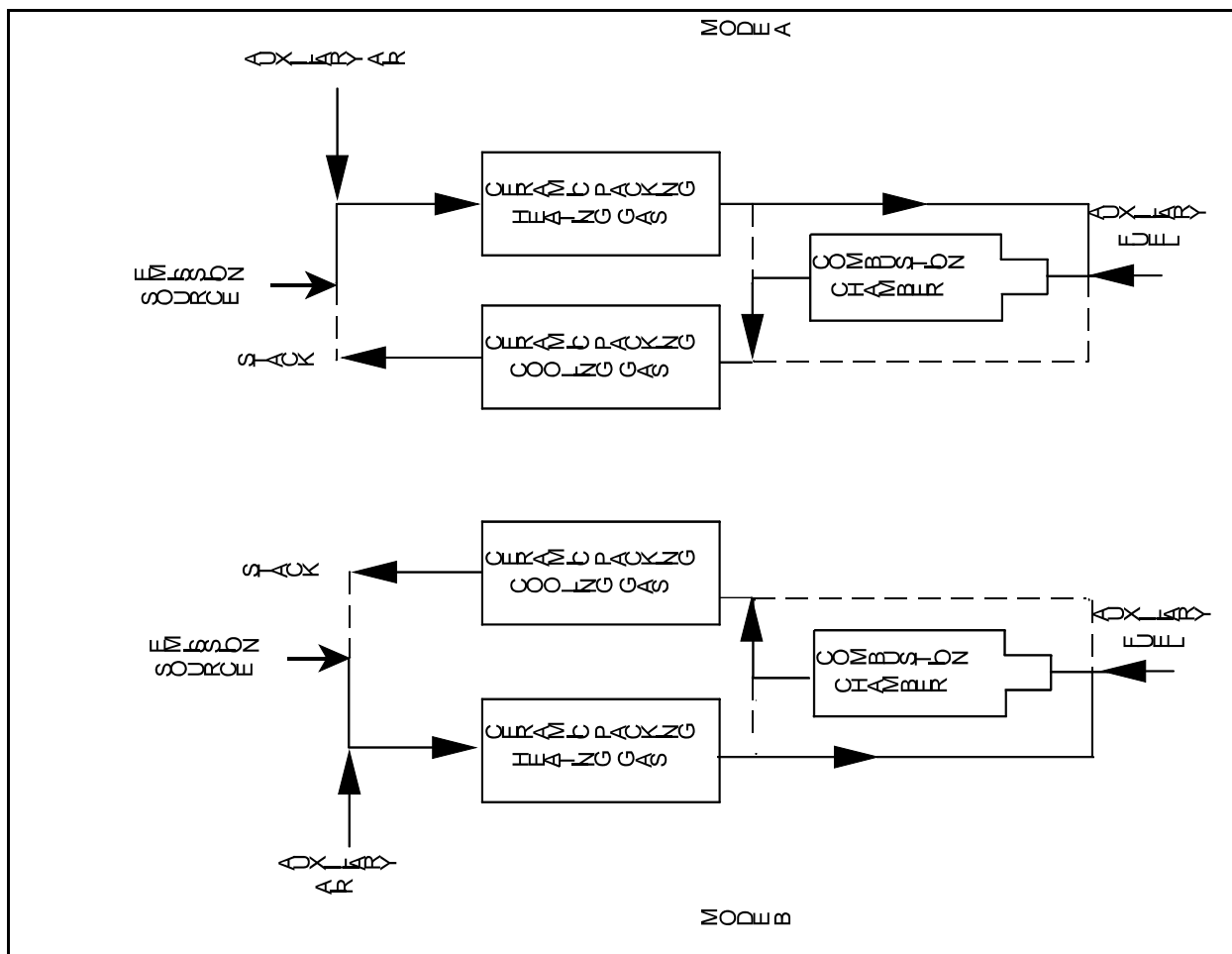


Figure 3-2. Regenerable-type thermal incinerator.

process exhaust passes through a bed of ceramic heat sink material that was left hot at the end of a preceding cycle. As the air passes over the ceramic, it extracts heat from the bed. This leaves the ceramic bed cool at the end of the cycle and raises the air temperature to near the desired thermal destruction temperature (combustion chamber temperature). Firing natural gas, propane, or fuel oil into the combustion chamber adds heat to reach the destruction temperature. The airstream leaving the combustion chamber passes through the other ceramic bed, which was left cool during the preceding cycle. The ceramic bed absorbs the heat from the airstream, leaving the ceramic bed hot at the end of this cycle and the exit airstream relatively cool.

The inlet and discharge airstreams are reversed, so that the ceramic beds absorb and reject heat from the airstream on a cyclical basis. When the cycle reverses and the ceramic bed at the inlet becomes the bed at the outlet, some contaminated air is left in the ceramic bed chamber. The volume of contaminated air in the inlet heat sink chamber must be displaced into the combustion chamber before extracting the high-temperature combustion air through it to attain the maximum overall destruction efficiency from a regenerative thermal incinerator. A system designed to “purge” the chamber is provided in a three-chamber design. In this system the same type of absorption/rejection of heat occurs, but the third chamber allows time between inlet and discharge cycles to purge each chamber at the end of an inlet cycle. Regenerative heat recovery systems can recover 95 percent of the energy in the incinerator exhaust gas, with a comparable reduction in fuel, the major operating cost.⁴

Thermal Incinerator Efficiency. Studies indicate that a well designed and operated commercial incinerator can achieve at least a 98 percent destruction efficiency (or an outlet concentration of 20 ppm) of nonhalogenated organics. This destruction efficiency corresponds to incinerators that are operated at 871°C (1600°F) with a nominal residence time of 0.75 second.³

Those metal can facilities with thermal incinerators reported destruction efficiencies ranging from 73 to 100 percent. However, most of the reported values were in the 90 to 95 percent range. (See Tables 4-6 through 4-9 for facility specific control device information.)

3.2.1.2 Catalytic Incineration

Catalytic incineration is comparable to thermal incineration in that VOC and/or organic HAP are heated to a temperature sufficient for oxidation to occur. The temperature required for oxidation with catalytic incineration is considerably lower than that required for thermal incineration because a catalyst is used to promote oxidation of contaminants. The catalyst is imposed on a large surface containing many active sites on which the catalytic reaction occurs. Platinum is the most widely used catalyst; palladium is also commonly used. Because the metals used as catalysts are expensive, only a thin film is applied to the supporting substrate. Ceramic materials are commonly used as the supporting substrate.⁵

Figure 3-3 is a schematic of a typical catalytic incineration system. As indicated in this figure, components of the system include a fan, a preheat chamber, a catalyst chamber, a waste gas preheater (recuperative heat recovery device), secondary heat recovery, and a stack. The preheat chamber is used to heat the incoming waste stream to the required oxidation temperature, usually between 149° and 482°C (300° and 900°F) for catalytic incineration.¹⁰ The mixing chamber is used to thoroughly mix the hot combustion products from the preheat chamber with the exhaust waste stream. This ensures that the stream sent to the catalyst bed is of uniform temperature. Combustion of the VOC in the waste gas then takes place at the catalyst bed. The catalyst bed may be a fixed bed or a fluidized bed consisting of individual pellets enclosed in a screened unit. The recuperative heat recovery device (if incorporated) is a shell-and-tube or plate-to-plate heat exchanger. A heat recovery device is used if supplemental fuel requirements are expected to be high.¹⁰

Many parameters affect the performance of a catalytic incineration system. The primary factors include operating temperature, space velocity (inverse of residence time), organic HAP/VOC concentration and species, and catalyst type and susceptibility to contaminants.⁵ The optimum operating temperature depends on the type of catalyst, as well as the concentration and type of organic HAP/VOC. Space velocity is defined as the volume of gas entering the catalyst bed divided by the volume of the catalyst bed. In general, as space velocity increases, destruction efficiency decreases.⁵ One factor that increases the space velocity is increased temperature. The

amount and type of organic HAP/VOC determine the heating value of the waste stream and thus the amount of supplemental fuel required to maintain the desired operating temperature.

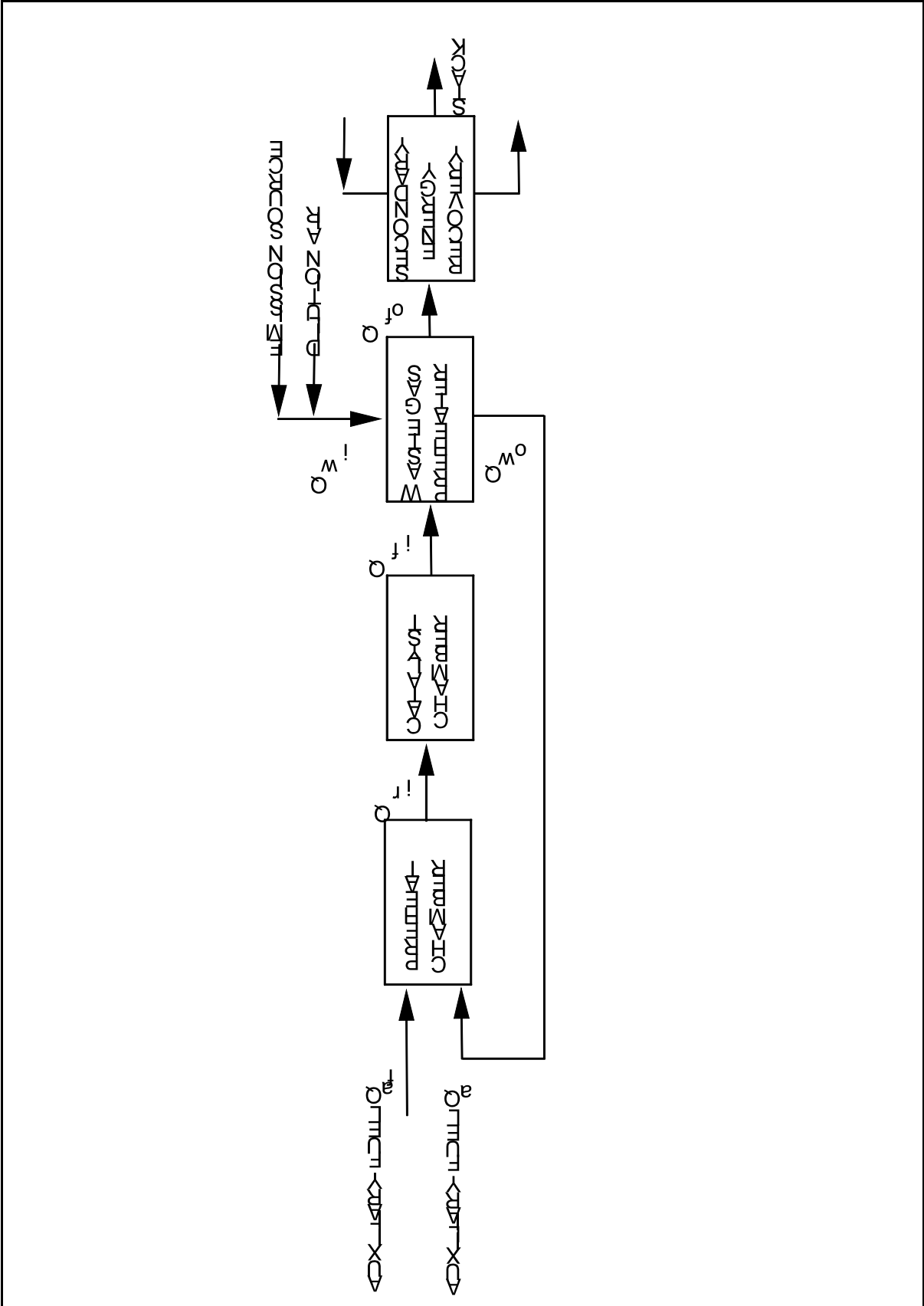


Figure 3-3. Schematic of a typical catalytic incineration system.

The type of catalyst that is used is determined by the organic HAP/VOC in the waste stream. Particulates and catalyst poisons in the waste stream can affect the efficiency of the catalyst and its lifetime. Some materials that are considered catalyst poisons include heavy metals (mercury, lead, iron, etc.), silicon, sulfur, halogens, organic solids, and inert particulates.⁵ Particulates and poisons reduce the activity of the catalyst site, minimizing sites available for the oxidation reaction. These materials can also mask, plug, or coat the catalyst surface, thereby eliminating available catalyst sites.

Standard Operating Conditions for Catalytic Incineration. The catalyst bed in catalytic incinerators generally operates at temperatures ranging between 149° and 482°C (300° and 900°F), with temperatures rarely exceeding 538°C (1000°F). The contact time required between the contaminant and the catalyst so that complete oxidation occurs is normally 0.3 second. The excess air requirements for catalytic incineration units are usually only 1 to 2 percent higher than the stoichiometric requirements.^{1,5} Catalytic incinerators can be designed to control waste gas flow rates up to about 1,416 m³/min (50,000 ft³/min). The VOC content of the waste stream may be in the part-per-million range up to 25 percent LEL. The range of operating temperatures reported in the ICR responses was 370° to 420°C (700° to 800°F) with a nominal residence time of 1.0 to 1.5 seconds.

Catalytic Incinerator Efficiency. A well operated and maintained catalytic incineration unit can achieve destruction efficiencies of 98 percent, comparable to thermal incineration units. The destruction efficiency would decrease in the presence of the catalyst poisons and particulates described above.⁶ Those metal can facilities with catalytic incinerators reported destruction efficiencies ranging from 90 to 98 percent. (See Tables 4-6 through 4-9 for facility specific control device information.)

3.2.2 Recovery Devices

Organic HAP and/or VOC in a waste gas stream can be collected through adsorption of the contaminants onto a porous bed. The contaminants can then be recovered, if desired, by desorption of the bed with steam or hot air. Contaminants can be condensed and recovered or

disposed of after desorption or regeneration. Alternatively, contaminants can be sent to an incinerator for destruction after regeneration by hot air. The following section discusses the use of activated carbon adsorption systems followed by steam and hot air regeneration.

3.2.2.1 Carbon Adsorption

The carbon adsorption process used to control organic HAP/VOC emissions from waste gas streams can be subdivided into two sequential processes. The first process involves the adsorption cycle, in which the waste gas stream is passed over the adsorbent bed for contaminant removal. The second process involves regeneration of the adsorbent bed, in which contaminants are removed using a small volume of steam or hot air, so that the carbon can be reused for contaminant removal.

Adsorption is the capture and retention of a contaminant (adsorbate) from the gas phase by an adsorbing solid (adsorbent). The four types of adsorbents most typically used are activated carbon, aluminum oxides, silica gels, and molecular sieves. Activated carbon is the most widely used adsorbent for air pollution control and is the only type of adsorbent discussed in this section.¹ Both the internal and external surfaces of the carbon are used as adsorption sites. Diffusion mechanisms control the transfer of the adsorbate from the gas phase to the external surface of the carbon, from the external surface of the carbon to internal pores, and finally to an active site in the pores. Adsorption depends on a mass transfer gradient from the gas phase to the surface. There are two distinct adsorption mechanisms: physical adsorption and chemisorption. In physical adsorption (also referred to as van der Waals adsorption), the adsorbate is attracted to the carbon by a weak bonding of gas molecules to the solid (similar to the attraction forces between molecules in a liquid).¹ Some method of heat removal from the carbon may be necessary because adsorption is an exothermic process, depending on the amount of contaminant being removed from the gas phase. In chemisorption, the adsorbate is actually chemically bonded with the adsorbing solid. Chemisorption is not as easily reversible as physical adsorption.⁷

Regeneration is the process of desorbing the contaminants from the carbon. Regeneration of the carbon bed is usually initiated prior to “breakthrough.” Breakthrough, as the name implies, is that point in the adsorption cycle at which the carbon bed approaches saturation and the concentration of organics in the effluent stream begins to increase dramatically. If the carbon bed is not regenerated, the concentration of VOC in the effluent will continue to increase until it is equal to that of the inlet; i.e., the carbon is saturated. Regeneration can be accomplished by reversing the conditions that are favorable to adsorption--by increasing the temperature and/or reducing the system pressure. The ease of regeneration depends on the magnitude of the forces holding the VOC to the surface of the carbon. The most common method of regeneration is steam stripping. Low-pressure, superheated steam is introduced into the carbon. The steam releases heat as it cools; this heat is then available for adsorbate vaporization. Another regeneration method is the use of hot, inert gas or hot air. With either steam or hot air regeneration, the desorbing agent flows through the bed in the direction opposite to the waste stream. This desorption scheme allows the exit end of the carbon to remain contaminant-free.¹

In a regeneration process, some adsorbate, known as the “heel,” may remain in the carbon after regeneration. The actual capacity of the carbon is referred to as the working capacity and is equal to the total capacity of the carbon less the capacity taken by the heel.⁷

Adsorption units that are commonly used to remove contaminant from waste gas streams include the following:

1. Fixed or rotating regenerable carbon beds;
2. Disposable/rechargeable carbon canisters;
3. Traveling bed carbon adsorbers;
4. Fluid bed carbon adsorbers; and
5. Chromatographic baghouses.

Of the five adsorption systems listed above, the first two are most commonly used for air pollution control. The disposable/rechargeable canisters are used for controlling low flow rates (less than 3 m³/min (100 ft³/min) and would not be used to control the high-volume flow rates

typical of the metal can surface coating operations. Only the fixed-bed, regenerable carbon adsorption system is discussed in this chapter.⁷

A fixed-bed, regenerable carbon adsorption system is presented in Figure 3-4. The components of the carbon adsorption system include:

1. A fan (to convey the waste gas into the carbon beds);
2. At least two fixed-bed carbon adsorption vessels;
3. A stack for the treated waste gas outlet;
4. A steam valve for introducing desorbing steam;
5. A condenser for the steam/contaminant desorbed stream; and
6. A decanter for separating the organic HAP/VOC condensate and water.

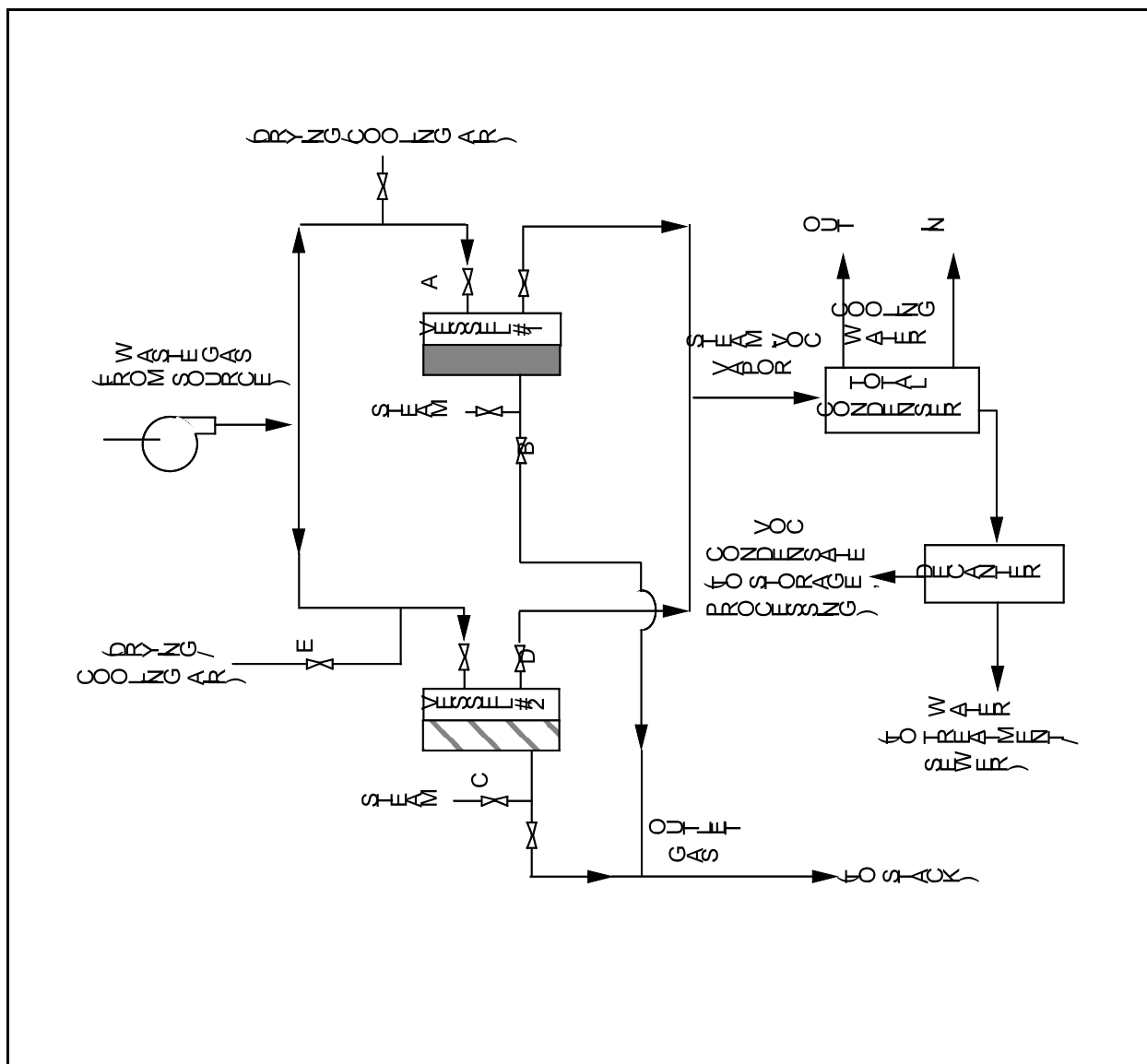


Figure 3-4. Typical carbon adsorber operating continuously with two fixed beds.

In the system depicted in Figure 3-4, one carbon vessel is being used for adsorption while the other is being regenerated. Both vessels will alternate in the adsorption and regeneration modes. The steam is used to regenerate a vessel and is then sent to a condenser. The condensate is a water and organic HAP/VOC mixture. The decanter can be used to separate the condensate into a water stream and a condensate stream. The resulting water may be treated or discharged to the sewer depending on its measured toxicity. The condensed organics can be recycled (if usable), used as a fuel, or disposed of.

Hot air or a hot inert gas could be employed in lieu of using steam for regeneration. After regeneration, the desorbing stream would then consist of an air or gas stream with a high organic HAP and/or VOC concentration. This air or gas stream could then be sent to an incinerator for final destruction of organic HAP and/or VOC.

Factors That Affect Adsorption Efficiency. Several factors affect the amount of material that can be adsorbed onto the carbon bed. These factors include type and concentration of contaminants in the waste gas, system temperature, system pressure, humidity of waste gas, and residence time.⁷

The type and concentration of contaminants in the waste stream determine the adsorption capacity of the carbon. Adsorption capacity is defined as the pounds of material adsorbed per pound of carbon. In general, adsorption capacity increases with a compound's molecular weight or boiling point, provided all other parameters remain constant. There is also a relationship between concentration and the carbon adsorption capacity. As concentration decreases, so does the carbon capacity. However, the capacity does not decrease proportionately with the concentration decrease. Therefore, carbon capacity still exists at very low pollutant concentration levels.⁷

Increases in operating temperature decrease adsorption efficiency. At higher temperatures, the vapor pressure of the contaminants increases, reversing the mass transfer gradient. Contaminants would then be more likely to return to the gas phase than to stay on the carbon. At lower temperatures, the vapor pressures are lower, so the carbon will likely retain the contaminants.¹

The system pressure also improves adsorption's effectiveness. Increases in the gas phase pressure promote more effective and rapid mass transfer of the contaminants from the gas phase to the carbon. Therefore, the probability that the contaminants will be captured is increased.¹

The relative humidity or moisture content of the gas phase reduce the adsorption efficiency. Although water vapor is not preferentially adsorbed over the contaminants, the presence of water vapor in the gas phase has been demonstrated to have a negative effect on the adsorption capacity of the carbon. However, the effect of humidity or moisture in the gas phase is insignificant for VOC concentrations greater than 1,000 ppm and during the initial startup of the adsorption cycle (the carbon is drier). Indeed, some moisture content in the gas phase can be beneficial. For instance, when high concentrations of contaminants with high heats of adsorption are present, the temperature of the carbon bed may rise considerably during adsorption due to the exothermic nature of the process. The presence of water may minimize the temperature rise.⁷

Adsorption efficiency varies slightly if contaminants don't have enough contact (residence) time with the active sites of the carbon which allows mass transfer to occur. Contaminants especially need this time if many molecules (high-concentration streams) are competing for the same sites. Residence time of the contaminants with the active sites can be increased by using larger carbon beds, but then the pressure drop across the system increases, resulting in increased operating costs.¹

Standard Operating Conditions of Carbon Adsorbers. Fixed-bed carbon adsorption units have been sized to handle flow rates ranging from several hundred to several hundred thousand ft³/min. There is no obvious practical limit to flowrate because multibed systems operate with multiple beds in simultaneous adsorption cycles. The VOC and/or organic HAP concentrations of the waste streams controlled by carbon adsorption units can range from the part per billion level to as high as 20 percent of the LEL. Adsorption systems typically operate at ambient pressure and temperatures ranging between 25° and 40°C (77° and 104°F).¹

Carbon Adsorption Efficiency. Carbon adsorption recovery efficiencies of 95 percent and greater have been demonstrated to be achievable in well designed and well operated units.⁸⁻¹⁰ The performance of the carbon adsorption unit is negatively affected by elevated temperature, low pressure, high humidity, as previously discussed.

3.3 POLLUTION PREVENTION TECHNIQUES

The following sections discuss pollution prevention alternatives to reducing air emissions associated with metal can surface coating operations. Some of these options, such as the use of high solids and waterborne coatings and inks, are widely used throughout the metal can industry, while others, such as UV-cured and powder coatings, are used in several smaller applications.

3.3.1 High Solids Coatings

3.3.1.1 Background

High solids coatings are solventborne coatings that have reduced organic solvent content. According to the CMI survey data presented in Table 2-3, high-solids coatings typically contain from 2.3 to 5.0 lb VOC/lb gal minus water coating, and the organic HAP content of high-solids coatings ranges from 0.2 to 0.7 lb HAP/lb solids applied. The range of organic HAP content of high solids inks used by facilities that responded to CMI's 1997 survey is from approximately 6 to 17 percent by weight. The most widely used high-solids coating is polyurethane.

High-solids coatings are typically applied by either spray or roller methods. High-solids coatings have higher viscosities than conventional coatings. Application of high-solids coatings requires different application equipment from conventional solventborne coatings, such as heating units to reduce viscosity.

3.3.1.2 Applicability to Metal Can Surface Coating Operations

High-solids coatings have replaced conventional solventborne coatings as exterior base coatings in some low-process three-piece and two-piece draw-redraw can manufacturing. ("Low process" means that there are no retort steps and that pre-coated metal is not subjected to fabrication steps that may damage the coating.) High solids coatings have also been developed for use as interior coatings for cans containing meat, pet food, fish, tomatoes, and juices, particularly shallow draw-redraw cans and easy-open can ends. High-solids decorative inks are also used in two-piece aluminum can manufacturing. These inks are polyester-based and have the consistency of a solid paste. The printing process is called dry offset lithography because the ink is almost a

solid. High solids solventborne end seal compounds are used for beer and beverage cans as well as food cans.

3.3.2 Waterborne Coatings

3.3.2.1 Background

Waterborne coatings are surface coatings in which water is the main solvent or dispersing agent.¹¹ The various waterborne formulations available have distinct differences based on the types of polymers used in the formulation. Waterborne coatings contain a polymer or resin base, water, and organic solvent. The organic polymers found in water-based coatings include alkyds, polyesters, vinyl acetates, acrylics, and epoxies, which can be dissolved, dispersed, or emulsified. The water acts as the main carrier or dispersant, while the organic solvent aids in wetting, viscosity control, and pigment dispersion. Waterborne coatings may be water emulsions, solutions, or colloidal dispersions. The various polymers determine the cured film properties of the finish. However, there is one common feature: each type employs water as the major solvent or carrying liquid for polymers.^{11,12}

Waterborne finishes formulated with water-emulsion polymers are true emulsions; the polymers are discrete water-insoluble spherical particles of high molecular weight uniformly dispersed in water. Waterborne coatings considered as solutions are formulated with copolymers formed in a polymerization reaction occurring in a water-miscible solvent such as alcohol. The polymers have polar groups that allow water-reducibility and, thus, true solutions of polymers in water. Waterborne finishes known as colloidal dispersions contain colloidal dispersion polymers in which particles of a medium molecular weight (not as high as the emulsion polymers) are dispersed in water. The colloidal dispersion polymers have polar groups, thus allowing some degree of solubility. The colloidal dispersion formulations are not true solutions but are also not true emulsions because there is some degree of solubility of the polymers in the solvent.¹²

Each type of waterborne coating exhibits different film properties depending on the type of polymer in the formulation. The water-emulsion formulations are of a higher molecular weight and therefore offer advantages in the areas of durability and chemical and stain resistance.^{11,12}

Water-reducible formulations offer high gloss, clarity, and good application properties. However, their film is not as durable as that of the water-emulsions, and the viscosity and properties of the finishes are very dependent on molecular weight.¹¹ The water-soluble formulations exhibit properties of the water-emulsion and water-reducible formulations. The water-soluble finishes offer high gloss and good application properties and are also durable and chemical- and stain-resistant.¹¹

Waterborne finishes can be formulated for air/force drying or for baking, depending on the binders in the formulation. Waterborne finishes may cure in the same manner as the solventborne finishes. Curing occurs through oxidative or thermosetting cross-linking reactions. Waterborne finishes may also cure via latex coalescence.^{11,13} Latex coalescence occurs when a polymer is dissolved in solvent, then dispersed in water. Either the solvent or water then evaporates, leaving a polymer dispersed in solvent or water. As the remaining liquid evaporates, the pressures force the polymer to coalesce. No polymerization takes place; these are a special form of nonconvertible finishes.

The VOC and organic HAP content of waterborne coatings varies substantially. Waterborne coatings are usually not free of VOC and/or organic HAP. Cosolvents are added to allow adequate coalescence and film formation, as well as color penetration for pigmented materials. Based on the survey information reported in the project database, the two-piece beverage industry segment uses predominantly waterborne coatings. Inside sprays for both food and beverage cans average 55 to 65 percent water with organic HAP contents ranging from 1.7 to 3.7 lb HAP/gal solids. The overvarnishes used on beverage cans averaged 53 percent water and 1.2 lb HAP/gal solids. Rim/bottom coatings averaged 40 percent water and 1.8 lb HAP/gal solids. The overall organic HAP emission reduction for a metal can facility depends on the number of finishing steps and coating lines for which waterborne finishes can be used.

3.3.2.2 Applicability to Metal Can Surface Coating Operations

Both solvent-borne and waterborne materials are extensively used in the surface coating operations associated with the metal can industry. In recent years, the industry and its coating suppliers have made significant strides in reformulating most of the solvent-borne coatings and inks, as described above, so that lower-HAP (and lower-VOC) materials can be used. Some of the lower organic HAP/VOC coatings may not apply to all segments of the metal can industry.

Waterborne coatings are currently being used by most of the metal can manufacturers. The potential exists for waterborne coatings to be used, at least in part, by all segments of the metal can industry. However, the waterborne coatings currently available are better suited to certain applications than others. According to the CMI survey data presented in Table 2-3, waterborne coatings contain approximately 1.4 to 3.6 lb VOC/lb gal coating, minus water. The organic HAP content of waterborne coatings ranged from 0.06 to 0.4 lb HAP/lb solids applied.

Beverage can manufacturers use waterborne coatings extensively. Waterborne coatings are used for two-piece beverage can base coats, overvarnishes, inside sprays, and rim coats. Waterborne coatings are also used for two-piece food can wash coats, two- and three-piece can inside sprays and exterior end coatings, and three-piece can exterior base coats. Waterborne interior side seam stripe coatings have been developed for thin and medium film weight requirements but have not yet been commercialized.

Waterborne coatings can use the same application equipment as conventional solventborne coatings; however, equipment used to apply waterborne coatings must be dedicated to waterborne coatings. This is because solventborne coating residues are incompatible with waterborne coatings and must be completely removed from the equipment before water-based coatings can be used. Removing solventborne coating residue from the application equipment is a laborious and uneconomical process. Moreover, additional costs may be incurred because some equipment that is susceptible to corrosion, including tanks, piping, and process equipment, may need to be replaced.

Water-based end seal compounds are used for general line and aerosol cans, and have limited application for certain beverages and foods. Conventional solventborne coatings are also used as interior coatings (including some sheet coatings, inside sprays, and side seam stripe coatings) for cans containing certain foods and non-food products (e.g., paints and varnishes) for which no suitable replacement coatings have been developed.

3.3.3 Ultraviolet (UV)-Curable Finishes

3.3.3.1 Background

Radiation curing is a technology that utilizes electromagnetic radiation energy to affect chemical and physical change of organic finish materials by the formation of cross-linked polymer networks. One type of radiation used is UV light. The primary components of UV-curable finishes are multifunctional polymers (acrylates, acrylated oligomers), monofunctional diluent monomers, and the photoinitiators. The oligomers provide most of the desired coating properties, such as flexibility, hardness, and chemical resistance. The monomers decrease the viscosity of the polymers and improve other features such as gloss, hardness, and curing speed. The photoinitiator absorbs the UV light and initiates free radical polymerization, the curing process. The diluent serves as a viscosity modifier for the coating, enabling the coating to be applied to the substrate. It is similar to a solvent in this regard. In traditional UV finishes, however, most of the diluent also polymerizes and becomes part of the coating film.¹⁴ However, the small amount of diluent in the coating that does not reach the piece and, thus, is not incorporated into the final film, is emitted.

Ultraviolet-curable finishes are convertible finishes; the curing process is via polymerization. The curing process for UV-curable finishes is very fast. As the substrate is exposed to UV radiation, the photoinitiator absorbs the light and initiates near-instant polymerization. Polymerization, or curing, of the material is rapid, providing a final film that is stain-, scratch-, and mar-resistant. Finished pieces can immediately be stacked because the curing is so rapid. Other properties of the UV-cured film include heat resistance, durability, and good build.

Ultraviolet-curable finishes do not typically contribute substantial organic HAP emissions (due to the polymerization process discussed above) and often are considered to contain up to 97 to 100 percent solids since 100 percent of the components react to form the coating. However, as previously stated, a plant's overall emission reductions depend on the number of coating steps used by a facility that switches from solvent-borne to UV-curable coatings.

Two categories of UV coatings are currently in use: (1) acrylate epoxies, urethanes, and polyesters known as "free radical" types; and (2) cationic epoxies. As the names imply, free radical UV coatings contain photochemical initiators that release free radicals when bombarded by UV light, whereas the photochemical initiators in cationic epoxies produce protons. Free radical UV coating technology is older and is the most commonly used type of UV coating. However, cationic epoxies are being developed with superior properties and are expected to eventually replace free radical-type UV coatings.

The UV coatings have the advantages of rapid curing, low process temperatures, extremely low VOC content (less than 0.01 lb VOC/gal coating) and HAP content, and lower energy costs due to the elimination of drying ovens. Additionally, UV application and curing equipment occupies less plant space than conventional coating and drying equipment. However, UV coatings are more expensive than conventional coatings. Also, UV coatings require specialized equipment; consequently, retrofitting an existing coating line involves a significant capital investment. Finally, UV-cured coatings are used only as exterior coatings because they have not been approved by the FDA for use in interior coatings, due to the tendency of UV coatings to release the photoinitiator compounds, which are potentially harmful, into the contents of the can.

3.3.3.2 Applicability to Metal Can Surface Coating Operations

Ultraviolet-curable finishes are currently used in only a few applications and segments of the metal can industry.¹⁴ Ultraviolet radiation-cured overvarnishes and inks are currently used at one two-piece beverage can facility and are used for rim coats at some two-piece beverage can facilities. Additionally, UV exterior coatings (including inks) are used on several sheet coating lines at steel can and can end sheet coating facilities. Ultraviolet radiation-cured inks are widely

used for three-piece can decoration. However, UV coatings that are not inks have not yet received widespread acceptance in the industry. According to a 1995 EPA report on UV coatings (report no. EPA-600/R-95-063), manufacturers have had the following problems with UV coatings: yellowing of UV overvarnishes, difficulties obtaining the proper shade with UV white base coats, inadequate abrasion resistance, and slow cure speed. However, representatives of UV coating manufacturers maintain that advances in UV coating chemistry, notably new cationic epoxy formulations with improved performance characteristics, will gain increasing acceptance by can manufacturers in the near future.

Ultraviolet-curable finishes can be applied using spray equipment, roll coaters, or curtain coaters. Therefore, the potential exists for UV-curable finishes to be used on can exteriors as well as flat coil or panels, and some companies see progress in this direction. However, curing of interior areas and three-dimensional pieces, such as the inside of a metal can and a can's curved exterior surface combined with the bottom, remains very difficult because all of the coating material must be exposed to the UV radiation. Problems arise in curing surfaces that do not get direct exposure to the radiation. Therefore, the only UV-curable finishes that are used in the metal can industry are on flat line operations. Many studies in other industries are being conducted in the area of three-dimensional UV-curing so that UV-curable materials may experience more widespread use in the future.¹⁴

3.3.4 Powder Coatings

3.3.4.1 Background

Powder coatings are composed of fine, dry particles of paint solids and contain very low concentrations of VOC and HAP. They are applied using electrostatic deposition, fluidized bed dipping, or flame spraying, and are heat-cured in infrared ovens.

There are two types of powder coatings: thermoplastic and thermoset. Thermoplastic powder coatings are based on high molecular weight thermoplastic resins. These coatings melt and flow upon the application of heat, even after they have cooled and solidified. Thermoset powder coatings, on the other hand, cannot be melted after heat is applied because the curing process

results in a chemical change to a heat resistant compound. Both types of powder coatings require high curing temperatures, ranging from 60° to 204°C (140° to 400°F).

3.3.4.2 Applicability to Metal Can Surface Coating Operations

Powder coatings exhibit many favorable qualities for can coating applications, including excellent resistance to various chemicals, abrasion resistance, and barrier qualities. Powder coatings can be used as rim coatings for two-piece beverage cans, and are currently used for three-piece side seam stripe coatings at some facilities. However, the application processes are generally not fast enough for can coating line speeds. Also, powder coatings are not yet available in the variety of colors, finishes, and textures required by can manufacturers and their customers.

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Chapter 4

Model Plants and Control Options

4.0 INTRODUCTION

This chapter describes model plants and control options for representative types of metal can surface coating facilities. As discussed in previous chapters, the project database contains information on 208 can manufacturing facilities producing more than 98 percent of all cans made in the United States. Therefore, the model plants described for this industry are quite representative of the actual facilities comprising the subcategory or coating type segment included. The model plants were developed to evaluate the general effects of various control options on the source category. However, since the project database includes practically all known affected sources, the associated costs and impacts discussed in Chapter 6 were developed for each individual facility rather than for the model plant types. Control options for each model plant were selected based on the applicability of presently available control technologies to the industry segment represented.

4.1 MODEL PLANTS

Model plants have been developed to represent the actual range of capacity and overall control efficiency as determined by responses to the information collection requests. Model plants have been specified for the following seven primary types of metal can surface coating facilities:

- Two-piece beverage can facilities;
- Two-piece food can facilities;
- One-piece aerosol can facilities;
- Sheetcoating facilities;
- Three-piece food can assembly facilities;

- Three-piece non-food can assembly facilities; and
- End lining facilities.

Because the majority of facilities comprising the metal can surface coating industry were surveyed and are included in the project database, these model plants represent groupings of actual facilities in the database. These groupings are based on the subcategories and coating type segments determined as part of the background information, determination of MACT floor(s), and evaluation of regulatory alternatives.

Table 4-1 summarizes data for the seven types of model plants, including the number of actual facilities in each model plant category, the total and average amounts of coatings and solids used by those facilities, and the associated total and average organic HAP emissions, both before and after existing controls. These total and average values were derived from the facility-specific values given in tables 4-2 through 4-8.

The number of facilities in each model plant category is the total number of sources in the project database that apply surface coatings of that type. Since an individual facility may apply more than one coating type, one facility may be represented in several model plants. However, each category includes only coatings specific to that category. For example, overvarnishes and interior body base coats are included only in the sheetcoating source category, end seal compounds only in the end lining source category, etc.

Table 4-1. Summary of Metal Can (Surface Coating) Model Plant Categories

Industry segment	Two-piece beverage	Two-piece food	One-piece aerosol	Sheetcoating	Food can assembly	Non-food can assembly	End lining
Number of Facilities (sources)	57	11	2	60	28	13	53
Total Coating Usage (gallons of coating)	25,758,833	2,503,204	146,875	9,265,269	351,724	34,216	2,607,435
Total Coating Solids Usage (gallons of solids)	6,243,476	604,999	47,692	3,496,786	115,419	13,001	1,127,850
Total HAP Emissions (tons/yr) Before Existing Controls	6,524	989	172	9,596	430	50	840
Total HAP Emissions (tons/yr) After Existing Controls	4,922	843	18	2,522	408	50	840
Model Plant No.	1	2	3	4	5	6	7
Average Coating Usage (gallons of coating)	451,909	227,564	73,438	154,421	12,562	2,632	49,197
Average Coating Solids (gallons of solids)	109,535	55,000	23,846	58,280	4,122	1,000	21,280
Average HAP Emissions (tons/yr) Before Existing Controls	114	90	86	160	15	4	16
Average HAP Emissions (tons/yr) After Existing Controls	86	77	9	42	15	4	16
Overall Control (%) with Existing Controls	25	15	90	74	5	0	0

4.1.1 Model Plant 1—Two-Piece Beverage Can

Two-piece beverage can manufacturing was determined to be a coating type segment within the one- and two-piece draw and iron subcategory. Model Plant 1 represents an overall average of a total industry population of 57 two-piece aluminum beverage can operations. Operating parameters for all 57 plants are given in Table 4-2, including information on annual coating usage, annual organic HAP emissions, and overall control efficiencies.

Twenty, or 35 percent, of the 57 facilities making two-piece beverage can bodies have control devices on at least some of their process lines. Since, the organic HAP usage and emission values for Model Plant 1 in Table 4-1 are an overall average of the total amount of organic HAP used and emitted by all 57 facilities, they include those facilities with multiple control devices, those with some controls, and those with no controls. The range of add-on control for the facilities used to determine Model Plant 1 is 0 (no control) to 86 percent.

Table 4-2. Two-Piece Beverage Can Plants

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
163	23,924	164,992	330,615	77,887	86
177	46,843	173,493	320,792	79,462	73
136	59,795	207,983	562,733	127,210	71
63	40,648	141,385	426,203	106,301	71
199	126,916	384,010	676,665	157,617	67
124	66,867	185,730	400,441	90,692	64
28	106,434	287,660	687,964	158,866	63
159	253,986	633,550	823,392	212,758	60
106	80,533	198,787	447,101	107,956	59
79	148,211	348,127	664,935	181,877	57
123	168,778	392,507	557,714	118,051	57
147	139,491	317,829	808,046	214,748	56
162	208,939	423,700	706,320	171,084	51
77	112,247	227,005	497,510	115,759	51
57	198,444	375,986	581,379	147,921	47
105	159,334	301,855	631,397	146,405	47
48	149,901	283,559	578,124	145,560	47
112	63,695	109,194	230,442	58,838	42
37	118,161	190,582	435,304	110,655	38
53	254,521	385,121	729,712	175,188	34
27	35,872	35,872	87,375	19,748	0
30	129,743	129,743	303,894	69,048	0
34	130,845	130,845	244,098	59,755	0
44	236,711	236,711	493,365	164,590	0
54	136,642	136,642	449,024	105,254	0
58	312,652	312,652	768,184	184,279	0
61	327,714	327,714	606,757	144,928	0
65	162,709	162,709	358,948	93,667	0
67	265,205	265,205	443,673	90,732	0
70	50,892	50,892	109,584	31,426	0
72	304,179	304,179	422,657	93,763	0

Table 4-2. (continued)

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
75	73,188	73,188	128,211	29,855	0
78	466,619	466,619	685,226	168,325	0
80	311,977	311,977	593,845	128,484	0
82	227,766	227,766	589,832	146,756	0
85	212,135	212,135	719,832	180,309	0
88	203,572	203,572	401,858	88,617	0
89	142,893	142,893	273,266	66,283	0
91	195,963	195,963	322,297	76,355	0
92	223,544	223,544	391,559	92,809	0
101	274,328	274,328	417,196	99,101	0
108	199,316	199,316	363,833	86,219	0
117	106,311	106,311	273,590	69,383	0
118	197,880	197,880	353,216	83,418	0
120	138,516	138,516	304,991	76,242	0
130	107,542	107,542	260,231	60,228	0
133	547,128	547,128	850,150	210,936	0
135	191,981	191,981	374,488	87,971	0
142	82,731	82,731	146,784	34,176	0
144	143,068	143,068	359,617	86,777	0
149	171,915	171,915	308,050	73,561	0
150	208,678	208,678	359,897	82,272	0
158	219,066	219,066	473,696	120,364	0
178	173,841	173,841	454,739	105,451	0
179	130,042	130,042	360,637	83,252	0
189	115,239	115,239	268,188	60,141	0
198	157,493	157,493	339,257	84,164	0

4.1.2 Model Plant 2—Two-Piece Food Can

Coating of two-piece draw and iron food cans was determined to be a separate coating type segment from the two-piece beverage can segment because of differences in the coating types applied. The two-piece food can segment uses inside sprays and base coats while the two-piece beverage can segment uses inside sprays, base coats, rim and bottom coats, overvarnishes, and decorative inks. Model Plant 2 represents an overall average of a total industry population of 11 two-piece food can operations. Operating parameters for all 11 plants are given in Table 4-3, including information on annual coating usage, annual organic HAP emissions, and overall control efficiencies.

Table 4-3. Two-Piece Food Can Plants

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
96	13,132	55,224	99,764	26,490	76
151	11,978	49,992	90,392	23,993	76
71	12,845	52,893	95,392	25,348	76
148	59,917	185,492	343,000	90,179	68
12	64,619	64,619	216,758	50,128	0
173	118,771	118,771	369,612	88,045	0
139	106,473	106,473	179,376	41,703	0
67	121,055	121,055	227,964	43,451	0
119	289,975	335,529	405,622	97,935	14
25	129,317	129,317	131,052	32,629	0
93	758,484	758,484	344,272	85,099	0

Five facilities, or 45 percent, of the 11 facilities making two-piece food can bodies have control devices on at least some of their process lines. The average organic HAP usage and emission values specified for Model Plant 2 in Table 4-1, therefore, include facilities with multiple control devices, those with some controls, and those with no controls. The range of control for the facilities used to determine Model Plant 2 is 0 (no control) to 76 percent.

4.1.3 Model Plant 3—One-Piece Aerosol Can

Due to the unique requirements of coatings used on aerosol cans, surface coating of one-piece aerosol cans was also considered a separate coating type segment within the draw and iron subcategory. Model Plant 3 represents an overall average of the 2 one-piece aerosol can facilities included in the database. Operating parameters for both plants are given in Table 4-4, including information on annual coating usage, annual organic HAP emissions, and overall control efficiencies.

Table 4-4. One-Piece Aerosol Plants

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
115	20,686	206,858	94,943	32,032	90
55	15,575	137,467	51,932	15,661	89

4.1.4 Model Plant 4—Sheetcoating

This subcategory includes all of the flat sheet metal coating operations associated with three-piece aerosol, food, and general line cans, decorative tins, two-piece draw redraw, and crowns and closures. The coatings used include interior and exterior base and end coatings, decorative inks, and overvarnishes, all of which are applied by roller to flat metal sheets. The best-performing sources typically control emissions through the use of partial or total enclosures routed to thermal or catalytic oxidizers that achieve VOC destruction efficiencies of 95 percent or higher. Fifty of the 60 sheetcoating facilities, or 83 percent, have at least one control device. Operating parameters for all 60 plants are given in Table 4-5, including information on annual coating usage, annual organic HAP emissions, and overall control efficiencies.

Table 4-5. Sheetcoating Plants

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
201	0	0	5,982	5,162	0
11	0	0	55	55	0
52	166	166	18,284	18,284	0
148	26,138	176,964	606,400	214,672	85
43	13,492	318,397	221,347	81,637	96
183	19,303	133,125	154,663	107,828	86
7	23,502	199,173	173,634	92,600	88
116	21,285	425,698	207,107	80,331	95
56	10,860	248,302	133,800	40,349	96
167	69,636	707,687	753,373	243,718	90
8	20,896	208,960	193,549	68,926	90
155	13,992	199,461	92,234	41,586	93
160	20,043	291,297	125,703	49,028	93
122	29,422	239,901	150,539	70,917	88
40	15,609	312,183	103,487	36,145	95
21	23,663	124,389	126,003	51,034	81
22	52,089	381,745	180,132	99,163	86
9	31,004	315,078	126,834	50,823	90
107	18,500	126,596	59,150	24,872	85
36	38,186	381,856	131,166	45,658	90
23	91,953	675,437	246,784	105,991	86
109	62,731	434,756	165,275	71,632	86
71	23,788	23,788	71,597	26,554	0
203	24,384	128,339	79,771	26,785	81
180	23,288	122,525	69,312	23,625	81
99	15,370	49,109	35,234	15,590	69
181	24,134	126,897	80,518	24,320	81
157	27,463	272,602	98,997	27,599	90
132	36,191	187,316	71,924	35,158	81
151	28,118	28,118	71,597	25,573	0
193	103,100	873,119	314,183	82,122	88
190	146,928	754,249	276,402	115,828	81

Table 4-5. (continued)

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
154	100,917	589,601	182,268	77,065	83
16	106,860	445,249	241,918	79,921	76
145	66,400	262,261	132,134	47,898	75
68	82,799	145,518	123,934	55,973	43
127	67,570	355,634	115,108	45,092	81
42	136,317	354,120	177,099	87,422	62
200	94,737	653,360	167,322	60,215	86
195	71,091	374,166	158,648	41,969	81
184	84,641	497,304	183,279	48,722	83
129	68,796	312,332	137,717	39,419	78
103	46,888	141,150	69,851	26,620	67
38	245,916	780,084	291,613	136,046	68
66	176,292	966,845	224,786	84,081	82
97	31,472	93,422	40,229	14,703	66
205	32,869	32,869	50,124	15,188	0
172	38,609	165,469	54,341	15,519	77
204	108,181	569,371	132,033	42,445	81
32	154,864	154,864	115,292	56,545	0
141	291,416	605,134	266,985	103,304	52
20	246,943	529,051	272,573	81,426	53
164	127,630	276,335	96,482	38,879	54
25	113,757	395,678	129,240	33,313	71
41	281,869	473,211	195,811	69,551	40
161	90,558	253,316	80,127	20,965	64
196	71,245	247,809	66,480	15,783	71
19	515,387	515,387	235,707	101,188	0
95	149,493	149,493	64,335	25,743	0
96	385,854	385,854	114,795	28,228	0

4.1.5 Model Plant 5—Three-Piece Food Can Body Assembly

The three-piece food can body assembly segment consists of facilities that apply aseptic side seam stripe, non-aseptic side seam stripe, and/or inside spray on can bodies that will be used to hold food products. Model Plant 5 represents an overall average of a total industry population of 28 three-piece food can assembly operations. Only one facility, or less than 4 percent of the total number, uses add-on control devices on a food can assembly operation. Operating parameters for all 28 plants are given in Table 4-6, including information on annual coating usage, annual organic HAP emissions, and overall control efficiencies.

Table 4-6. Three-Piece Food Can Body Assembly Plants

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
8	5,573	5,573	1,802	848	0
16	23,610	66,979	48,555	10,286	65
26	7,903	7,903	6,875	2,428	0
47	26,726	26,726	5,619	1,693	0
59	67,061	67,061	14,339	4,188	0
71	6,309	6,309	2,394	859	0
83	64,691	64,691	13,366	4,238	0
107	1,542	1,542	2,090	487	0
121	4,269	4,269	882	280	0
127	9,052	9,052	12,560	2,926	0
134	30,575	30,575	23,485	5,351	0
137	9,059	9,059	2,200	662	0
143	7,889	7,889	1,537	329	0
145	200	200	55	28	0
148	199,297	199,297	45,100	14,652	0
151	6,427	6,427	2,394	859	0
157	8,472	8,472	7,822	6,363	0
160	29,664	29,664	19,174	6,010	0
161	5,181	5,181	1,787	664	0
165	23,054	23,054	7,810	3,541	0
167	10,598	10,598	10,446	8,646	0

Table 4-6. (continued)

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
190	38,591	38,591	14,820	4,357	0
192	5,209	5,209	2,028	873	0
192	31,743	31,743	6,903	1,964	0
194	24,562	24,562	16,775	4,200	0
195	23,295	23,295	5,236	1,878	0
200	22,922	22,922	14,080	4,335	0
202	17,213	17,213	9,341	4,661	0
204	18,899	18,899	12,207	3,960	0
205	58,053	58,053	22,007	8,184	0
206	27,904	27,904	18,035	5,667	0

4.1.6 Model Plant 6—Three-Piece Non-Food Can Body Assembly

The three-piece non-food can body assembly segment consists of facilities that apply non-aseptic side seam stripe on cans that will be used to hold nonfood and aerosol products. Facilities in this category do not use aseptic side seam stripes and inside sprays. Model Plant 6 represents an overall average of 13 three-piece non-food can body assembly facilities. None of these facilities use add-on control devices to control emissions from non-food can body assembly coating operations. Operating parameters for all 13 plants are given in Table 4-7, including information on annual coating usage, annual organic HAP emissions, and overall control efficiencies.

Table 4-7. Three-Piece Non-Food Can Body Assembly Plants

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
11	6,040	6,040	1,510	380	0
32	3,057	3,057	5,647	4,168	0
40	1,078	1,078	400	89	0
42	30,288	30,288	7,752	2,109	0
66	4,397	4,397	1,101	293	0
68	10,382	10,382	2,719	753	0
103	9,965	9,965	2,681	765	0
107	3,999	3,999	1,484	329	0
110	2,964	2,964	1,100	244	0
145	18,894	18,894	5,536	1,239	0
164	2,199	2,199	816	181	0
180	4,788	4,788	1,506	486	0
183	0	0	1,964	1,964	0

4.1.7 Model Plant 7—End Lining

End lining operations involve the application of end seal compound onto end pieces. The end seal compound is applied in a bead around the end piece, and curing takes place under ambient conditions rather than in a curing oven. Since end seal compounds take a longer period of time to cure than other coatings, controlling HAP emissions is inefficient. No facilities in the database use add-on control devices on end lining operations. Operating parameters for all 53 facilities in this subcategory are given in Table 4-8, including information on annual coating usage, annual organic HAP emissions, and overall control efficiencies.

Table 4-8. End Lining Operations Plants

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
2	33,930	33,930	11,083	6,761	0
8	0	0	42,529	23,774	0
8	5,821	5,821	31,498	12,221	0
11	0	0	5,221	2,906	0
16	18,963	18,963	43,618	20,958	0
18	133,909	133,909	43,477	20,130	0
21	0	0	20,552	7,572	0
22	94,744	94,744	503,543	213,813	0
25	6,381	6,381	18,990	7,368	0
32	22,594	22,594	17,458	7,213	0
40	0	0	19,756	11,656	0
42	0	0	53,602	25,251	0
47	7,413	7,413	40,113	15,564	0
62	385,762	385,762	124,723	57,321	0
66	8,712	8,712	24,454	9,354	0
67	0	0	79,409	38,148	0
68	0	0	26,349	14,298	0
71	7,037	7,037	20,942	8,125	0
80	0	0	60,667	35,854	0
84	72,071	72,071	70,658	32,220	0
95	0	0	16,412	6,046	0
96	9,202	9,202	27,387	10,626	0
100	24,865	24,865	74,004	28,714	0
103	0	0	7,227	4,148	0
107	0	0	16,000	9,440	0
126	135,930	135,930	51,169	23,691	0
127	11,282	11,282	22,385	8,685	0
134	13,242	13,242	43,209	16,968	0
136	102,833	102,833	38,710	17,923	0
139	12,430	12,430	36,994	14,354	0
143	97,667	97,667	28,822	6,742	0

Table 4-8. (continued)

Blind facility ID	HAP emissions (lbs) after existing controls	HAP emissions (lbs) before existing controls	Coating usage (gal of coating)	Solids usage (gal of solids)	Overall control (%)
145	4,979	4,979	42,276	19,500	0
148	57,994	57,994	172,600	66,969	0
149	0	0	31,968	23,538	0
151	3,870	3,870	20,942	8,125	0
160	5,673	5,673	30,700	11,912	0
161	30,863	30,863	91,855	35,640	0
164	0	0	1,763	1,040	0
171	2,473	2,473	29,442	14,186	0
172	6,486	6,486	25,121	11,091	0
175	4,920	4,920	20,421	7,907	0
179	144,554	144,554	46,933	21,730	0
180	0	0	15,080	9,186	0
185	143,864	143,864	74,004	26,567	0
190	7,625	7,625	41,263	16,010	0
191	0	0	81,080	33,486	0
192	14,380	14,380	42,797	16,605	0
193	8,814	8,814	26,233	10,178	0
194	2,283	2,283	12,357	4,794	0
197	13,500	13,500	40,178	15,589	0
199	0	0	19,826	9,532	0
200	6,939	6,939	37,550	14,569	0
204	11,299	11,299	61,143	23,723	0
205	7,037	7,037	20,942	8,125	0

4.2 CONTROL OPTIONS

Control options available to the metal can surface coating industry include increased capture and control, reformulation of coatings, and use of alternate coating types, such as UV-cured or powder.

4.2.1 Control Options for Two-Piece Draw and Iron Beverage and Food Can

The two-piece draw and iron can coating subcategory uses primarily waterborne coatings to meet VOC emissions limitations imposed by federal and state regulations. Use of these coatings has diminished the need for facilities to utilize add-on control devices because a majority of the facilities meet current VOC emission limits. Reported facility data indicate that the beverage can segment currently controls 25 percent of its overall organic HAP emissions, with the highest individual facility control efficiency at 86 percent. The food can segment currently controls 15 percent of its overall organic HAP emissions, with the highest individual facility control efficiency at 76 percent. Twenty of the 57 two-piece beverage facilities and 5 of 11 food can facilities use add-on control devices. All of the control devices used at two-piece beverage and food facilities are thermal or catalytic oxidizers with recuperative or regenerative systems. Table 4-9 and Table 4-10 summarize the control systems for each controlled facility in the two-piece beverage and food can segments, respectively.

With existing coating technologies and metal can surface coating requirements, the most significant decrease in organic HAP emissions from these segments could be achieved through the addition of add-on control systems. The majority of metal can coatings used in these segments have already been reformulated to contain the minimum amounts of VOC and organic HAP achievable with current waterborne coating technology and still meet stringent performance requirements.

Table 4-9. Summary of Two-Piece Beverage Facility Control Device Characteristics

Blind Facility ID	No. of Control Devices	Oxidizer Type	Recuperative	Regenerative
28	2	Thermal		X
37	1	Thermal		X
48	1	Thermal	X	
53	1	Thermal		X
57	1	Thermal		X
63	1	Thermal		X
77	1	Thermal		X
79	1	Catalytic	X	
105	1	Thermal		X
106	2	Thermal	X	X
112	1	Catalytic	X	
123	1	Thermal		X
124	1	Thermal		X
136	2	Thermal		X
147	1	Thermal		X
159	1	Thermal		X
162	1	Thermal		X
163	1	Thermal	X	
177	1	Thermal		X
199	1	Thermal		X

Table 4-10. Summary of Two-Piece Food Facility Control Device Characteristics

Blind Facility ID	No. of Control Devices	Oxidizer Type	Recuperative	Regenerative
71	1	Thermal		X
96	2	Thermal	X	X
119	1	Thermal	X	
148	2	Thermal		X
151	1	Thermal		X

The use of UV-cured coatings is another possible way to lower organic HAP emissions without the use of add-on control devices. There are currently 11 facilities using UV-cured coatings for decorative inks, overvarnish, and rim/bottom coat. There are a number of reasons that the use of UV-cured coatings is not widespread: the cost associated with retrofitting existing production lines, the limited number of coatings that meet the manufacturers internal stringent QA/QC requirements, the involved process of certifying the coating with the FDA, and the process of convincing customers that the coating meets their specific performance requirements.

4.2.2 Control Options for One-Piece Aerosol Cans

Two facilities are included in the one-piece aerosol can segment, both of which use add-on controls. One facility uses an adsorption system and the second facility uses a catalytic oxidizer to control emissions. The average control efficiency for the two facilities is 89.5 percent, with one achieving 90 percent control efficiency and the other 89 percent. Table 4-11 is a summary of the control systems for these facilities.

Table 4-11. Summary of One-Piece Aerosol Facility Control Device Characteristics

Blind Facility ID	No. of Control Devices	Oxidizer Type	Recuperative	Regenerative
55	5	Adsorber		
115	2	Catalytic Oxidizer	X	

4.2.3 Control Options for Sheetcoating Operations

There are several control options for sheetcoating operations, including increased capture and control, reformulation, and use of UV and powder coatings. This subcategory currently controls approximately 74 percent of the organic HAP emissions generated from coatings. There are a total of 107 control devices at fifty facilities. The number of control devices at controlled facilities ranges from one to thirteen. All controlled facilities use thermal or catalytic oxidizers, usually with some type of heat recovery system. Table 4-12 presents a summary of the control device systems for the sheetcoating subcategory.

Table 4-12. Summary of Sheetcoating Control Device Characteristics

Blind Facility ID	No. of Control Devices	Control/Oxidizer Type	Recuperative	Regenerative
7	1	Thermal		X
8	2	Thermal	X	
9	4	Thermal	X	
16	4	Catalytic		
20	1	Thermal	X	
21	3	Thermal	X	
22	2	Thermal		
23	2	Thermal		
25	1	Thermal	X	
36	1	Thermal	X	
38	4	Thermal and Catalytic	X	
40	2	Thermal	X	
41	13	Catalytic		
42	1	Catalytic		
43	4	Thermal	X	
56	3	Thermal	X	
66	3	Thermal and Catalytic		
68	2	Thermal	X	
97	4	Thermal	X	
99	1	Catalytic	X	
103	1	Thermal		X
107	1	Thermal		X
109	3	Thermal		X
116	1	Thermal		X
122	1	Thermal		X
127	3	Thermal and Catalytic		
129	1	Thermal	X	
132	1	Thermal		X
141	1	Thermal		X
145	2	Catalytic	X	
148	2	Thermal		X
154	1	Thermal		
155	1	Thermal		
157	1	Thermal		
160	1	Thermal		
161	2	Thermal		

Table 4-12. (continued)

Blind Facility ID	No. of Control Devices	Control/Oxidizer Type	Recuperative	Regenerative
164	1	Thermal		X
167	2	Thermal	X	
172	5	Catalytic		
180	1	Catalytic		X
181	1	Catalytic	X	
183	1	Thermal		
184	1	Thermal		X
190	1	Catalytic	X	
193	2	Thermal	X	
195	2	Thermal	X	
196	4	Catalytic		X
200	1	Thermal	X	
203	2	Thermal	X	X
204	2	Thermal	X	

New coating technologies, including UV-cured and powder coatings, could also reduce HAP use and emissions. Twenty facilities in this subcategory use 28 UV coatings. Table 4-13 is a summary of the can and coating types for which UV coatings are currently being used.

Table 4-13. Current UV-Cured Coating Uses

Industry Segment	Coating Type
Decorative tin	Decorative inks
Three-piece aerosol can	Decorative inks
	Overvarnish
Three-piece food can	Decorative inks
	Exterior body base coat
	Exterior end base coat
	Interior body base coat
	Interior end base coat
Three-piece general line can	Decorative inks
	Overvarnish

4.2.4 Control Options for Three-Piece Food and Non-Food Can Assembly and End Lining

Only one facility in the three-piece food can assembly segment uses add-on controls, and there are currently no add-on controls in either the three-piece non-food can assembly or end lining operation segments. The coatings used in this segment include side seam stripe, inside spray, and end seal compound for both aseptic and non-aseptic applications. Since control options for these three segments are the same, they are discussed together. The only cost effective option for these facilities is coating reformulation. The use, formulation, and application methods of coatings used in these segments makes use of add-on controls for organic HAP emissions impractical and inefficient.

Side seam stripes cure within a very short period of time after application. Side seam stripe is applied to the can seam just after it is welded, and the heat from the weld serves to cure it. Because the equipment used to weld and apply side seam stripe is stationary, the can must be moving. In order to capture emissions, an enclosure would have to be built around the entire path the cans travel from the time of application until the coating is fully cured. Capturing and controlling emissions would be quite expensive because of the low organic HAP concentration in the airstream. As stated previously, use of powder side seam stripe is an option for lowering organic HAP emissions for certain applications.

The major organic HAP constituent in end seal compounds is hexane, which is being replaced with heptane as a way to eliminate organic HAP emissions. This segment of the industry is currently in the process of integrating reformulated end seal compounds into the manufacturing process for all non-aseptic applications. The reformulated coating is expected to replace all non-aseptic end seal compounds within the near future. Some aseptic end seal compounds may also need to be reformulated in order to meet the MACT limits.

4.3 ENHANCED MONITORING

4.3.1 Enhanced Monitoring for Two-Piece Beverage and Food Cans and Sheetcoating Operations

A system must be in place in all facilities to monitor the usage of organic HAP. For facilities operating control devices, capture and control device performance must be monitored. Organic HAP levels in coatings must be determined using formulation data of sufficient quality to assure accurate determination of organic HAP emissions. A Material Safety Data Sheet (MSDS) may not provide data accurate enough to show compliance with a regulation, but a certified product data sheet will. For facilities that meet the applicable regulations through the use of compliant coatings, data must be specific and accurate enough to determine compliance with emission limits.

Capture equipment must be monitored to allow the determination of capture efficiency. For a permanent total enclosure (PTE), the pressure drop across the fan or measure of fan current usage can be an indicator of capture efficiency. For capture equipment that does not meet the definition of a PTE, an alternate method must be used to determine capture efficiency.

Oxidizer performance must be monitored to ensure the destruction efficiency of the unit. This must first be determined through compliance testing and later through monitoring of parameters such as the combustion/oxidation chamber temperature. Additional parameters such as pressure drop, auxiliary fuel usage, and fan current can be monitored in conjunction with the temperature to determine control device performance. Oxidizer temperature must be maintained at or above the temperature used to demonstrate compliance.

Capture and control device parameters can be monitored manually by measuring and recording pertinent parameter values at required intervals or through the use of continuous recorders such as strip chart recorders or plant control systems.

4.3.2 Enhanced Monitoring for Three-Piece Can Assembly and End Lining Operations

Organic HAP control for these two segments is based on the use of low- or no-HAP coatings. Monitoring requirements include accurate accounting of organic HAP usage to demonstrate compliance.

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Chapter 5

Summary of Environmental and Energy Impacts

This chapter discusses primary air, secondary environmental (air, water, and solid waste), and energy impacts for existing sources resulting from the control of HAP emissions under the proposed standards for the metal can manufacturing surface coating source category. Potential impacts are presented for each of the seven model plants which were derived from the subcategories and industry segments discussed previously :

- Two-piece beverage can body facilities;
- Two-piece food can body facilities;
- One-piece aerosol can body facilities;
- Sheetcoating facilities;
- Three-piece food can body assembly facilities;
- Three-piece non-food can body assembly facilities; and
- End lining facilities.

5.1 BASIS FOR IMPACTS ANALYSIS

This analysis assumes that regenerative thermal oxidizers (RTO) will be used to control organic HAP emissions to comply with the proposed standards for HAP emissions from two-piece beverage can body coating, two-piece food can body coating, and sheetcoating operations. There are only two one-piece aerosol can facilities in the data base, both of which meet the existing source emission limit. Therefore, no additional controls will be needed in these facilities to meet the proposed standards. This analysis also assumes that both food and non-food three-piece can body assembly facilities and both aseptic and non-aseptic end lining

operations will use reformulated coatings to achieve compliance with the proposed standards. These assumptions were based on control techniques currently employed by the industry and practical limitations associated with the surface coating processes involved.

5.2 PRIMARY AIR IMPACTS

Primary air impacts consist of the reduction in organic HAP emissions from the baseline level that is directly attributable to the proposed standards. The proposed standards are expected to reduce organic HAP emissions from existing metal can manufacturing facilities by 6,800 tons per year, or 71 percent, from a baseline level of 9,600 tons per year (ton/yr). A summary of the primary air impacts associated with implementation of the proposed standards is shown in Table 5-1.

Table 5-1. Summary of Primary Air Impacts

Emission Source (Subcategory or Industry Segment)	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
Two-piece beverage can body coatings	4,922	1,881	3,111	63
Two-piece food can body coatings	843	153	690	82
One-piece aerosol can body coatings	18	18	0	0
Sheetcoatings	2,522	436	2,087	82
Three-piece food can assembly coatings:	408	314	94	23
- inside spray	34	29	5	15
- aseptic side seam stripe	93	92	1	1
- nonaseptic side seam stripe	281	193	88	31
Three-piece non-food can assembly coatings:	49	41	8	15
- general line side seam stripe	11	9	1	11
- aerosol side seam stripe	39	32	6	17
End lining coatings:	841	38	803	95
- aseptic end seal compounds	38	38	0	0
- nonaseptic end seal compounds	803	0	803	100

Total	9,603	2,811	6,792	71
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Tables 5-2 through 5-8 present the primary air impacts resulting from individual facilities and the overall impact to the seven primary industry categories.

Table 5-2. Two-Piece Beverage Can Segment Impacts

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
27	17.9	5.8	12.1	67.5
28	53.2	46.9	6.4	11.9
30	64.9	20.4	44.5	68.6
34	65.4	17.6	47.8	73.1
37	59.1	32.6	26.4	44.7
44	118.4	48.6	69.8	59.0
48	75.0	42.9	32.0	42.7
53	127.3	51.7	75.6	59.4
54	68.3	31.0	37.3	54.6
57	99.2	43.6	55.6	56.0
58	156.3	54.4	102.0	65.2
61	163.9	42.8	121.1	73.9
63	20.3	20.3	0.0	0.0
65	81.4	27.6	53.7	66.0
67	132.6	26.8	105.8	79.8
70	25.4	9.3	16.2	63.6
72	152.1	27.7	124.4	81.8
75	36.6	8.8	27.8	75.9
77	56.1	34.1	22.0	39.2
78	233.3	49.7	183.7	78.7
79	74.1	53.7	20.5	27.6
80	156.0	37.9	118.1	75.7
82	113.9	43.3	70.6	62.0
85	106.1	53.2	52.9	49.9
88	101.8	26.1	75.6	74.3
89	71.4	19.6	51.9	72.6

Table 5-2. (continued)

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
91	98.0	22.5	75.5	77.0
92	111.8	27.4	84.4	75.5
101	137.2	29.2	107.9	78.7
105	79.7	43.2	36.5	45.8
106	40.3	31.8	8.4	20.9
108	99.7	25.4	74.2	74.5
112	31.8	17.4	14.5	45.5
117	53.2	20.5	32.7	61.5
118	98.9	24.6	74.3	75.1
120	69.3	22.5	46.8	67.5
123	84.4	34.8	49.6	58.7
124	33.4	26.8	6.7	20.0
130	53.8	17.8	36.0	67.0
133	273.6	62.2	211.3	77.3
135	96.0	26.0	70.0	73.0
136	29.9	29.9	0.0	0.0
142	41.4	10.1	31.3	75.6
144	71.5	25.6	45.9	64.2
147	69.7	63.4	6.4	9.2
149	86.0	21.7	64.3	74.8
150	104.3	24.3	80.1	76.7
158	109.5	35.5	74.0	67.6
159	127.0	62.8	64.2	50.6
162	104.5	50.5	54.0	51.7
163	12.0	12.0	0.0	0.0
177	23.4	23.4	0.0	0.0
178	86.9	31.1	55.8	64.2
179	65.0	24.6	40.5	62.2
189	57.6	17.7	39.9	69.2
198	78.7	24.8	53.9	68.5
199	63.5	46.5	17.0	26.7
Total	4,921.8	1,810.7	3,111.1	63.2

Table 5-3. Two-Piece Food Can Segment Impacts

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
12	32.3	12.8	19.5	60.4
25	64.7	8.3	56.3	87.1
67	60.5	11.1	49.4	81.7
71	6.4	6.4	0.0	0.0
93	379.2	21.7	357.5	94.3
96	6.6	6.6	0.0	0.0
119	145.0	25.0	120.0	82.8
139	53.2	10.6	42.6	80.0
148	30.0	23.0	7.0	23.2
151	6.0	6.0	0.0	0.0
173	59.4	22.5	36.9	62.2
Total	843.3	153.1	690.2	81.9

Table 5-4. One-Piece Aerosol Can Segment Impacts

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
115	10.3	10.3	0.0	0.0
55	7.8	7.8	0.0	0.0
Total	18.1	18.1	0.0	0.0

Table 5-5. Sheetcoating Segment Impacts

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
7	11.8	11.8	0.0	0.0
8	10.4	9.1	1.3	12.5
9	15.5	6.7	8.8	56.8
11	0.0	0.0	0.0	0.0
16	53.4	10.6	42.8	80.2
19	257.7	13.4	244.3	94.8
20	123.5	10.8	112.7	91.3
21	11.8	6.8	5.1	43.2
22	26.0	13.1	12.9	49.6
23	46.0	14.0	31.9	69.3
25	56.9	4.4	52.5	92.3
32	77.4	7.5	69.9	90.3
36	19.1	6.0	13.0	68.1
38	123.0	18.0	104.9	85.3
40	7.8	4.8	3.0	38.5
41	140.9	9.2	131.7	93.5
42	68.2	11.6	56.6	83.0
43	6.7	6.7	0.0	0.0
52	0.1	0.1	0.0	0.0
56	5.4	5.3	0.1	1.9
66	88.1	11.1	77.0	87.4
68	41.4	7.4	34.0	82.1
71	11.9	3.5	8.4	70.6
95	74.7	3.4	71.3	95.4
96	192.9	3.7	189.2	98.1
97	15.7	1.9	13.8	87.9
99	7.7	2.1	5.6	72.7
103	23.4	3.5	19.9	85.0
107	9.2	3.3	6.0	65.2
109	31.4	9.5	21.9	69.7
116	10.6	10.6	0.0	0.0
122	14.7	9.4	5.3	36.1
127	33.8	6.0	27.8	82.2

Table 5-5. (continued)

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
129	34.4	5.2	29.2	84.9
132	18.1	4.7	13.4	74.0
141	145.7	13.7	132.0	90.6
145	33.2	6.3	26.9	81.0
148	13.1	13.1	0.0	0.0
151	14.1	3.4	10.7	75.9
154	50.5	10.2	40.2	79.6
155	7.0	5.5	1.5	21.4
157	13.7	3.7	10.1	73.7
160	10.0	6.5	3.5	35.0
161	45.3	2.8	42.5	93.8
164	63.8	5.2	58.7	92.0
167	34.8	32.3	2.5	7.2
172	19.3	2.1	17.2	89.1
180	11.6	3.1	8.5	73.3
181	12.1	3.2	8.8	72.7
183	9.7	9.7	0.0	0.0
184	42.3	6.5	35.9	84.9
190	73.5	15.3	58.1	79.0
193	51.5	10.9	40.7	79.0
195	35.5	5.6	30.0	84.5
196	35.6	2.1	33.5	94.1
200	47.4	8.0	39.4	83.1
201	0.0	0.0	0.0	??
203	12.2	3.5	8.6	70.5
204	54.1	5.6	48.5	89.6
205	16.4	2.0	14.4	87.8
Total	2,522.0	435.5	2,086.5	82.7

Table 5-6. Food Can Assembly Segment Impacts

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
8	2.8	2.8	0.0	0.0
16	11.8	11.2	0.6	5.2
26	4.0	4.0	0.0	0.0
47	13.4	8.9	4.4	33.2
59	33.5	29.4	4.2	12.4
71	3.2	2.8	0.3	10.5
83	32.3	15.6	16.8	51.8
107	0.8	0.6	0.2	23.3
121	2.1	1.0	1.1	51.8
127	4.5	3.6	1.0	21.4
134	15.3	9.1	6.2	40.5
137	4.5	2.2	2.4	52.0
143	3.9	1.1	2.9	72.6
145	0.1	0.1	0.0	7.4
148	99.6	61.9	37.8	37.9
151	3.2	2.8	0.4	12.1
157	4.2	4.2	0.0	0.0
160	14.8	13.9	0.9	6.4
161	2.6	2.2	0.4	15.8
165	11.5	11.5	0.0	0.0
167	5.3	5.3	0.0	0.0
190	19.3	14.3	5.0	25.8
192	18.5	18.5	0.0	0.0
194	12.3	9.2	3.1	25.1
195	11.6	11.6	0.1	0.6
200	11.5	9.6	1.9	16.3
202	8.6	8.4	0.2	2.6
204	9.4	8.9	0.5	5.7
205	29.0	26.9	2.1	7.4
206	14.0	12.5	1.5	10.7
Total	407.8	313.9	93.9	23.0

Table 5-7. Non-Food Can Assembly Segment Impacts

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
11	3.0	1.9	1.2	38.1
32	1.5	1.5	0.0	0.0
40.0	0.5	0.5	0.0	0.0
42.0	15.1	12.5	2.6	17.5
66	2.2	1.8	0.4	19.2
68	5.2	4.4	0.8	15.7
103	5.0	4.3	0.7	13.6
107	2.0	2.0	0.0	0.0
110	1.5	1.5	0.0	0.0
145	9.4	7.5	1.9	20.4
164	1.1	1.1	0.0	0.0
180	2.4	2.4	0.0	0.0
183	0.0	0.0	0.0	0.0
Total	49.0	41.4	7.6	15.5

Table 5-8. End Lining Segment Impacts

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
2	17.0	0.0	17.0	100.0
8	2.9	2.9	0.0	0.0
11	0.0	0.0	0.0	0.0
16	9.5	0.0	9.5	100.0
18	67.0	0.0	67.0	100.0
21	0.0	0.0	0.0	0.0
22	47.4	0.0	47.4	100.0
25	3.2	0.0	3.2	100.0
32	11.3	0.0	11.3	100.0
40	0.0	0.0	0.0	0.0
42	0.0	0.0	0.0	0.0
47	3.7	3.7	0.0	0.0
62	192.9	0.0	192.9	100.0
66	4.4	2.2	2.2	50.5
67	0.0	0.0	0.0	0.0

Table 5-8. (continued)

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
68	0.0	0.0	0.0	0.0
71	3.5	0.0	3.5	100.0
80	0.0	0.0	0.0	0.0
84	36.0	0.0	36.0	100.0
95	0.0	0.0	0.0	0.0
96	4.6	0.0	4.6	100.0
100	12.4	0.0	12.4	100.0
103	0.0	0.0	0.0	0.0
107	0.0	0.0	0.0	0.0
126	68.0	0.0	68.0	100.0
127	5.6	0.0	5.6	100.0
134	6.6	3.7	2.9	43.4
136	51.4	0.0	51.4	100.0
139	6.2	0.0	6.2	100.0
143	48.8	0.0	48.8	100.0
145	2.5	2.5	0.0	0.0
148	29.0	0.0	29.0	100.0
149	0.0	0.0	0.0	0.0
151	1.9	1.9	0.0	0.0
160	2.8	2.8	0.0	0.0
161	15.4	0.0	15.4	100.0
164	0.0	0.0	0.0	0.0
171	1.2	1.2	0.0	0.0
172	3.2	1.5	1.7	53.8
175	2.5	1.8	0.6	25.4
179	72.3	0.0	72.3	100.0
180	0.0	0.0	0.0	0.0
185	71.9	0.0	71.9	100.0
190	3.8	3.8	0.0	0.0
191	0.0	0.0	0.0	0.0
192	7.2	0.0	7.2	100.0
193	4.4	0.0	4.4	100.0
194	1.1	1.1	0.0	0.0

Table 5-8. (continued)

Facility ID	HAP Baseline Emissions (ton/yr)	HAP Emissions After MACT (ton/yr)	Emission reduction from baseline	
			ton/yr	Percent
197	6.7	0.0	6.7	100.0
199	0.0	0.0	0.0	0.0
200	3.5	3.5	0.0	0.0
204	5.6	5.6	0.0	0.0
205	3.5	0.0	3.5	100.0
Total	841.1	38.4	802.7	95.4

5.3 SECONDARY ENVIRONMENTAL IMPACTS

Secondary environmental impacts include any adverse or beneficial environmental impacts other than the primary impacts described in Section 5.2. Secondary impacts include impacts that result from the operation of any new or additional add-on HAP control systems. To comply with the proposed standard, it is anticipated that metal can manufacturing surface coating facilities in the one- and two-piece draw and iron beverage and food can and sheetcoating subcategories will use regenerative thermal oxidizer control systems that result in secondary air impacts. Secondary water and solid waste impacts for these subcategories are expected to be minimal.

Secondary impacts for the three-piece can body assembly and end lining coating subcategories are expected to be negligible. It is anticipated that can assembly facilities and end lining operations will use reformulated coatings to comply with the proposed standard. Use of reformulated coatings will not have any secondary environmental impacts. It is anticipated that the reformulated coating organic HAP constituents will be replaced with other VOC.

5.3.1 Secondary Air Impacts

Secondary air impacts consist of generation of byproducts from fuel combustion needed to operate control devices and reduction of VOC. Fuel combustion is necessary to maintain operating temperatures in regenerative thermal oxidizers (RTOs). Byproducts of fuel combustion include emission of carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO₂), and particulate matter less than 10 microns in diameter (PM₁₀).

Regenerative thermal oxidizers use natural gas as the auxiliary fuel. Estimated natural gas consumption rates are described in Section 5.4. Emissions from combustion in the RTOs were estimated using AP-42 emission factors for large uncontrolled industrial boilers.

Electricity for the operation of RTOs and associated auxiliary equipment was assumed to be generated at coal-fired utility plants built since 1978. Estimated electricity requirements and the fuel energy needed to generate this electricity are described in Section 5.4. Utility plants built since 1978 are subject to the new source performance standards (NSPS) in subpart Da of 40 CFR 60.¹ Emissions of CO, NO_x, SO₂, and PM₁₀ were calculated using AP-42 emission factors.² The sulfur content of the coal was assumed to be 3.4 percent. A summary of the estimated impacts for each of the four secondary air emission source types is presented in Table 5-9.

In addition to the generation of by-product emissions from fuel combustion, secondary air impacts include the reduction of VOC emissions. Volatile organic compounds are precursors to ozone. Both non-HAP VOC and organic HAP VOC are reduced by implementation of the standards, but the amount of VOC reduction achieved by the standard has not been estimated. Therefore, the secondary air impact of reduced VOC emissions cannot be quantified.

Table 5-9. Summary of Secondary Air Impacts

	Increased emissions, ton/yr			
	CO ^a	NO _x ^b	SO ₂ ^c	PM ₁₀ ^d
Total	35.18	144.67	774.08	69.61

^a CO emissions were estimated using AP-42 emission factors of 5 lb CO/ton of coal and 84 lb CO/10⁶ ft³ of natural gas.³

^b NO_x emissions were estimated using AP-42 emission factors of 11 lb NO_x/ton of coal and 190 lb NO_x/10⁶ ft³ of natural gas.³

^c SO₂ emissions were estimated using AP-42 emission factors of 68.4 lb SO₂/ton of coal and 0.6 lb SO₂/10⁶ ft³ of natural gas.³

^d PM₁₀ emissions were estimated using AP-42 emission factors of 13.2 lb PM₁₀/ton of coal and 1.9 lb PM₁₀/10⁶ ft³ of natural gas.³

5.3.2 Secondary Water Impacts

No secondary water impacts are expected.

5.3.3 Secondary Solid Waste Impacts

Solid waste impacts are expected to be minimal. Since the pollutants produced from the implementation of controls (RTOs or reformulation) are expected to consist primarily of volatilized solvents (i.e., organic HAP and VOC), very little particulate matter or solid waste will be generated.

5.4 ENERGY IMPACTS

Energy impacts consist of the electricity and fuel needed to operate the RTOs used to comply with the proposed standards. The estimated electricity and fuel impacts for each of the three subcategories using RTOs are presented in Table 5-10. In each case the impacts are based on the total amount of electricity and fuel needed to operate the control device; any additional electricity and fuel needs for existing controls are assumed to be negligible. The electricity and fuel impacts are discussed in the sections below. No energy impacts are associated with the reformulation of coatings.

Table 5-10. Summary of Energy Impacts

Subcategory or segment	Increase in electricity consumption, kwh/yr	Increase in fuel energy, Btu/yr		
		To generate electricity	Auxiliary fuel for RTOs	Total
Two-piece beverage can body	2.85e+07	2.78e+11	5.57e+11	8.35e+11
Two-piece food can body	3.81e+06	3.72e+10	7.44e+10	1.12e+11
Sheetcoating	2.09e+06	2.04e+10	4.08e+10	6.12e+10
Total	3.44e+07	3.35e+11	6.72e+11	1.01e+12

5.4.1 Electricity

Electricity would be needed to operate RTOs used to control emissions for the two-piece beverage can, two-piece food can, and sheetcoating segments. Specifically, electricity would be needed to operate the RTOs' fans and electronics. As noted above, electricity was assumed to be generated in coal-fired utility plants. The amount of fuel energy required to generate the electricity was estimated using a heating value of 14,000 Btu/lb of coal⁴ and a power plant efficiency of 35 percent. The amount of electricity required to operate the RTOs was determined

using the total annual cost spreadsheet program.⁵ The spreadsheet calculates the amount of electricity using the airflow of each RTO.

5.4.2 Fuel

In addition to electricity, fuel would be required to operate the RTOs. The amount of natural gas needed to operate the RTOs was determined by using the total annual cost spreadsheet program.⁵ The spreadsheet calculates the amount of natural gas required using the airflow of each RTO. If a facility provided the amount of natural gas in the metal can information collection request (ICR) response, then that amount was used. A RTO retention chamber temperature of 1425°F (774°C) was used for cost calculations. Additional details on the procedure used to calculate fuel requirements are described in the OAQPS Control Cost Manual.⁶

5.5 References

1. 40 CFR Part 60. Subpart Da.
2. AP-42. 1995 Edition. Section 1.1.
3. AP-42. 1995 Edition. p. 1.1-18 thru 21 and 1.4-5 thru 1.4-6.
4. AP-42. 1995 Edition. p. 1.1-1.
5. Vataavuk, William M. Estimating Costs of Air Pollution Control. Boca Raton, FL. Lewis Publishers, 1990.
6. OAQPS Control Cost Manual. Fourth Edition. EPA 450/3-90-006. January 1990. Chapter 3.

Chapter 6

Model Plant Control Costs

6.0 INTRODUCTION

Model plants and their associated control options were described in Chapter 4. Since the project database contains information from essentially all known affected sources, the model plants and estimated control costs are representative of the actual sources comprising each industry segment or subcategory. This chapter describes the estimated costs of applying the control options to all sources in each of the seven primary model plant categories.

There are 150 MACT floor facilities in the database, including eight synthetic minor sources, based on their status as a title V permitted source. Although used in determining the MACT floor limits for the applicable model plant categories, the eight synthetic minor source facilities were not assigned any costs since they will not have to comply with any of the NESHAP requirements.

Section 6.1 discusses assumptions that were made in calculating costs associated with the metal can surface coating NESHAP. The control scenarios evaluated are described, and the inputs used for the costing analysis are discussed. Results of the costing analysis are presented in Section 6.2, both by the seven types of model plants and for the metal can surface coating industry overall. The cost effectiveness of add-on controls is presented in Section 6.3. Section 6.4 describes the cost impact to small businesses, and references are provided in Section 6.5.

6.1 ASSUMPTIONS

This section describes the assumptions that were made in the costing analysis. The assumptions are divided into sections associated with add-on control devices; monitoring, recordkeeping and reporting; and material reformulation.

6.1.1 Capital Equipment Costs

Calculation of capital equipment costs is based on the assumption that all sources in the two-piece beverage, two-piece food, and sheetcoating industry segments will be required to install new control equipment including capture devices/hoods, regenerative thermal oxidizers (RTOs), and associated ductwork. It was assumed that new control equipment would be installed at all sources with HAP emissions greater than the proposed HAP emission limit for the applicable model plant category or segment, regardless of whether the source currently uses control equipment. Thus, at a source with control equipment it was assumed that the old control equipment would be removed, and the new control equipment would be used to control total airflow from coating operations and associated HAP emissions. Because some sources may, in reality, be able to retain and/or modify existing controls and only add new controls for a portion of the air stream to achieve the required overall emissions reductions, this assumption may result in an overestimation of actual costs.

For the few sources that have existing organic HAP emission levels within 10 percent of the applicable organic HAP emission limit, it was assumed that those sources would only have to improve or enhance their current capture efficiency to demonstrate compliance. Using the proposed limits, three sources (one two-piece beverage can source and two sheetcoating sources) were identified that met the criteria for needing only capture device enhancements. The capital equipment costs for capture and ductwork modifications for each of these three sources were estimated to be \$400,000. This results in an annualized cost of \$97,550 per source based on an estimated equipment life of 10 years and an interest rate of 7 percent.

There are only two affected major source one-piece aerosol can sources, so the MACT floor is set by the higher HAP emission rate. Therefore, both sources are expected to meet the organic

HAP emission limit without added material costs or capital equipment. All other model plant categories are assumed to use reformulated coatings to limit surface coating HAP emissions and comply with the proposed MACT limits. These model plant categories are largely uncontrolled, and the organic HAP emission limits can be met by reformulation.

Inputs for the add-on control analysis were developed primarily from the MACT database. Equations from the EPA cost manual were then used to develop capital equipment and operation/maintenance costs for each source.^{1,2} Capital equipment costs reflect a single RTO being purchased to reduce HAP emissions to comply with the applicable emission source limit.

To calculate the capital costs, the solvent loading and total air flow of the RTO had to be estimated. The total amount of air flow that will be routed to the RTO determines the size of the RTO and, thus, the cost of installing and maintaining it. Most sources with add-on control equipment included gas flows as part of the information collection request (ICR) submittal. Using data from these sources, a correlation was made between gas flow in standard cubic feet per minute (scfm) and total gallons of coating used at the facility. This correlation was not valid for the entire range of reported coating usage, so gas flows were grouped by divisions in the data and averaged. These divisions are shown in Table 6-1.

Using a combination of ICR information and the information in Table 6-1, each facility in the two-piece beverage, two-piece food, and sheetcoating model plant categories was analyzed. If the facility was previously uncontrolled or submitted no air flow information, a total air flow was assigned according to the total coating usage at the facility. This air flow was used as an input for equations from the EPA cost manual to develop capital equipment costs for each facility.¹ The capital equipment costs include purchase, installation, and operation of an RTO and installation costs of \$200,000 for a permanent total enclosure. Both costs are annualized based on an equipment life of 10 years and an interest rate of 7 percent.

Table 6-1. Correlation Between Coating Usage and RTO Air Flows

Total coating usage (gallons)	Total air flow (scfm)
0-200,000	20,000
200,001-650,000	22,000
>650,000	25,000

The control device inlet temperature was based on an average of database sources. The waste gas heating value was estimated at 0.1 BTU/standard cubic foot (scf) and was used in calculating the amount of auxiliary fuel required to operate the thermal oxidizer. Since the actual waste gas heating value is likely to be higher, this conservatively estimates the amount of auxiliary fuel required. It was assumed that a new RTO would have 95 percent heat recovery. Other assumptions for capital equipment costing include a 10-year equipment life cycle and 7 percent interest rate, resulting in a cost recovery factor of 0.1424.³ Labor required to operate the thermal oxidizer was estimated based on the EPA Cost Manual, and the labor rate for this industry was obtained from the Bureau of Labor Statistics.⁴ Natural gas and electricity unit costs were estimated based on information obtained from the U.S. Department of Energy web sites.^{5,6}

6.1.2 Monitoring, Recordkeeping, and Reporting Costs

Since monitoring, recordkeeping, and reporting (MR&R) will be done on a continuous basis after the compliance date, the associated costs are considered annual costs. Based on the proposed NESHAP requirements for compliance training of all staff involved with coating operations, daily coating records, monthly record compilation, and semi-annual reporting, an average metal can surface coating facility will spend an estimated 1,193 labor hours per year (914 technical, 9 management, and 270 clerical) to implement the proposed MR&R requirements.³ The total technical labor hours include the tasks conducted by a “coating, painting and spraying machine operator” which total 729 hours annually. These tasks include tracking the coating usage on each coating line, periodic checking of the monitoring equipment, annual calibration of the monitoring equipment, and maintenance of the monitoring equipment. Using recent labor rates for the metal can industry (based on SIC group 341) from the Bureau of Labor and Statistics, the fully burdened labor rates are \$73.35/hr for technical (e.g., engineer), \$30.26 for a coating process operator, \$83.58/hr for management, and \$27.93/hr for clerical

personnel.⁴ Multiplying the labor rates by the estimated hours for MR&R results in an average annual MR&R cost of \$52,700 per facility. This total cost includes computer equipment costs, performance testing costs, monitoring equipment costs, and operation and maintenance costs which are discussed in more detail in the following sections.

6.1.2.1 Computer Equipment Costs

Recordkeeping and reporting costs assume the use of a computer and software for tracking coating usage at each facility. An assumed cost of \$2,000 for computer equipment, including spreadsheet software, was used. Facilities using more than 100,000 gallons of coatings per year were excluded based on an assumption that computer equipment is readily available at such large facilities. Of the 142 major source facilities, an estimated 35 facilities will require computer equipment. Assuming that a new computer will be bought every 5 years and using a 7 percent interest rate, the capital recovery factor is 0.2439. Multiplying the capital investment cost of \$2,000 by the capital recovery factor yields an annualized computer equipment cost of \$488 for each of the 35 facilities required to purchase computers.

6.1.2.2 Performance Testing Costs

Any major source purchasing and installing new capture and control equipment to comply with the NESHAP will also have to conduct performance testing. Performance testing on an RTO was estimated to require 160 hours per air pollution control device (APCD). Testing of the associated capture device(s) or enclosure(s) using method 204 was estimated to require 80 hours per device, for a total of 240 hours per APCD. Contract labor was estimated at \$80 per hour for conducting the performance testing, resulting in a total cost estimate of \$19,200 per APCD (240 hours x \$80/hr). Since performance testing is expected to occur once with each title V permit renewal and renewals typically occur once every 5 years, performance testing costs are annualized using a 5-year life cycle and 7 percent interest rate, giving a cost recovery factor of 0.2439. This results in an annualized cost of \$4,683 per control device.

6.1.2.3 Monitoring Equipment Costs

Any major source purchasing and installing new capture and control equipment to comply with the NESHAP is also required to purchase and install monitoring equipment. We assumed that continuous parameter monitoring of the RTO combustion temperature would be used to meet the monitoring requirement of the standard. The cost of a data acquisition system was estimated to be \$4,000. This includes \$3,000 for a data logger and \$1,000 for software and necessary accessories (including thermocouples, electrical wiring, etc.).⁷ We also estimated a 10-year equipment life cycle for the monitoring equipment and 7 percent interest rate, resulting in a cost recovery factor of 0.1424.³ Since we estimate that 122 of the 142 major source facilities will require monitoring equipment, the total annualized cost per source is approximately \$570 per year.

6.1.2.4 Operation and Maintenance Costs

Operation and maintenance include the costs associated with the paperwork requirement incurred continuously over the life of the ICR. For rules that require respondents to submit notifications and reports to EPA and maintain records these costs are estimated for photocopying and postage. Photocopying costs per response were estimated at 0.5 hour of clerical labor at a wage rate of \$27.93/hr. First class postage was estimated at \$7.63 per response for mailing to regulatory agencies. Photocopying and postage costs will be applied to the semi-annual reports that are required for compliance. There will be a total of 284 responses per year from the 142 sources. This equals 142 clerical labor hours and a total annual burden of \$5,991.

6.1.3 Material Costs

It was assumed that facilities in model plant categories that are expected to use add-on control devices to limit HAP emissions from coating operations will not change to lower HAP coatings. Facilities in the two-piece beverage can, two-piece food can, and sheetcoating segments were assumed to purchase and install a new RTO rather than incur material costs. The only exceptions are facilities with reported organic HAP emission rates that are less than 10 percent above the organic HAP emission rate for these coating type segments. In these three cases, it was assumed that the source could meet the limit by improving existing capture equipment at an

annualized cost of \$98,000. All other model plant categories, except for one-piece aerosol can facilities, are assumed to reformulate coatings to limit surface coating HAP emissions.

Since reformulation costs vary in different coating type segments, industry representatives and trade associations were consulted for accurate cost ranges. Since some of the specific material cost ranges received from industry are considered confidential business information (CBI), an average cost was estimated for each coating type segment. The coating usage of each source was analyzed to estimate the amount of high HAP-containing coatings used by the facility in the baseline year of 1997. A high HAP-containing coating is defined as a coating with an organic HAP content per volume of solids (lb HAP/gal solids) greater than the MACT floor limit for the coating type segment. Costs were calculated by assuming that each source will use the same amount of coatings that were consumed in the baseline year of 1997 and that there will be a higher cost per gallon for low- or no-HAP coatings than for high HAP-content coatings. The cost increase was assumed to be \$2.00 per gallon for inside sprays, \$5.00 per gallon for side seam stripes, and \$2.00 per gallon for non-aseptic end seal compounds. These incremental costs are the estimated additional material costs that each facility will incur, rather than total material costs.

If a source had an organic HAP emission rate less than or equal to the proposed organic HAP emission limit for a coating type segment, no additional material costs were assigned to the source. If a source had an organic HAP emission rate higher than the proposed organic HAP emission rate for a coating type segment, material costs at the per gallon rate for the coating type were used.

6.2 OVERALL COSTS

This section presents results of the add-on control costing analysis. Results for individual industry segments are presented first, followed by overall industry total annual cost (TAC) estimates.

6.2.1 Estimated Costs for Industry Segments

This section contains a summary table for each model plant showing the blind facility identification, whether the facility is a MACT floor facility, a synthetic minor source, or a small business, and the number of existing APCDs at the source. Remaining columns show the various costs expected to be incurred by that source to comply with the metal can surface coating NESHAP.

6.2.1.1 Two-Piece Beverage Can Sources (Model Plant 1)

Estimated costs for two-piece beverage can sources (Model Plant 1) are shown in Table 6-2. There are 57 affected major sources with annualized costs of \$19.3 million for capital equipment and \$2.8 million for MR&R. These costs total \$22.1 million per year.

6.2.1.2 Two-Piece Food Can Sources (Model Plant 2)

Estimated costs for two-piece food can sources (Model Plant 2) are given in Table 6-3. There are 11 affected major sources with annualized costs of \$2.8 million for capital equipment, and \$327,000 for MR&R. These costs total \$3.1 million per year.

6.2.1.3 One-Piece Aerosol Can Sources (Model Plant 3)

Estimated costs for one-piece aerosol can sources (Model Plant 3) are shown in Table 6-4. Since there are only two affected major sources in this segment, the MACT floor is set by the higher HAP emission rate. Therefore, both facilities are expected to meet the organic HAP emission limit without added material costs or capital equipment. The two facilities combined have annualized costs of \$105,000 for MR&R.

6.2.1.4 Sheetcoating Sources (Model Plant 4)

Estimated costs for sheetcoating sources (Model Plant 4) are presented in Table 6-5. There are 60 affected sources (56 major sources and 4 synthetic minor sources). These sources have annualized costs of \$22.8 million for capital equipment and \$1.9 million for MR&R. These costs total \$24.7 million per year.

6.2.1.5 Three-Piece Food Can Assembly Sources (Model Plant 5)

Estimated costs for three-piece food can assembly sources (Model Plant 5) are given in Table 6-6. There are 27 major sources and 3 synthetic minor sources. These sources have annualized costs of \$1.0 million for material and \$743,000 for MR&R. These costs total \$1.8 million per year.

6.2.1.6 Three-Piece Nonfood Can Assembly Sources (Model Plant 6)

Estimated costs for three-piece nonfood can assembly sources (Model Plant 6) are presented in Table 6-7. There are 13 affected sources (11 major sources and 2 synthetic minors). These sources have annualized costs of \$70,000 for material and \$186,000 for recordkeeping and reporting. These costs total \$256,000 per year.

6.2.1.7 End Lining Sources (Model Plant 7)

Estimated costs for end lining sources (Model Plant 7) are shown in Table 6-8. There are 54 affected sources (49 major sources and 5 synthetic minors). These sources have annualized costs of \$2.9 million for material and \$1.3 million for MR&R. These costs total \$4.2 million per year.

6.2.2 Overall Total Annual Cost

The total annual cost is the sum of annualized material costs, annualized computer costs, annualized performance testing costs, annualized capital equipment costs, and annual recordkeeping and reporting costs for all affected sources. The total annual cost for the metal can surface coating NESHAP for the 142 affected major sources is estimated to be \$56.2 million. A summary of the total annual costs associated with implementation of the metal can surface coating NESHAP is provided in Table 6-9.

Table 6-2. Two-Piece Beverage Can Sources (Model Plant 1) Costs

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
89					\$0	\$360,074	\$52,700	\$412,774
65					\$0	\$360,074	\$52,700	\$412,774
48				1	\$0	\$738,922	\$52,700	\$791,622
130					\$0	\$360,074	\$52,700	\$412,774
112				1	\$0	\$285,739	\$52,700	\$338,439
118					\$0	\$360,074	\$52,700	\$412,774
144					\$0	\$360,074	\$52,700	\$412,774
108					\$0	\$360,074	\$52,700	\$412,774
101					\$0	\$360,074	\$52,700	\$412,774
58					\$0	\$387,340	\$52,700	\$440,040
117					\$0	\$360,074	\$52,700	\$412,774
106				2	\$0	\$440,603	\$52,700	\$493,303
37				1	\$0	\$330,613	\$52,700	\$383,313
163	Yes			1	\$0	\$0	\$52,700	\$52,700
158					\$0	\$360,074	\$52,700	\$412,774
30					\$0	\$360,074	\$52,700	\$412,774
70					\$0	\$341,897	\$52,700	\$394,597
80					\$0	\$387,340	\$26,350	\$413,690
78					\$0	\$387,340	\$52,700	\$440,040
67					\$0	\$193,670	\$17,567	\$211,237
162				1	\$0	\$407,242	\$52,700	\$459,942
159				1	\$0	\$334,679	\$52,700	\$387,379
123				1	\$0	\$360,074	\$52,700	\$412,774
72					\$0	\$360,074	\$52,700	\$412,774
44					\$0	\$360,074	\$52,700	\$412,774
189					\$0	\$360,074	\$52,700	\$412,774

Table 6-2. (continued)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
136	Yes			2	\$0	\$0	\$26,350	\$26,350
124	Yes			1	\$0	\$296,040	\$52,700	\$348,740
28	Yes			2	\$0	\$382,531	\$52,700	\$435,231
88					\$0	\$360,074	\$52,700	\$412,774
54					\$0	\$360,074	\$52,700	\$412,774
27					\$0	\$341,897	\$52,700	\$394,597
178					\$0	\$360,074	\$52,700	\$412,774
63	Yes			1	\$0	\$0	\$52,700	\$52,700
92					\$0	\$360,074	\$52,700	\$412,774
179					\$0	\$360,074	\$26,350	\$386,424
85					\$0	\$387,340	\$52,700	\$440,040
53				1	\$0	\$466,936	\$52,700	\$519,636
61					\$0	\$360,074	\$52,700	\$412,774
79				1	\$0	\$285,594	\$52,700	\$338,294
198					\$0	\$360,074	\$52,700	\$412,774
133					\$0	\$387,340	\$52,700	\$440,040
82					\$0	\$360,074	\$52,700	\$412,774
57				1	\$0	\$439,170	\$52,700	\$491,870
147	Yes			1	\$0	\$97,556	\$52,700	\$150,256
105				1	\$0	\$405,080	\$52,700	\$457,780
135					\$0	\$360,074	\$52,700	\$412,774
150					\$0	\$360,074	\$52,700	\$412,774
77				1	\$0	\$391,798	\$52,700	\$444,498
91					\$0	\$360,074	\$52,700	\$412,774
177	Yes			1	\$0	\$0	\$52,700	\$52,700
120					\$0	\$360,074	\$52,700	\$412,774

Table 6-2. (continued)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
34					\$0	\$360,074	\$52,700	\$412,774
149					\$0	\$360,074	\$26,350	\$386,424
199				1	\$0	\$405,080	\$26,350	\$431,430
142					\$0	\$341,897	\$52,700	\$394,597
75					\$0	\$341,897	\$52,700	\$394,597
Totals	7	0	0	23	0	\$19,287,617	\$2,837,017	\$22,124,630

Table 6-3. Two-Piece Food Can Sources (Model Plant 2) Costs

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
67					\$0	\$193,670	\$17,567	\$211,237
12	Yes				\$0	\$360,074	\$52,700	\$412,774
173					\$0	\$360,074	\$52,700	\$412,774
139					\$0	\$360,074	\$26,350	\$386,424
25					\$0	\$130,929	\$17,567	\$148,496
93					\$0	\$360,074	\$52,700	\$412,774
148	Yes			1	\$0	\$352,071	\$10,540	\$362,611
71	Yes			1	\$0	\$0	\$13,175	\$13,175
151	Yes			1	\$0	\$0	\$13,175	\$13,175
119				2	\$0	\$644,086	\$52,700	\$696,786
96	Yes			1	\$0	\$0	\$17,567	\$17,567
Totals	5	0	0	6	\$0	\$2,761,052	\$326,741	\$3,087,793

Table 6-4. One-Piece Aerosol Sources (Model Plant 3) Control Costs

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
115	Yes			2	\$0	\$0	\$52,700	\$52,700
55	Yes		Yes	12	\$0	\$0	\$52,700	\$52,700
Totals	2	0	1	14	\$0	\$0	\$105,400	\$105,400

Table 6-5. Sheetcoating Sources (Model Plant 4) Control Costs

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
190				1	\$0	\$316,847	\$17,567	\$334,414
22				2	\$0	\$689,944	\$26,350	\$716,294
32				1	\$0	\$220,948	\$17,567	\$238,515
66				3	\$0	\$351,586	\$13,175	\$364,761
183	Yes			1	\$0	\$0	\$26,350	\$26,350
43	Yes			3	\$0	\$0	\$52,700	\$52,700
16		Yes	Yes	1	\$0	\$0	\$0	\$0
200				1	\$0	\$283,685	\$13,175	\$296,860
56	Yes			3	\$0	\$97,556	\$52,700	\$150,256
164				1	\$0	\$271,329	\$17,567	\$288,896
145				2	\$0	\$602,431	\$10,540	\$612,971
122				1	\$0	\$333,108	\$52,700	\$385,808
204				2	\$0	\$283,685	\$13,175	\$296,860
107				1	\$0	\$407,242	\$13,175	\$420,417
172				2	\$0	\$571,264	\$17,567	\$588,831
132				1	\$0	\$307,161	\$52,700	\$359,861
36				1	\$0	\$252,795	\$52,700	\$305,495
40				2	\$0	\$250,744	\$17,567	\$268,311
52		Yes			\$0	\$0	\$0	\$0
8				2	\$0	\$252,795	\$13,175	\$265,970
20				1	\$0	\$314,574	\$52,700	\$367,274
127				3	\$0	\$326,930	\$17,567	\$344,497
21				3	\$0	\$617,501	\$26,350	\$643,851
23				2	\$0	\$602,473	\$52,700	\$655,173
203				2	\$0	\$677,250	\$52,700	\$729,950
97				4	\$0	\$476,988	\$52,700	\$529,688

Table 6-5. (continued)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
201			Yes		\$0	\$0	\$52,700	\$52,700
160				1	\$0	\$341,897	\$13,175	\$355,072
167	Yes			2	\$0	\$97,556	\$26,350	\$123,906
129				1	\$0	\$406,505	\$52,700	\$459,205
205					\$0	\$341,897	\$17,567	\$359,464
161				2	\$0	\$333,108	\$17,567	\$350,675
157				1	\$0	\$641,700	\$26,350	\$668,050
95				1	\$0	\$286,825	\$26,350	\$313,175
184				1	\$0	\$299,112	\$52,700	\$351,812
25				1	\$0	\$130,929	\$17,567	\$148,496
195				2	\$0	\$325,815	\$17,567	\$343,382
193				2	\$0	\$362,841	\$26,350	\$389,191
148				1	\$0	\$0	\$10,540	\$10,540
71					\$0	\$261,859	\$13,175	\$275,034
151					\$0	\$261,859	\$13,175	\$275,034
9				4	\$0	\$1,668,097	\$52,700	\$1,720,797
196				4	\$0	\$666,836	\$52,700	\$719,536
96					\$0	\$632,445	\$17,567	\$650,012
7	Yes			1	\$0	\$0	\$52,700	\$52,700
68				2	\$0	\$670,553	\$13,175	\$683,728
19					\$0	\$360,074	\$52,700	\$412,774
99				1	\$0	\$270,131	\$52,700	\$322,831
11		Yes			\$0	\$0	\$0	\$0
103		Yes		1	\$0	\$0	\$0	\$0
181				1	\$0	\$500,735	\$52,700	\$553,435
42				1	\$0	\$514,615	\$13,175	\$527,790

Table 6-5. (continued)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
116	Yes			1	\$0	\$0	\$52,700	\$52,700
41				12	\$0	\$1,787,523	\$52,700	\$1,840,223
180				1	\$0	\$495,670	\$17,567	\$513,237
141				1	\$0	\$446,675	\$52,700	\$499,375
154			Yes	1	\$0	\$525,227	\$52,700	\$577,927
38				3	\$0	\$773,740	\$52,700	\$826,440
109				3	\$0	\$567,451	\$52,700	\$620,151
155			Yes	1	\$0	\$304,383	\$52,700	\$357,083
Totals	6	4	4	99	\$0	\$22,784,893	\$1,865,584	\$24,650,478

Table 6-6. Three-Piece Food Can Assembly Sources (Model Plant 5)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
26		Yes			\$0	\$0	\$0	\$0
137		Yes			\$0	\$0	\$0	\$0
83	Yes				\$72,902	\$0	\$52,700	\$125,602
59					\$128,843	\$0	\$52,700	\$181,543
190					\$74,100	\$0	\$17,567	\$91,667
121	Yes				\$0	\$0	\$0	\$0
47					\$40,455	\$0	\$35,133	\$75,588
16	Yes	Yes	Yes	2	\$0	\$0	\$0	\$0
200					\$41,525	\$0	\$26,350	\$67,875
202	Yes				\$33,483	\$0	\$52,700	\$86,183
145	Yes				\$275	\$0	\$10,540	\$10,815
204	Yes				\$20,120	\$0	\$26,350	\$46,470
107					\$4,180	\$0	\$13,175	\$17,355
206	Yes				\$53,460	\$0	\$52,700	\$106,160
134					\$64,625	\$0	\$26,350	\$90,975
8	Yes				\$9,010	\$0	\$13,175	\$22,185
165	Yes				\$32,540	\$0	\$52,700	\$85,240
127					\$25,120	\$0	\$17,567	\$42,687
194					\$54,445	\$0	\$35,133	\$89,578
160	Yes				\$5,950	\$0	\$26,350	\$32,300
167					\$0	\$0	\$26,350	\$26,350
205	Yes				\$105,730	\$0	\$17,567	\$123,297
161					\$8,935	\$0	\$17,567	\$26,502
157					\$0	\$0	\$26,350	\$26,350
192	Yes				\$34,515	\$0	\$35,133	\$69,648
143					\$7,685	\$0	\$26,350	\$34,035

Table 6-6. (continued)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
195	Yes				\$26,180	\$0	\$35,133	\$61,313
148	Yes				\$179,500	\$0	\$21,080	\$200,580
71					\$11,970	\$0	\$13,175	\$25,145
151					\$11,970	\$0	\$13,175	\$25,145
Totals	14	3	1	0	\$1,047,518	\$0	\$743,070	\$1,790,588

Table 6-7. Three-Piece Nonfood Can Assembly Sources (Model Plant 6)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
32					\$0	\$0	\$17,567	\$17,567
66					\$5,505	\$0	\$13,175	\$18,680
183					\$0	\$0	\$26,350	\$26,350
110	Yes				\$0	\$0	\$0	\$0
164	Yes				\$0	\$0	\$17,567	\$17,567
145					\$8,700	\$0	\$10,540	\$19,240
107	Yes				\$0	\$0	\$13,175	\$13,175
40	Yes				\$0	\$0	\$17,567	\$17,567
68	Yes				\$13,595	\$0	\$26,350	\$39,945
11	Yes	Yes			\$0	\$0	\$0	\$0
103	Yes	Yes			\$0	\$0	\$0	\$0
42	Yes				\$34,650	\$0	\$26,350	\$61,000
180	Yes				\$7,530	\$0	\$17,567	\$25,097
Totals	9	2	0	0	\$69,980	\$0	\$186,208	\$256,188

Table 6-8. End Lining Operations (Model Plant 7)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
84					\$141,316	\$0	\$52,700	\$194,016
140					\$0	\$0	\$0	\$0
190	Yes				\$0	\$0	\$17,567	\$17,567
47	Yes				\$0	\$0	\$17,567	\$17,567
22					\$751,936	\$0	\$26,350	\$778,286
80	Yes				\$0	\$0	\$26,350	\$26,350
67	Yes				\$0	\$0	\$17,567	\$17,567
32					\$34,916	\$0	\$17,567	\$52,483
66					\$2,202	\$0	\$26,350	\$28,552
16		Yes	Yes		\$0	\$0	\$0	\$0
62					\$249,447	\$0	\$52,700	\$302,147
200					\$0	\$0	\$13,175	\$13,175
136					\$77,420	\$0	\$26,350	\$103,770
164	Yes				\$0	\$0	\$17,567	\$17,567
145	Yes				\$0	\$0	\$21,080	\$21,080
204	Yes				\$0	\$0	\$13,175	\$13,175
107	Yes				\$0	\$0	\$13,175	\$13,175
172					\$1,970	\$0	\$35,133	\$37,103
134	Yes				\$3,441	\$0	\$26,350	\$29,791
40	Yes				\$0	\$0	\$17,567	\$17,567
8					\$0	\$0	\$26,350	\$26,350
18					\$86,954	\$0	\$52,700	\$139,654
179					\$93,866	\$0	\$26,350	\$120,216
126					\$102,338	\$0	\$52,700	\$155,038
127					\$44,770	\$0	\$17,567	\$62,337
21					\$0	\$0	\$26,350	\$26,350

Table 6-8. (continued)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
2			Yes		\$22,166	\$0	\$52,700	\$74,866
171		Yes	Yes		\$0	\$0	\$0	\$0
175		Yes	Yes		\$0	\$0	\$0	\$0
191					\$0	\$0	\$52,700	\$52,700
149					\$0	\$0	\$26,350	\$26,350
199					\$0	\$0	\$26,350	\$26,350
194					\$0	\$0	\$17,567	\$17,567
160					\$0	\$0	\$13,175	\$13,175
139					\$73,988	\$0	\$26,350	\$100,338
205					\$41,884	\$0	\$17,567	\$59,451
161					\$183,710	\$0	\$17,567	\$201,277
95					\$0	\$0	\$26,350	\$26,350
192					\$85,594	\$0	\$17,567	\$103,161
143					\$57,644	\$0	\$26,350	\$83,994
25					\$37,980	\$0	\$17,567	\$55,547
193					\$52,466	\$0	\$26,350	\$78,816
148					\$345,200	\$0	\$10,540	\$355,740
71					\$41,884	\$0	\$13,175	\$55,059
151					\$0	\$0	\$13,175	\$13,175
197					\$80,356	\$0	\$52,700	\$133,056
100					\$148,008	\$0	\$52,700	\$200,708
185					\$148,008	\$0	\$52,700	\$200,708
96					\$54,774	\$0	\$17,567	\$72,341
68					\$0	\$0	\$13,175	\$13,175
11		Yes			\$0	\$0	\$0	\$0
103		Yes			\$0	\$0	\$0	\$0

Table 6-8. (continued)

Blind FACID	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
42					\$0	\$0	\$13,175	\$13,175
180					\$0	\$0	\$17,567	\$17,567
Totals	10	5	4	0	\$2,964,238	\$0	\$1,261,291	\$4,225,529

Table 6-9. Summary of Total Annual Costs

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
26	Nonaseptic side seam stripe (Food)		Yes			\$0	\$0	\$0	\$0
137	Nonaseptic side seam stripe (Food)		Yes			\$0	\$0	\$0	\$0
84	Nonaseptic end seal compounds					\$141,316	\$0	\$52,700	\$194,016
89	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
65	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
48	Beverage can coatings				1	\$0	\$738,922	\$52,700	\$791,622
130	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
112	Beverage can coatings				1	\$0	\$285,739	\$52,700	\$338,439
118	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
144	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
140	Nonaseptic end seal compounds					\$0	\$0	\$0	\$0
108	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
101	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
58	Beverage can coatings					\$0	\$387,340	\$52,700	\$440,040
117	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
106	Beverage can coatings				2	\$0	\$440,603	\$52,700	\$493,303
37	Beverage can coatings				1	\$0	\$330,613	\$52,700	\$383,313
163	Beverage can coatings	Yes			1	\$0	\$0	\$52,700	\$52,700
158	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
30	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
70	Beverage can coatings					\$0	\$341,897	\$52,700	\$394,597
83	Aseptic side seam stripe (Food)	Yes				\$6,071	\$0	\$26,350	\$32,421
83	Nonaseptic side seam stripe (Food)					\$66,831	\$0	\$26,350	\$93,181
59	Aseptic side seam stripe (Food)					\$57,150	\$0	\$26,350	\$83,500
59	Nonaseptic side seam stripe (Food)					\$71,693	\$0	\$26,350	\$98,043
190	Aseptic end seal compounds	Yes				\$0	\$0	\$17,567	\$17,567

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
190	Nonaseptic side seam stripe (Food)					\$74,100	\$0	\$17,567	\$91,667
190	Sheetcoating				1	\$0	\$316,847	\$17,567	\$334,414
121	Aseptic side seam stripe (Food)	Yes				\$0	\$0	\$0	\$0
121	Nonaseptic side seam stripe (Food)					\$0	\$0	\$0	\$0
47	Aseptic end seal compounds	Yes				\$0	\$0	\$17,567	\$17,567
47	Aseptic side seam stripe (Food)					\$12,360	\$0	\$17,567	\$29,927
47	Nonaseptic side seam stripe (Food)					\$28,095	\$0	\$17,567	\$45,662
22	Nonaseptic end seal compounds					\$751,936	\$0	\$26,350	\$778,286
22	Sheetcoatings				2	\$0	\$689,944	\$26,350	\$716,294
80	Beverage can coatings					\$0	\$387,340	\$26,350	\$413,690
80	Nonaseptic end seal compounds	Yes				\$0	\$0	\$26,350	\$26,350
78	Beverage can coatings					\$0	\$387,340	\$52,700	\$440,040
67	Beverage can coatings					\$0	\$193,670	\$17,567	\$211,237
67	Food can coatings					\$0	\$193,670	\$17,567	\$211,237
67	Nonaseptic end seal compounds	Yes				\$0	\$0	\$17,567	\$17,567
162	Beverage can coatings				1	\$0	\$407,242	\$52,700	\$459,942
159	Beverage can coatings				1	\$0	\$334,679	\$52,700	\$387,379
123	Beverage can coatings				1	\$0	\$360,074	\$52,700	\$412,774
72	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
32	General line side seam stripe (nonfood)					\$0	\$0	\$17,567	\$17,567
32	Nonaseptic end seal compounds					\$34,916	\$0	\$17,567	\$52,483
32	Sheetcoatings				1	\$0	\$220,948	\$17,567	\$238,515
66	Aerosol side seam stripe (nonfood)					\$5,505	\$0	\$13,175	\$18,680
66	Aseptic end seal compounds					\$0	\$0	\$13,175	\$13,175
66	Nonaseptic end seal compounds					\$2,202	\$0	\$13,175	\$15,377
66	Sheetcoatings				3	\$0	\$351,586	\$13,175	\$364,761

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
183	General line side seam stripe (nonfood)					\$0	\$0	\$26,350	\$26,350
183	Sheetcoatings	Yes			1	\$0	\$0	\$26,350	\$26,350
43	Sheetcoatings	Yes			3	\$0	\$0	\$52,700	\$52,700
16	Inside spray	Yes	Yes	Yes	1	\$0	\$0	\$0	\$0
16	Nonaseptic end seal compounds		Yes	Yes		\$0	\$0	\$0	\$0
16	Nonaseptic side seam stripe (Food)		Yes	Yes	1	\$0	\$0	\$0	\$0
16	Sheetcoatings		Yes	Yes	1	\$0	\$0	\$0	\$0
115	Aerosol can coatings	Yes			2	\$0	\$0	\$52,700	\$52,700
44	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
189	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
62	Nonaseptic end seal compounds					\$249,447	\$0	\$52,700	\$302,147
200	Aseptic end seal compounds					\$0	\$0	\$13,175	\$13,175
200	Inside spray					\$19,250	\$0	\$13,175	\$32,425
200	Nonaseptic side seam stripe (Food)					\$22,275	\$0	\$13,175	\$35,450
200	Sheetcoatings				1	\$0	\$283,685	\$13,175	\$296,860
110	Aerosol side seam stripe (nonfood)	Yes				\$0	\$0	\$0	\$0
56	Sheetcoatings	Yes			3	\$0	\$97,556	\$52,700	\$150,256
136	Beverage can coatings	Yes			2	\$0	\$0	\$26,350	\$26,350
136	Nonaseptic end seal compounds					\$77,420	\$0	\$26,350	\$103,770
12	Food can coatings	Yes				\$0	\$360,074	\$52,700	\$412,774
164	Aerosol side seam stripe (nonfood)	Yes				\$0	\$0	\$17,567	\$17,567
164	Nonaseptic end seal compounds	Yes				\$0	\$0	\$17,567	\$17,567
164	Sheetcoatings				1	\$0	\$271,329	\$17,567	\$288,896
124	Beverage can coatings	Yes			1	\$0	\$296,040	\$52,700	\$348,740
202	Inside spray	Yes				\$7,040	\$0	\$26,350	\$33,390
202	Nonaseptic side seam stripe (Food)					\$26,443	\$0	\$26,350	\$52,793

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
28	Beverage can coatings	Yes			2	\$0	\$382,531	\$52,700	\$435,231
145	Aerosol side seam stripe (nonfood)					\$8,700	\$0	\$10,540	\$19,240
145	Aseptic end seal compounds					\$0	\$0	\$10,540	\$10,540
145	Nonaseptic end seal compounds	Yes				\$0	\$0	\$10,540	\$10,540
145	Nonaseptic side seam stripe (Food)	Yes				\$275	\$0	\$10,540	\$10,815
145	Sheetcoatings				2	\$0	\$602,431	\$10,540	\$612,971
88	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
54	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
122	Sheetcoatings				1	\$0	\$333,108	\$52,700	\$385,808
27	Beverage can coatings					\$0	\$341,897	\$52,700	\$394,597
178	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
204	Aseptic end seal compounds	Yes				\$0	\$0	\$13,175	\$13,175
204	Inside spray	Yes				\$0	\$0	\$13,175	\$13,175
204	Nonaseptic side seam stripe (Food)					\$20,120	\$0	\$13,175	\$33,295
204	Sheetcoatings				2	\$0	\$283,685	\$13,175	\$296,860
107	Aerosol side seam stripe (nonfood)	Yes				\$0	\$0	\$13,175	\$13,175
107	Inside spray					\$4,180	\$0	\$13,175	\$17,355
107	Nonaseptic end seal compounds	Yes				\$0	\$0	\$13,175	\$13,175
107	Sheetcoatings				1	\$0	\$407,242	\$13,175	\$420,417
206	Inside spray	Yes				\$21,560	\$0	\$26,350	\$47,910
206	Nonaseptic side seam stripe (Food)					\$31,900	\$0	\$26,350	\$58,250
172	Aseptic end seal compounds	Yes				\$0	\$0	\$17,567	\$17,567
172	Nonaseptic end seal compounds					\$1,970	\$0	\$17,567	\$19,537
172	Sheetcoatings				2	\$0	\$571,264	\$17,567	\$588,831
134	Aseptic end seal compounds	Yes				\$0	\$0	\$13,175	\$13,175
134	Inside spray					\$35,200	\$0	\$13,175	\$48,375

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
134	Nonaseptic end seal compounds					\$3,441	\$0	\$13,175	\$16,616
134	Nonaseptic side seam stripe (Food)					\$29,425	\$0	\$13,175	\$42,600
132	Sheetcoatings				1	\$0	\$307,161	\$52,700	\$359,861
36	Sheetcoatings				1	\$0	\$252,795	\$52,700	\$305,495
40	Aerosol side seam stripe (nonfood)	Yes				\$0	\$0	\$17,567	\$17,567
40	Nonaseptic end seal compounds	Yes				\$0	\$0	\$17,567	\$17,567
40	Sheetcoatings				2	\$0	\$250,744	\$17,567	\$268,311
52	Sheetcoatings		Yes			\$0	\$0	\$0	\$0
63	Beverage can coatings	Yes			1	\$0	\$0	\$52,700	\$52,700
8	Aseptic end seal compounds					\$0	\$0	\$13,175	\$13,175
8	Nonaseptic end seal compounds					\$0	\$0	\$13,175	\$13,175
8	Nonaseptic side seam stripe (Food)	Yes				\$9,010	\$0	\$13,175	\$22,185
8	Sheetcoatings				2	\$0	\$252,795	\$13,175	\$265,970
92	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
18	Nonaseptic end seal compounds					\$86,954	\$0	\$52,700	\$139,654
179	Beverage can coatings					\$0	\$360,074	\$26,350	\$386,424
179	Nonaseptic end seal compounds					\$93,866	\$0	\$26,350	\$120,216
20	Sheetcoatings				1	\$0	\$314,574	\$52,700	\$367,274
165	Nonaseptic side seam stripe (Food)	Yes				\$32,540	\$0	\$52,700	\$85,240
126	Nonaseptic end seal compounds					\$102,338	\$0	\$52,700	\$155,038
173	Food can coatings					\$0	\$360,074	\$52,700	\$412,774
127	Inside spray					\$25,120	\$0	\$17,567	\$42,687
127	Nonaseptic end seal compounds					\$44,770	\$0	\$17,567	\$62,337
127	Sheetcoatings				3	\$0	\$326,930	\$17,567	\$344,497
85	Beverage can coatings					\$0	\$387,340	\$52,700	\$440,040
21	Nonaseptic end seal compounds					\$0	\$0	\$26,350	\$26,350

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
21	Sheetcoatings				3	\$0	\$617,501	\$26,350	\$643,851
23	Sheetcoatings				2	\$0	\$602,473	\$52,700	\$655,173
203	Sheetcoatings				2	\$0	\$677,250	\$52,700	\$729,950
97	Sheetcoatings				4	\$0	\$476,988	\$52,700	\$529,688
53	Beverage can coatings				1	\$0	\$466,936	\$52,700	\$519,636
61	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
79	Beverage can coatings				1	\$0	\$285,594	\$52,700	\$338,294
198	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
133	Beverage can coatings					\$0	\$387,340	\$52,700	\$440,040
82	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
57	Beverage can coatings				1	\$0	\$439,170	\$52,700	\$491,870
147	Beverage can coatings	Yes			1	\$0	\$97,556	\$52,700	\$150,256
2	Nonaseptic end seal compounds			Yes		\$22,166	\$0	\$52,700	\$74,866
171	Aseptic end seal compounds		Yes	Yes		\$0	\$0	\$0	\$0
171	Nonaseptic end seal compounds		Yes	Yes		\$0	\$0	\$0	\$0
201	Sheetcoatings			Yes		\$0	\$0	\$52,700	\$52,700
55	Aerosol can coatings	Yes		Yes	12	\$0	\$0	\$52,700	\$52,700
175	Aseptic end seal compounds		Yes	Yes		\$0	\$0	\$0	\$0
175	Nonaseptic end seal compounds		Yes	Yes		\$0	\$0	\$0	\$0
105	Beverage can coatings				1	\$0	\$405,080	\$52,700	\$457,780
135	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
150	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
77	Beverage can coatings				1	\$0	\$391,798	\$52,700	\$444,498
91	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
191	Nonaseptic end seal compounds					\$0	\$0	\$52,700	\$52,700
177	Beverage can coatings	Yes			1	\$0	\$0	\$52,700	\$52,700

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
120	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
34	Beverage can coatings					\$0	\$360,074	\$52,700	\$412,774
149	Beverage can coatings					\$0	\$360,074	\$26,350	\$386,424
149	Nonaseptic end seal compounds					\$0	\$0	\$26,350	\$26,350
199	Beverage can coatings				1	\$0	\$405,080	\$26,350	\$431,430
199	Nonaseptic end seal compounds					\$0	\$0	\$26,350	\$26,350
142	Beverage can coatings					\$0	\$341,897	\$52,700	\$394,597
75	Beverage can coatings					\$0	\$341,897	\$52,700	\$394,597
194	Aseptic end seal compounds					\$0	\$0	\$17,567	\$17,567
194	Inside spray					\$19,620	\$0	\$17,567	\$37,187
194	Nonaseptic side seam stripe (Food)					\$34,825	\$0	\$17,567	\$52,392
160	Aseptic end seal compounds					\$0	\$0	\$13,175	\$13,175
160	Inside spray	Yes				\$0	\$0	\$13,175	\$13,175
160	Nonaseptic side seam stripe (Food)					\$5,950	\$0	\$13,175	\$19,125
160	Sheetcoatings				1	\$0	\$341,897	\$13,175	\$355,072
167	Nonaseptic side seam stripe (Food)					\$0	\$0	\$26,350	\$26,350
167	Sheetcoatings	Yes			2	\$0	\$97,556	\$26,350	\$123,906
139	Food can coatings					\$0	\$360,074	\$26,350	\$386,424
139	Nonaseptic end seal compounds					\$73,988	\$0	\$26,350	\$100,338
129	Sheetcoatings				1	\$0	\$406,505	\$52,700	\$459,205
205	Nonaseptic end seal compounds					\$41,884	\$0	\$17,567	\$59,451
205	Nonaseptic side seam stripe (Food)	Yes				\$105,730	\$0	\$17,567	\$123,297
205	Sheetcoatings					\$0	\$341,897	\$17,567	\$359,464
161	Nonaseptic end seal compounds					\$183,710	\$0	\$17,567	\$201,277
161	Nonaseptic side seam stripe (Food)					\$8,935	\$0	\$17,567	\$26,502
161	Sheetcoatings				2	\$0	\$333,108	\$17,567	\$350,675

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
157	Nonaseptic side seam stripe (Food)					\$0	\$0	\$26,350	\$26,350
157	Sheetcoatings				1	\$0	\$641,700	\$26,350	\$668,050
95	Nonaseptic end seal compounds					\$0	\$0	\$26,350	\$26,350
95	Sheetcoatings				1	\$0	\$286,825	\$26,350	\$313,175
192	Aseptic side seam stripe (Food)	Yes				\$0	\$0	\$17,567	\$17,567
192	Nonaseptic end seal compounds					\$85,594	\$0	\$17,567	\$103,161
192	Nonaseptic side seam stripe (Food)	Yes				\$34,515	\$0	\$17,567	\$52,082
184	Sheetcoatings				1	\$0	\$299,112	\$52,700	\$351,812
143	Nonaseptic end seal compounds					\$57,644	\$0	\$26,350	\$83,994
143	Nonaseptic side seam stripe (Food)					\$7,685	\$0	\$26,350	\$34,035
25	Food can coatings					\$0	\$130,929	\$17,567	\$148,496
25	Nonaseptic end seal compounds					\$37,980	\$0	\$17,567	\$55,547
25	Sheetcoatings				1	\$0	\$130,929	\$17,567	\$148,496
195	Aseptic side seam stripe (Food)	Yes				\$0	\$0	\$17,567	\$17,567
195	Nonaseptic side seam stripe (Food)					\$26,180	\$0	\$17,567	\$43,747
195	Sheetcoatings				2	\$0	\$325,815	\$17,567	\$343,382
193	Nonaseptic end seal compounds					\$52,466	\$0	\$26,350	\$78,816
193	Sheetcoatings				2	\$0	\$362,841	\$26,350	\$389,191
93	Food can coatings					\$0	\$360,074	\$52,700	\$412,774
148	Aseptic side seam stripe (Food)	Yes				\$0	\$0	\$10,540	\$10,540
148	Food can coatings	Yes			1	\$0	\$352,071	\$10,540	\$362,611
148	Nonaseptic end seal compounds					\$345,200	\$0	\$10,540	\$355,740
148	Nonaseptic side seam stripe (Food)					\$179,500	\$0	\$10,540	\$190,040
148	Sheetcoatings				1	\$0	\$0	\$10,540	\$10,540
71	Food can coatings	Yes			1	\$0	\$0	\$13,175	\$13,175
71	Nonaseptic end seal compounds					\$41,884	\$0	\$13,175	\$55,059

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
71	Nonaseptic side seam stripe (Food)					\$11,970	\$0	\$13,175	\$25,145
71	Sheetcoatings					\$0	\$261,859	\$13,175	\$275,034
151	Aseptic end seal compounds					\$0	\$0	\$13,175	\$13,175
151	Food can coatings	Yes			1	\$0	\$0	\$13,175	\$13,175
151	Nonaseptic side seam stripe (Food)					\$11,970	\$0	\$13,175	\$25,145
151	Sheetcoatings					\$0	\$261,859	\$13,175	\$275,034
197	Nonaseptic end seal compounds					\$80,356	\$0	\$52,700	\$133,056
9	Sheetcoatings				4	\$0	\$1,668,097	\$52,700	\$1,720,797
196	Sheetcoatings				4	\$0	\$666,836	\$52,700	\$719,536
100	Nonaseptic end seal compounds					\$148,008	\$0	\$52,700	\$200,708
119	Food can coatings				2	\$0	\$644,086	\$52,700	\$696,786
185	Nonaseptic end seal compounds					\$148,008	\$0	\$52,700	\$200,708
96	Food can coatings	Yes			1	\$0	\$0	\$17,567	\$17,567
96	Nonaseptic end seal compounds					\$54,774	\$0	\$17,567	\$72,341
96	Sheetcoatings					\$0	\$632,445	\$17,567	\$650,012
7	Sheetcoatings	Yes			1	\$0	\$0	\$52,700	\$52,700
68	Aerosol side seam stripe (nonfood)	Yes				\$11,000	\$0	\$13,175	\$24,175
68	General line side seam stripe (nonfood)	Yes				\$2,595	\$0	\$13,175	\$15,770
68	Nonaseptic end seal compounds					\$0	\$0	\$13,175	\$13,175
68	Sheetcoatings				2	\$0	\$670,553	\$13,175	\$683,728
19	Sheetcoatings					\$0	\$360,074	\$52,700	\$412,774
99	Sheetcoatings				1	\$0	\$270,131	\$52,700	\$322,831
11	General line side seam stripe (nonfood)	Yes	Yes			\$0	\$0	\$0	\$0
11	Nonaseptic end seal compounds		Yes			\$0	\$0	\$0	\$0
11	Sheetcoatings		Yes			\$0	\$0	\$0	\$0
103	Aerosol side seam stripe (nonfood)		Yes			\$0	\$0	\$0	\$0

Table 6-9. (continued)

Blind FACID	Model Plant Category	Floor Facility	Synthetic Minor	Small Business	Number of APCDs	Annual Material Costs	Annualized Capital Costs	Annual MR&R Costs	Total Annual Costs
103	General line side seam stripe (nonfood)	Yes	Yes			\$0	\$0	\$0	\$0
103	Nonaseptic end seal compounds		Yes			\$0	\$0	\$0	\$0
103	Sheetcoatings		Yes		1	\$0	\$0	\$0	\$0
181	Sheetcoatings				1	\$0	\$500,735	\$52,700	\$553,435
42	Aerosol side seam stripe (nonfood)					\$34,650	\$0	\$13,175	\$47,825
42	General line side seam stripe (nonfood)	Yes				\$0	\$0	\$13,175	\$13,175
42	Nonaseptic end seal compounds					\$0	\$0	\$13,175	\$13,175
42	Sheetcoatings				1	\$0	\$514,615	\$13,175	\$527,790
116	Sheetcoatings	Yes			1	\$0	\$0	\$52,700	\$52,700
41	Sheetcoatings				12	\$0	\$1,787,523	\$52,700	\$1,840,223
180	General line side seam stripe (nonfood)	Yes				\$7,530	\$0	\$17,567	\$25,097
180	Nonaseptic end seal compounds					\$0	\$0	\$17,567	\$17,567
180	Sheetcoatings				1	\$0	\$495,670	\$17,567	\$513,237
141	Sheetcoatings				1	\$0	\$446,675	\$52,700	\$499,375
154	Sheetcoatings			Yes	1	\$0	\$525,227	\$52,700	\$577,927
38	Sheetcoatings				3	\$0	\$773,740	\$52,700	\$826,440
109	Sheetcoatings				3	\$0	\$567,451	\$52,700	\$620,151
155	Sheetcoatings			Yes	1	\$0	\$304,383	\$52,700	\$357,083
	Totals	56	18	13	144	\$4,081,736	\$44,833,563	\$7,325,316	\$56,240,611

6.3 COST EFFECTIVENESS

The cost effectiveness of controlling organic HAP emissions from metal can surface coating operations is the cost per ton of HAP emissions reduced. Table 6-10 shows total HAP reduction, total control costs, and cost effectiveness for each of the four primary industry subcategories. Overall cost effectiveness for the metal can surface coating industry cost also provided.

Cost effectiveness for the seven industry segments ranges from \$4,500/ton (\$4,900/Mg) to \$33,600/ton (\$37,000/Mg). The cost effectiveness for the overall metal can surface coating industry is \$8,300/ton (\$9,100/Mg).

Table 6-10. Cost Effectiveness of Controls for Metal Can (Surface Coating) Industry

MACT Implementation	Model Plant							
	Two-Piece Beverage Can Sources	Two-Piece Food Can Sources	One-Piece Aerosol Can Sources	Sheetcoating Sources	Three-Piece Food Can Assembly	Three-Piece Nonfood Can Assembly	End Lining Operations	Totals
Emission Reductions								
Total HAP emission reductions (ton/yr)	3,111	690	0	2,087	94	8	803	6,792
(Mg/yr)	2,822	626	0	1,893	85	7	728	6,162
Industry Costs								
Materials	\$0	\$0	\$0	\$0	\$1,047,518	\$69,980	\$2,964,238	\$4,081,736
Capital Equipment	\$19,287,617	\$2,761,053	\$0	\$22,784,893	\$0	\$0	\$0	\$44,833,563
MR&R	\$2,837,017	\$326,740	\$105,400	\$1,865,580	\$743,070	\$186,207	\$1,261,287	\$7,325,301
Total cost for industry	\$22,124,634	\$3,087,793	\$105,400	\$24,650,473	\$1,790,588	\$256,187	\$4,225,525	\$56,240,600
Cost Effectiveness (\$/ton)	\$7,112	\$4,475		\$11,811	\$19,049	\$32,023	\$5,262	\$8,280
(\$/Mg)	\$7,840	\$4,933		\$13,022	\$21,066	\$36,598	\$5,804	\$9,127

6.4 SMALL BUSINESSES

Based on the small business size cut-off of 1,000 corporate employees established by SIC code 3411, 15 companies in the project database were identified as small businesses. Seven are designated as area sources. Therefore, there are eight small businesses included in the total population of facilities used for evaluating and determining MACT floor(s). These eight facilities are identified in Table 6-9. Only five of the facilities are major sources of HAP emissions and will have to meet the NESHAP requirements. The other three facilities are synthetic minor sources. Total annual costs for the five major source small businesses are \$1.1 million.

6.5 REFERENCES

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