Preliminary Industry Characterization:

Metal Can Manufacturing--Surface Coating

U. S. Environmental Protection Agency

Coatings and Consumer Products Group

Emission Standards Division

Office of Air Quality Planning and Standards

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EXECUTIVE SUMMARY

Under Section 112(d) of the Clean Air Act (the Act), the U.S. Environmental Protection Agency (EPA) is developing national emission standards for hazardous air pollutants (NESHAP) for the metal can manufacturing–surface coating source category. The EPA is required to publish final emission standards for the metal can manufacturing–surface coating source category by November 15, 2000.

There is a possibility that case-by-case maximum achievable control technology (MACT) determinations will be required under Section 112 (g) for newly constructed and/or reconstructed major sources. The information summarized in this document can be used by States that may have to make case-by-case MACT determinations under Sections 112(g) or 112(j) of the Act.

Section 1 of this document gives an overview of the initial MACT development phase for this source category. Section 2 summarizes the issues raised and information gathering techniques used in this process. A preliminary characterization of the metal can manufacturing–surface coating source category is given in Section 3. Section 3 also focuses on the source category's products, types of coatings used, application methods, emissions, and emission control techniques.

1.0 OVERVIEW OF INITIAL MACT DEVELOPMENT PHASE FOR THE METAL CAN MANUFACTURING--SURFACE COATING SOURCE CATEGORY

Under Section 112(d) of the Clean Air Act (the Act), the U.S. Environmental Protection Agency (EPA) is developing national emission standards for hazardous air pollutants (NESHAP) for the metal can manufacturing–surface coating source category. The EPA is required to publish final emission standards for the metal can manufacturing–surface coating source category by November 15, 2000.

The Act requires that the emission standards for new sources be no less stringent than the emission control achieved in practice by the best controlled similar source. For existing sources, the emission control can be less stringent than the emission control for new sources, but it must be no less stringent than the average emission limitation achieved by best performing 12 percent of existing sources (for which the EPA has emissions information). In categories or subcategories with fewer than 30 sources, emission control for existing sources must be no less stringent than the average emission limitation achieved by the best performing 5 sources. The NESHAP are commonly known as maximum achievable control technology (MACT) standards.

The MACT standards development for the metal can manufacturing--surface coating industry began with a Coating Regulations Workshop for representatives of EPA and interested stakeholders in April 1997 and continues as a coordinated effort to promote consistency and joint resolution of issues common across nine coating source categories.[1] The first phase was one in which EPA gathered readily available information about the industry with the help of representatives from the regulated industry, State and local air pollution agencies, small business assistance providers, and environmental groups. The goals of the first phase were to either fully or partially:

1. Understand the coating processes;
2. Identify typical emission points and the relative emissions from each;

[1] The workshop covered eight categories: fabric printing, coating and dyeing; large appliances; metal can; metal coil; metal furniture; miscellaneous metal parts; plastic parts; and wood building products. The automobile and light duty truck surface coating project was started subsequently.

3. Identify the range(s) of emission reduction techniques and their effectiveness;
4. Make an initial determination of the scope of each category;
5. Determine the relationships and overlaps among the source categories;
6. Locate as many facilities as possible, particularly major sources;
7. Identify and involve representatives from each industry segment;
8. Complete informational site visits;
9. Identify issues and data needs and develop a plan for addressing them;
10. Develop questionnaire(s) for additional data gathering; and
11. Document results of the first phase of regulatory development for each source category.

The associations that participated in the stakeholder process were the Can Manufacturers Institute (CMI), National Paint and Coatings Association (NPCA), and the Chemical Manufacturers Association (CMA) Solvents Council. The States that participated in the process were Florida, Oklahoma, New York, Georgia, South Carolina, and North Carolina. Appendix A contains a complete list of participants.

The information summarized in this document can be used by States that may have to make case-by-case MACT determinations under Sections 112(g) or 112(j) of the Act. The initial phase of the regulatory development focused primarily on the characterization of the can manufacturing industry’s coating application methods, types, and emissions. This document summarizes that phase of rule development.

This document includes a description of the emission control technologies EPA identified that are currently used in practice by the industry and that could serve as the basis of MACT. Within the short time-frame allotted for this initial phase, however, only limited data were collected. The information summarized in this document was collected prior to July 15, 1998. Additional information will be collected and considered before the metal can manufacturing surface coating standards are promulgated.

During the next phase, EPA will continue to build on the knowledge gained to date and proceed with more focused investigation and data analyses. We will also continue our efforts to coordinate cross-cutting issues. We will continue to identify technical and policy issues that need to be addressed in the rule making and enlist the help of the stakeholders in resolving those issues.

2.0 SUMMARY OF INITIAL MACT DEVELOPMENT PROCESS

2.1 Roundtable Meetings

The first phase of development of the NESHAP for Metal Can Manufacturing--Surface Coating began on April 8 and 9, 1997 with a workshop held by the Coatings and Consumer Products Group (CCPG) of the Emission Standards Division (ESD) in Research Triangle Park, North Carolina. The workshop presented information on the standards development process. As part of the workshop, EPA held breakout sessions with representatives of each of eight source categories that the CCPG plans to regulate, including one for the metal can manufacturing–surface coating source category. At this workshop and subsequent roundtable meetings, a number of industry stakeholders were identified (see Appendix A for a list of stakeholders that have contributed to the development of the preliminary industry characterization for metal can manufacturing–surface coating).

On May 8, 1997, representatives from Can Manufacturers Institute (CMI) and its member companies met with the EPA to describe the various can manufacturing processes and hazardous air pollutant (HAP) emissions from these processes. The effect of coating performance requirements on coating formulations and HAP content was also discussed.

The first stakeholder roundtable meeting was held on June 17, 1997. In that meeting, the EPA presented its preliminary industry profile and received comments from stakeholders. Subcategorization and overlap issues were also discussed, as were future collection efforts, including the timetable for gathering data from States and developing Section 114 information collection requests (ICR's).

A regulatory subgroup meeting was held on July 23, 1997. The discussion focused on the role of the regulatory subgroup, issues raised in stakeholder meetings, and how the regulatory subgroup could assist in data gathering activities. At this meeting, several States offered to gather permit information.

A second industry roundtable meeting was held on August 20, 1997. The primary purpose of the meeting was to brief the stakeholders on the status of the EPA's PMACT development efforts and to allow stakeholders to comment on or add to the information the EPA had obtained to date. Other discussion items included future data collection activities, such as site visits and an information collection request (ICR) for the industry that will be used in establishing the MACT floor.

The next meeting was held on June 30, 1998 to discuss stakeholders comments on the draft ICR and list of recipients.

2.2 Site Visits

The EPA representatives visited two can manufacturing plants to collect information on the industry. One of the facilities visited manufactures 2-piece draw-and-iron beverage cans, and the other facility manufactures 3-piece steel food cans and 2-piece draw-and-iron steel food cans. The food can manufacturing facility included an ultraviolet radiation-cured (UV-cured) exterior coating line. These visits focused on collecting general facility information and information on the coating processes, emission sources, and the types of coatings used.

2.3 Basis of the Preliminary Industry Characterization

As of July 1998, the EPA, with assistance from State regulatory agencies, has collected background information for the metal can surface coating source category from the Aerometric Information Retrieval System (AIRS), Source Test Information Retrieval System (STIRS), and Toxic Chemical Release Inventory (TRI) data bases; the Census of Manufactures; and State regulations and permit information. In addition, CMI has provided the EPA with a summary of the various types of coating formulations used by can manufacturers and the content of volatile organic compounds (VOC's) and HAP's, as well as coating line data on coating HAP content and add-on capture and control levels from a survey the conducted of their member companies. Other information has been obtained through meetings and telephone discussions with stakeholders. The information gathered is summarized in this document and will be used for the development of MACT. Additional information from ICR's and other sources will be collected and considered before emission standards for metal can surface coating operations are proposed.

3.0 METAL CAN MANUFACTURING--SURFACE COATING SOURCE CATEGORY

This section 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 section was obtained from readily available sources including the literature, industry representatives, and State, and local air pollution control agencies.

3.1 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, 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 (e.g., potato chip and popcorn tins), and crowns and closures (e.g., metal bottle caps and jar lids) are similar to traditional cans and are sometimes coated on the same lines as traditional cans. Because of the similarities and co-location with the coating of traditional cans, the EPA is currently examining the coating of decorative tins and crowns and closures as part of the metal can source category.

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

The coating of some can parts is done on metal coil coating lines. There is a separate NESHAP under development for metal coil surface coating, which is examining all metal coil coating, regardless of the product manufactured from the coil. Therefore, the coil coating of can parts will not be examined as part of the metal can NESHAP. Additionally, there are some can parts or labels that are not metal. Examples include the paper labels on food cans, and the cardboard bodies of composite cans (e.g., frozen fruit juice cans). These are not included under the source category for metal cans, but may be regulated under another category, such as paper and other web coating, or printing and publishing.

Approximately 365 plants in the U.S. are engaged in one or more can manufacturing processes, as identified by SIC code 3411. Figure 1 presents the distribution of can plants across the country. As Figure 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 contents.

The operations performed by can manufacturing facilities vary from plant to plant. Many of these plants operate complete can manufacturing processes. However, some plants only perform sheet printing and coating, sending finished sheets to other facilities that complete the can manufacturing process. Other plants only produce can ends from coils or sheets that may be purchased pre-coated or coated on site. Still other plants operate can manufacturing processes along with production of other container products such as crowns and closures. In addition, some can manufacturing facilities are co-located with food packaging plants.

Figure 2 presents 1995 shipments of the various types of cans produced in the U.S., broken down by end use. As the figure indicates, the vast majority of cans are used to contain food and beverage products, whereas non-food packaging accounts for only about 3 percent of metal can production.

The two basic types of metal cans produced today are 2-piece cans and 3-piece cans. Table 1 summarizes the different variations of 2-and 3-piece cans and typical uses. As Table 1 shows, 2-piece draw-and-iron aluminum cans are typically used as beverage containers but may also be used to contain food and non-food products. Cans containing non-food products are called general line cans. Another type of aluminum draw-and-iron can is the 1-piece aluminum can, which is used for aerosol and pumped products such as saline solution, perfume, and air freshener as well as non-propelled products such as fuel additives. The 1-piece can is so called because the aerosol or pump valve is attached directly onto the top of the can (i.e., no top end piece is required). One-piece aluminum cans are sometimes called bottles by some industry representatives. Two-piece steel draw-and-iron cans are used to contain food.

Two-piece steel and aluminum draw-redraw cans, which are shallower than draw-and-iron cans, are used as containers for food products, including pet foods, tuna, salmon, and snack foods, and also for non-food products such as car wax, shoe polish, and Sterno fuel. Can ends are used for all types of cans and include the standard ends as well as 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 non-metal materials.

Figure 3 presents 1995 shipments and market share for 2- and 3-piece cans. As Figure 3 shows, current production is dominated by 2-piece cans, which accounted for 84 percent of cans shipped in 1995.

TABLE 1. TYPES OF CANS AND THEIR USES

Process	**Material Used**	**Products Contained**
3-piece	steel	food, juices, spices, aspirin, & other non-food items such as paints and glues (includes decorative tins); includes aerosols
draw & iron	aluminum (1- and 2-piece)	2-piece: primarily beer, carbonated beverages, juices 1-piece: aerosol & pump products (perfume, air freshener, saline solution); fuel additives
	steel (2-piece only)	food, other non-food items
2-piece draw/redraw	steel, aluminum	food, shoe polish, sterno fuel, car wax, other non-food items
ends	steel, aluminum	all (except 1-piece draw & iron)
crowns and closures	steel	food & non-food items

3.2 Metal Can Manufacturing and Coating Processes

Can manufacturing processes can be broadly grouped into 3-piece and 2-piece can body manufacturing and can end manufacturing. Two-piece can manufacturing includes cans manufactured by the draw-and-iron and draw-redraw processes. Can manufacturing processes are described in detail in Sections 3.2.1 through 3.2.3. The manufacture of 1-piece draw-and-iron cans is discussed under the draw-and-iron process description.

3.2.1 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 3.3 contains a detailed discussion of the coatings used in can manufacturing.

Interior coatings are applied to protect the can from corrosion by the contents and/or to protect the contents from being contaminated by dissolved metal from the can. Occasionally, however, pigmented interior coatings are applied to 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 3.2.3) 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 striping, which is performed with a spray; and repair coatings, which are sprayed.

Figure 4 illustrates the application of coatings to sheets. Steel sheets are fed to a conveyor by a sheet feeder. The sheets are transferred to the coater, where the coating is transferred from a tray to the roll coater by a series of rollers, then is applied 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 curing oven operates at temperatures of up to 425°F. Typically, multiple heating zones are required to achieve the temperature profile that results in proper curing of coatings. The heating zone is followed by a cooling zone that cools 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 used. 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.

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.

Decorations on 3-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 is not included in this source category. Inks are applied using the offset lithography process, which is illustrated in Figure 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 to an exterior base coat but may be applied directly to the metal. The transfer of inks is influenced by environmental 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 are cured 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 3-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 solvent- 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 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 rolled 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 used to make the ends.

In addition to protective interior coatings that are roll-coated onto flat sheets that are then formed, 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.

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.

3.2.2 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-redraw process or the draw-and-iron process. After the fabrication process, various coatings are applied and cured. These processes are described in detail below.

3.2.2.1 Draw-and iron process

3.2.2.1.1 Aluminum beverage cans and 1-piece cans

Figure 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 is cured at 350°F to 400°F in single or multi-pass continuous, high production ovens at a rate of 500 to 2000 cans per minute.

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. An overvarnish is then roller-applied while the inks are still wet, then a rim coat is applied to the bottom of the can with a roller 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 2-piece aluminum beverage cans uses UV-cured printing inks and overvarnishes. These coatings are applied in the same manner as solvent- 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. 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 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.

3.2.2.1.2 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.

3.2.2.2 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 pre-coated coils; if so, there are no additional coating steps in the manufacturing process (coil coating for draw-redraw cans is expected to be 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 3-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.

3.2.3 Can ends

3.2.3.1 Aluminum beverage can ends

Aluminum beverage can ends are made exclusively from pre-coated 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.

3.2.3.2 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 3-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.

3.3 Coatings

Can manufacturing processes include several coating application steps, as described in Section 3.2. Table 2 summarizes the different types of coating formulations applied to cans and their specific uses.

Section 3.3.1 introduces the general types of coatings used in can manufacturing; Section 3.3.2 describes the required properties and formulations of can coatings according to the application process and the end use of the can.

TABLE 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 (3-piece cans)
Inside sprays	Protect metal from contents and vice versa (2-piece cans; some 3-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

3.3.1 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's). However, in the 1970's, 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 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 3. The VOC information is not directly related to the development of the MACT standards for HAP's, however, it is included on the table and following discussion because many HAP's are VOC's and also as additional background information. The VOC and HAP content were reported in different units and cannot be directly compared ; however, EPA does not have the information to accurately convert the data to common units. Note that the HAP content data reflect as-applied values, which in some cases, such as 3-piece can fabrication, includes addition of thinning materials that may contain HAP's. Each coating category is described in more detail below.

TABLE 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	3-piece can inside spray	

Coating Technology	VOC Content (lb VOC/gal coating minus water)	Range of HAP Content (lb HAP/lb solids applied)	Main Industry Uses	Comments
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	3-piece cans: -Fruits & vegetables -Soups & pastas -Meat & fish -Pet food -Paint & aerosol	Solvent reformulation will increase cost & VOC content. Waterborne & high-solids coatings are not viable for paint & aerosol products.
Waterborne Epoxy	1.7 - 2.0	0.04 - 0.10	3-piece cans: -Fruits & vegetables -Soups & pastas	Waterborne creates operational inefficiencies if coaters cannot be dedicated. Pigmented types not yet developed.
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 -3-piece cans -Meat, fish, pet food -Tomatoes, juices	Expanding usage in recent years
Oleoresinous	1.2 - 3.5	0 - 0.1	3-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

Coating Technology	VOC Content (lb VOC/gal coating minus water)	Range of HAP Content (lb HAP/lb solids applied)	Main Industry Uses	Comments
High Solids -Varnish -White	 2.6 - 3.0 2.3 - 3.0	 0.1 - 0.2 0.1 - 0.2	Low-process decorated 3-piece bodies: -Tomato products -Aerosol & general line cans	UV not an option for whites
UV Overvarnish	< 0.01	< 0.01	Decorated 3-piece bodies -Low-process foods -Aerosol & 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	
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 (non-aseptic) -sanitary (aseptic)	Reformulation is required to eliminate HAP's from high-solids solventbase sealants Waterbase end seal compounds have limited commercial use on aseptic packs

Coating Technology	VOC Content (lb VOC/gal coating minus water)	Range of HAP Content (lb HAP/lb solids applied)	Main Industry Uses	Comments
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 & 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 & medium film weight applications	-Early development state -No dedicated commercial lines -Will require extensive testing and customer approval to expand use
Powder coatings	< 0.01	< 0.01	Thick film requirements: -Acid foods -Latex paints	Not practical for lower film weight requirements

Notes:

a Source: Supplier Coating Matrix submitted 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.

3.3.1.1 Conventional solventborne coatings

According to Table 3, conventional solventborne coatings have high concentrations of VOC's, typically 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 0.02 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 manufacturers are subject to regulations limiting VOC emissions, low-VOC coatings are being developed as replacements for conventional solventborne coatings in many applications. However, conventional solventborne coatings are still used for 3-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 3-piece cans, and draw-redraw cans). In addition, conventional solventborne inks are used in 3-piece steel can lithographic printing. Current conventional solventborne 3-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 non-food products (e.g., paints and varnishes) for which no suitable low-VOC coatings have been developed. Conventional solventborne coatings have been eliminated from 2-piece beverage can coating and are expected to be eliminated from 2-piece draw-and-iron food can manufacturing by 1999.

3.3.1.2 High-solids coatings

High solids coatings are solventborne coatings that have reduced organic solvent content. According to Table 3, high-solids coatings typically contain from 2.3 to 5.0 lb VOC/lb gal minus water coating, and the HAP content of high-solids coatings ranges from 0.2 to 0.7 lb HAP/lb solids applied. The range of 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.

High-solids coatings have replaced conventional solventborne coatings as exterior base coatings in some low-process 3-piece and 2-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 sheet 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 2-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 a solid. High solids solventborne end seal compounds are used for beer and beverage cans as well as food cans.

3.3.1.3 Waterborne coatings

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. According to Table 3, waterborne coatings contain approximately and approximately 1.4 to 3.6 lb VOC/lb gal coating, minus water. The HAP content of waterborne coatings shown in Table 3 ranges from 0.06 to 0.4 lb HAP/lb solids applied.

Beverage can manufacturers use waterborne coatings extensively. Waterborne coatings are used for 2-piece beverage can base coats, overvarnishes, inside sprays, and rim coats. Waterborne coatings are also used for 2-piece food can wash coats, 2- and 3-piece can inside sprays and exterior end coatings, and 3-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, which 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.

Waterbased end seal compounds are used for general line and aerosol cans, and have limited application for certain beverages and foods.

3.3.1.4 Ultraviolet radiation-cured (UV-cured) coatings

Ultraviolet radiation-cured coatings have three components: oligomers, monomers, and photochemical initiators. 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 photochemical initiators are unstable chemicals that form protons or free radicals when bombarded by UV radiation to initiate the cross-linking process. UV-cured coatings are cured by medium-pressure mercury vapor lamps.

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 according to Table 3) 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.

Ultraviolet radiation–cured overvarnishes and inks are currently used at one 2-piece beverage can facility and are used for rim coats at about 20 other 2-piece beverage can facilities. Additionally, UV exterior coatings (including inks) are used on 100 sheet coating lines at 30 steel can and can end sheet coating facilities. Ultraviolet radiation-cured inks are widely used for 3-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.

3.3.1.5 Powder coatings

Powder coatings are composed of fine, dry particles of paint solids and contain very low concentrations of VOC's and HAP's. 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 140°F to 400°F.

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 2-piece beverage cans, and are currently used for 3-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.

3.3.2 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 20-30 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 2-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.

3.3.2.1 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 non-food 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 non-food 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.

3.3.2.2 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 pre-formed cans. Coating operations in this category include the 2- and 3-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 2-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.

3.4 Characterization of HAP Emissions from Metal Can Surface Coating Facilities

3.4.1 HAP Emissions

Table 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 HAP emissions (not considering the facilities' potential to emit).

TABLE 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 + 2 facilities under SIC code 3466)

As Table 4 shows, glycol ethers represent 71 percent of reported HAP emissions from these facilities. The reason for this is that ethylene glycol monobutyl ether (EGBE), a type of glycol ether, is the primary solvent used in waterborne beverage can coatings, which accounted for 84 percent of 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 non-HAP compound) for n-hexane. Waterbased end seal compounds for beverage cans contain no HAP's. However, there are still some solventborne compounds in use that contain n-hexane.

3.4.2 <u>HAP Emission Sources and Emission Reduction Techniques</u>

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.

3.4.2.1 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's; 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.

Table 5 summarizes EPA's current information on the emission reduction techniques used in the various coating operations performed 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 coating (discussed further in the next section); and (2) the availability of "compliant"coatings (i.e., coatings with VOC or HAP content below applicable emission limits) for the end use of cans that are produced by a facility. For example, the data in Table 5 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 coatings have not been developed. Conversely, most 2-piece beverage can facilities use waterborne coatings without control because coatings have been developed that allow facilities to meet regulations in most areas without add-on controls.

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).

Table 6 summarizes the performance of add-on controls used on existing can coating lines. These data are also derived from the results of CMI's 1997 survey except where footnoted. As indicated in Table 6, the best-performing add-on control scenario for most coating operations is capture of 90 percent of emissions or greater from the coating application, flashoff, and drying operations, vented to an incinerator with a destruction efficiency of at least 95 percent. An exception is sheet coating operations, some of which are housed in total enclosures (i.e., enclosures that meet EPA Method 204 criteria for a permanent total enclosure), thus achieving 100 percent capture. While emissions from a few end seal compound and side seam stripe application operations are captured and incinerated, these operations are typically uncontrolled as discussed above. The capture device efficiency data reflect the combined capture efficiency for the application, flashoff, and curing steps since most State and local regulations require facilities to demonstrate compliance with a single overall capture efficiency for the entire coating operation.

3.4.2.2 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 3-piece can manufacturing facilities because the roller material is not compatible with waterbased 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, avoiding or restricting the use of atomizing sprays, and the use of low-vapor-pressure solvents where possible. Emissions from dedicated cleaning stations are sometimes routed to incinerators.

3.4.2.3 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. Facilitywide air emissions of acids from can washing operations are typically much less than 1 ton per year and are typically uncontrolled.

3.4.2.4 Mixing operations

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

3.4.2.5 Coating/solvent storage

Can 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.

3.4.2.6 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 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.

TABLE 5. 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 Water-borne	Non-HAP Solvent-borne	Waterborne coatings + capture/ incineration	HAP-Containing Solventborne coatings + capture/ incineration	HAP-Containing Waterborne coatings	HAP-Containing Solventborne coatings (no emission reduction)
SHEET COATING								
3-piece printing	100	0	0	63	0	0	0	0
3-piece can overvarnish	30	0	0	0	0	26	0	34
3-piece sheet base coating	3	0	0	0	3	106	4	9
2-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
2-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								
2-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
3-piece steel food cans	0	0	0	0	0	1	0	0
2-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

TABLE 5. 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 Water-borne	Non-HAP Solvent-borne	Waterborne coatings + capture/ incineration	HAP-Containing Solventborne coatings + capture/ incineration	HAP-Containing Waterborne coatings	HAP-Containing Solventborne coatings (no emission reduction)
Beverage can Overvarnish	5	0	0	0	49	0	128	0
Rim coat	20	NK[d]	NK	NK	NK	NK	NK	NK
Steel food can wash coat	0	0	0	0	2	0	5	0
SIDE SEAM STRIPE[c]								
Overall	0	6	0	0	0	1	0	227

Notes:

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. In a telephone conversation with a representative from Can Corporation of America's facility in Blandon, PA, the representative confirmed that the facility controls emissions from one of its side seam stripe coating lines.

d. "NK" = not known.

TABLE 6. ADD-ON CONTROL EFFICIENCIES CURRENTLY ACHIEVED BY COATING PROCESS/END USE[a]

Coating process/end use	(1) Range of CE achieved (percent)[b]	(2) Range of DE achieved (percent)[c]	Best OCE achieved by a particular line (percent)[d]		
			(3) CE	(4) DE	(5) OCE [(4) X (5)]
SHEET COATING					
3-piece printing	60 - 100	90 - 95	100	95	95
3-piece can overvarnish	60 - 100	90 - 95	100	95	95
3-piece sheet base coating	60 - 100	90 - 95	100	95	95
2-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
2-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
3-piece steel food cans	77 - 97.5	91.6 - 92	97.5	92	89.7
2-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

Notes:

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. Only one facility in the U.S., Can Corporation of America's Blandon, PA facility, controls emissions from side seam striping operations, per a conversation with a representative from the facility. The representative estimated that the capture efficiency is approximately 90 percent.

3.5 Summary of Federal/State/Local Regulations

The EPA published a control techniques guidelines document (CTG) for controlling VOC emissions from can manufacturing operations in 1977 (EPA-450/2-77-008). The CTG recommended emission limits for all coating operations based on reasonably available control technology (RACT). Table 7 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's actually emitted to these levels using add-on controls.

TABLE 7. 1977 CTG (RACT) VOC LIMITS

Affected Operations	VOC Limit (kg VOC/L coating - water)
Sheet basecoat and overvarnish	0.34
2-piece can exterior	0.34
2- and 3-piece can interior body spray, 2-piece can end	0.51
3-piece can side seam spray	0.66
End seal compound	0.44

Most State VOC rules are at exactly these levels, at least for non-attainment areas within the State. However, a few local and regional agencies, such as California's Bay Area and South Coast air quality management districts (AQMD's) have adopted stricter standards. The South Coast limits also affect manufacturers of pails, 55-gallon drums, and decorative tins, which are regulated as miscellaneous metal parts in some States. Table 8 summarizes the Bay Area and South Coast AQMD VOC limits. In addition to limits from coating operations, both the Bay Area and South Coast regulate cleaning operations. For example, metal can 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 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.

TABLE 8. 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
2-piece can exterior base coat & varnish	0.25	0.25
2- piece can interior body spray	0.51	0.51
3-piece can interior body spray	0.51	0.44
2-piece can exterior end	0.51	--
3-piece can side seam spray	0.66	0.66
Inks	0.30	0.30
End seal compound:		
Food/beverage cans	0.44	0.44
Non-food	--	0

[a] South Coast AQMD also has a list of "exempt" solvents that may be subtracted from the VOC total.

In addition to VOC regulations, many States have their own air toxics programs that may apply to can coating facilities. These regulations typically regulate a large number of chemical compounds. Many States have their own list of air toxics, many of which are also designated as HAP's under the Clean Air Act. 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 attainment status of the location, and other considerations. If emissions exceed the allowable concentration, the facility must reduce emissions.

In 1983, EPA promulgated a new source performance standard (NSPS) for 2-piece beverage can surface coating (40 CFR 60, subpart WW). The NSPS emission limits are more stringent than the CTG, and are expressed in terms of kilograms of VOC emitted per liter of coating solids used. For example, the NSPS limit for 2-piece can exterior base coatings is 0.29 kilogram of VOC per liter of coating solids (0.46 kg VOC/liter of coating solids for clear base coats), whereas the applicable CTG limit is equivalent to 0.53 kg VOC/liter of coating solids. Table 9 summarizes the NSPS emission limits. These limits apply to new sources nationwide, regardless of nonattainment status.

TABLE 9. 2-PIECE BEVERAGE CAN NSPS VOC EMISSION LIMITS

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

4.0 SUMMARY OF COMMENTS AND EPA RESPONSES

The EPA received comments from CMI and from Radtech International, an industry association for the advancement of UV processing technology. Comments from CMI included corrections of specific technical information and more general content-related comments. The EPA made the technical revisions. The more general comments are discussed below.

The CMI commented that EPA should provide a complete list of references for the information in the document, and more clearly indicate the sources of information in the text. The EPA has responded to this comment by clarifying sources of information in the text and providing citations of more significant references in the text.

The CMI commented that Table 3, Coating Technologies: VOC/HAP Content and Uses reports HAP information in terms of lb HAP/lb solid film applied, and therefore incorporates certain assumptions for coating processes that use HAP-containing thinning materials. Furthermore, CMI stated that the HAP content values are not necessarily “typical” formulations as characterized in the draft document. The information in the table was developed by a group of coating suppliers working through CMI. The CMI suggested that the EPA address these points by using coating data in terms of percent of HAP by weight extracted from the CMI’s 1997 survey of its members. The EPA chose to keep the data in Table 3 in the terms originally provided. However, the text describing the table and the table headings have been revised to address the points raised by the CMI related to characterization of the information. The information in terms of percent of HAP by weight provided by the 1997 CMI survey is shown in the text of document under the discussion of coating types. There is insufficient information about the coatings to convert either set of information into the units of the other.

The CMI commented that Tables 5 and 6 should include information on uncontrolled, or total, lines on which EPA had information. Table 5 already includes all of the lines for which the EPA had information. However, EPA recognizes that it was not explicitly clear that the coating lines that use conventional solventborne coatings without controls can be considered uncontrolled. To clarify this fact, the heading of the column in Table 5 indicating the number of lines that use conventional solventborne coatings has been revised to read “HAP-containing solventborne coatings (no emission reduction).” Table 6 is intended to show specifically the control efficiencies achieved on coating lines that employ add-on controls, and is extracted from the same data set as Table 5.

Both CMI and Radtech International commented on the discussion of UV coatings in Section 3.3.1.4. The CMI stated that this discussion was unbalanced in favor of UV coatings and understated the barriers to UV coating in the industry. Radtech suggested removing text indicating that UV coatings do not meet some customers’ requirements for “quality and variety of color.” The EPA revised the text based on information from a 1995 EPA document that discusses barriers to UV coatings. The EPA believes that the discussion represents a neutral and balanced discussion of UV coatings. Radtech International suggested revisions to the number of lines using UV coatings, including inks. The EPA revised the document accordingly.

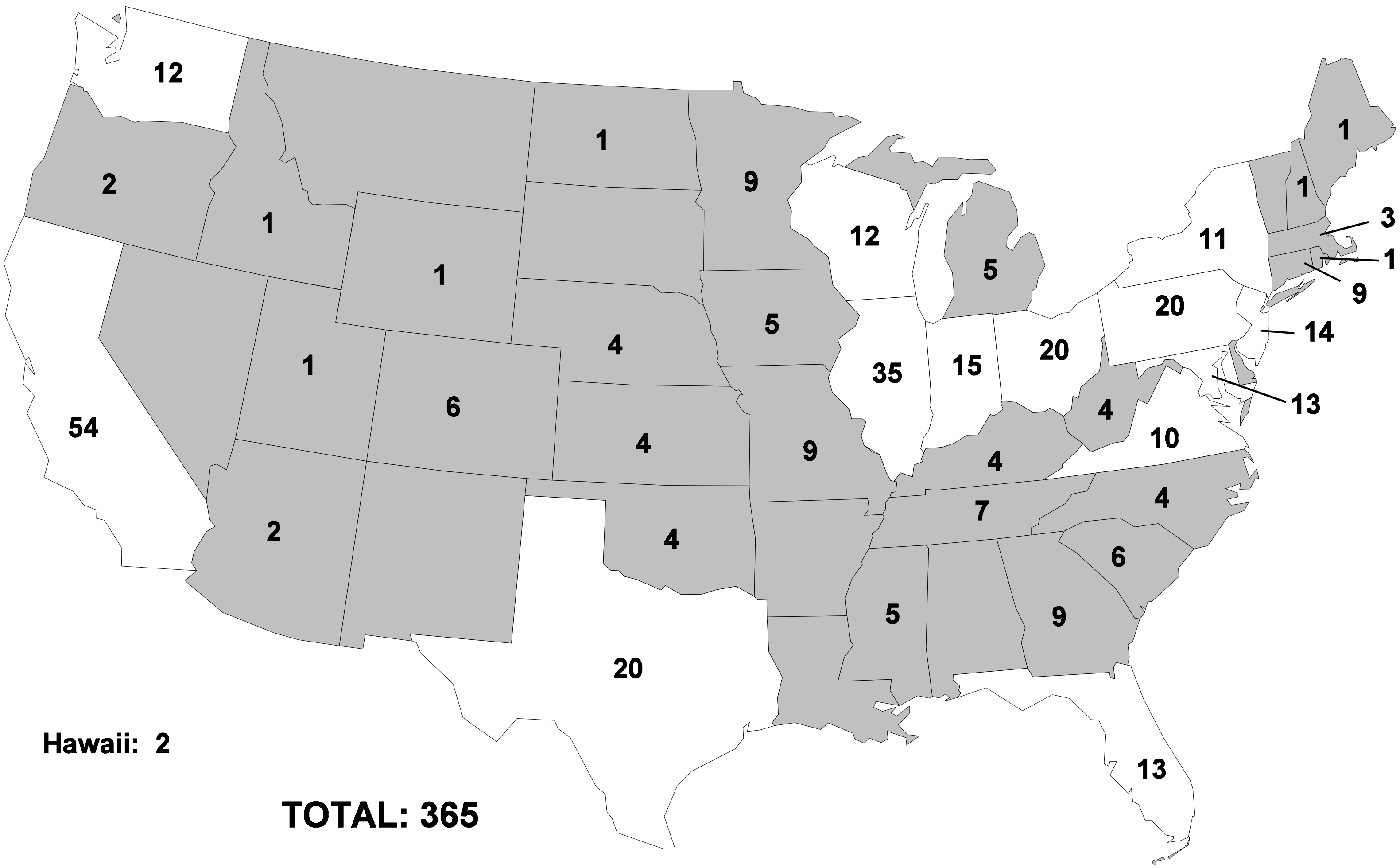


Figure 1. Number of can manufacturing plants by State.

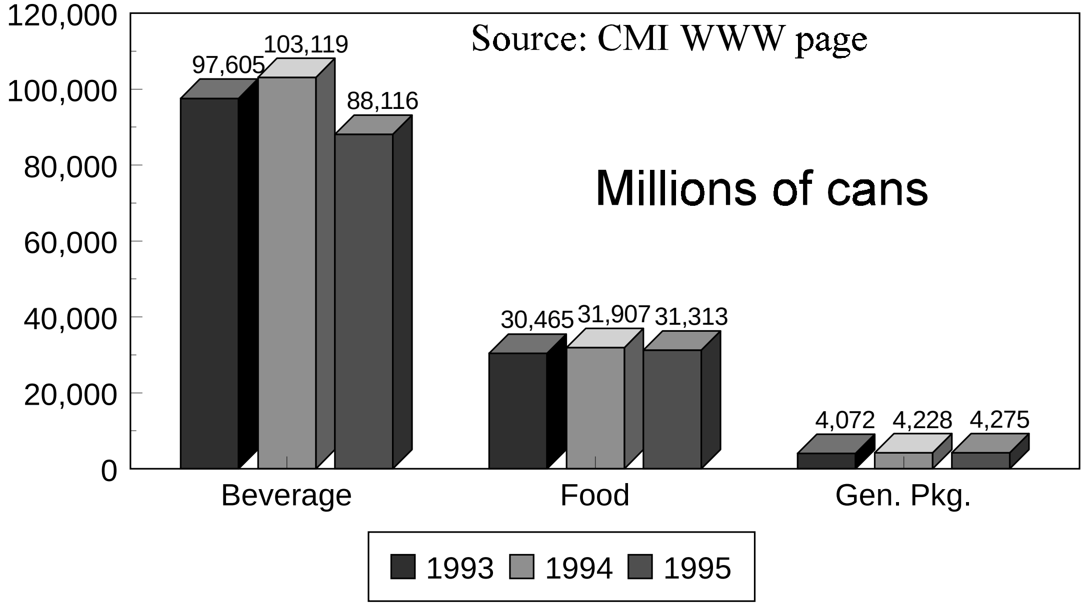
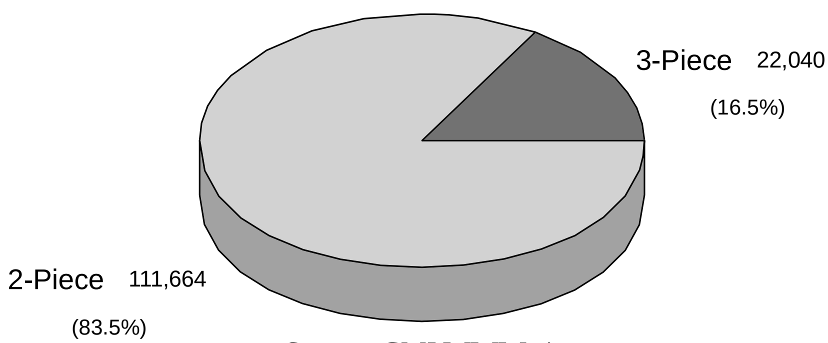


Figure 2. Metal can shipments by end use, 1993-1995



Source: CMI WWW site

Millions of Cans

Figure 3. 1995 metal can shipments by manufacturing process.

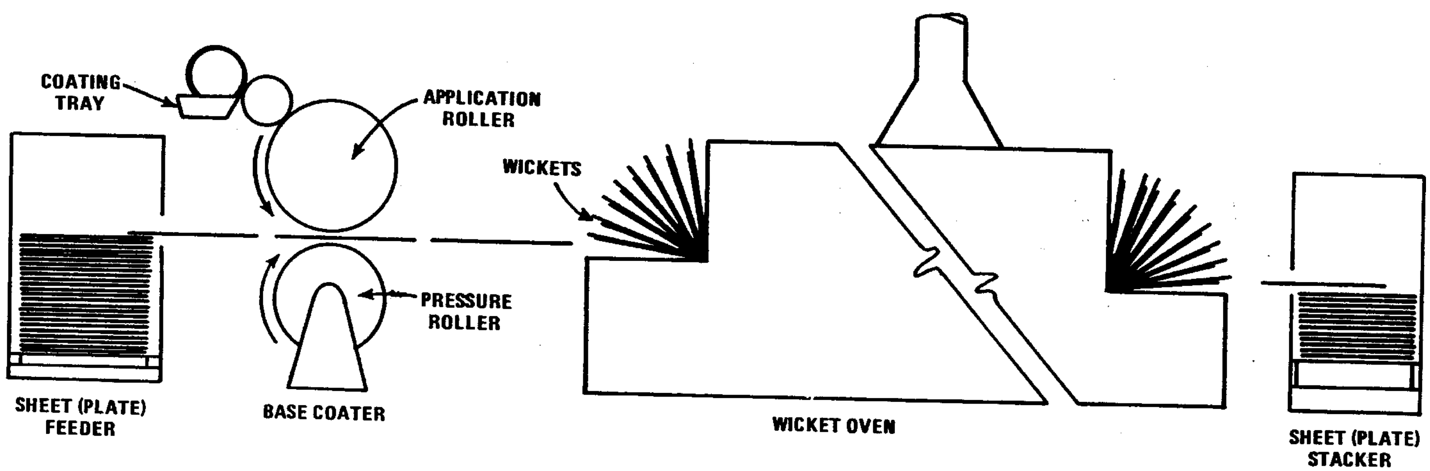


Figure 4. 3-piece can sheet base coating operation.

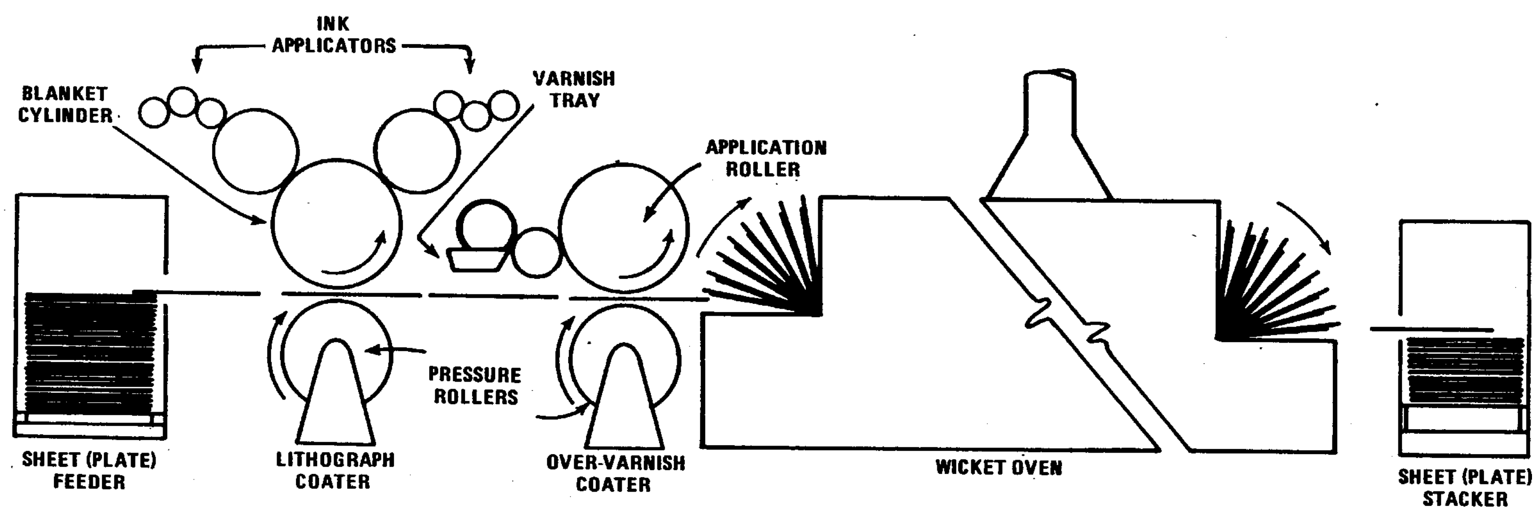


Figure 5. Sheet printing operation.

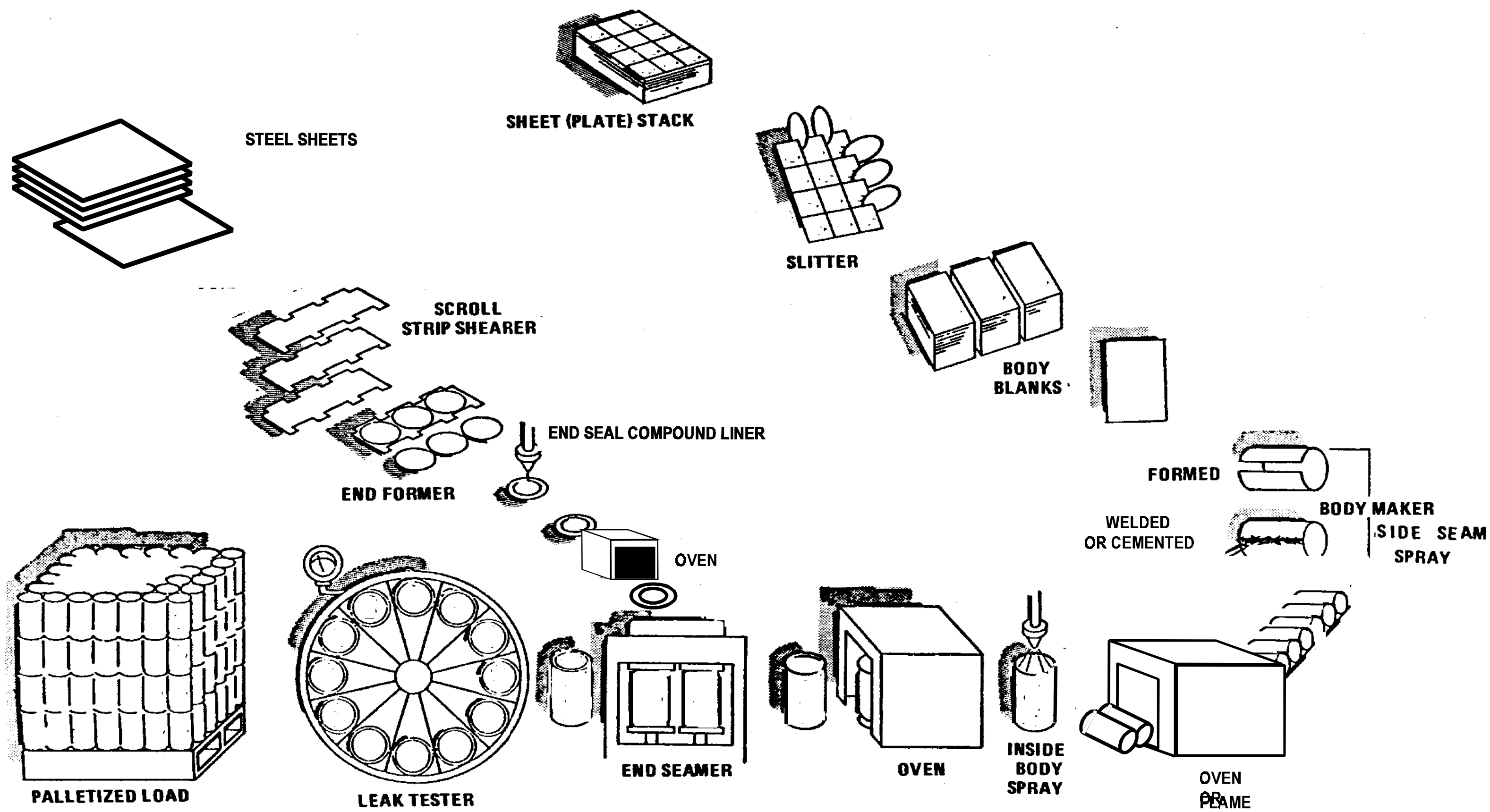


Figure 6. 3-piece can fabrication process.

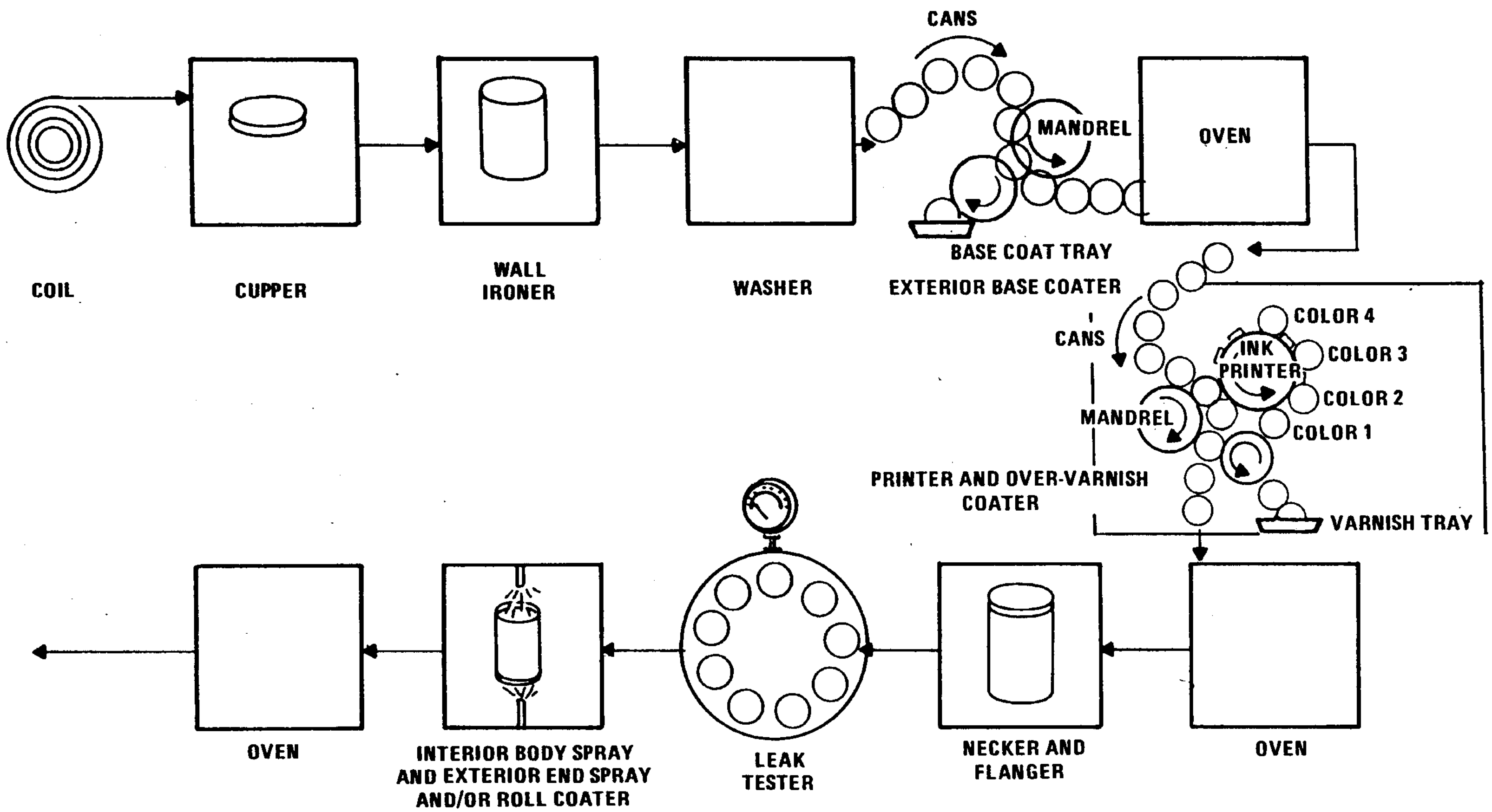


Figure 7. 2-piece draw-and-iron aluminum beverage can manufacturing process.

APPENDIX A: LIST OF STAKEHOLDERS

TABLE A-1. INDUSTRY STAKEHOLDERS

Name	Affiliation
Mr. Pat Aluotto	BASF
Mr. Mike Antry	Crown Cork & Seal Company
Ms. Joette Bailey	Ball Corporation
Mr. Bob Brady	Coors Brewing Company
Mr. Dan Brennan	The Glidden Company
Mr. Robert Budway	Can Manufacturers Institute (CMI)
Mr. Stephen Byrne	Cytec Industries
Mr. Glenn Ceckowski	J. L. Clark, Incorporated
Mr. Nick Chadha	International Technology (IT) Corporation (consultant to CMI)
Mr. William Chelak	ARCO Chemical
Mr. Jun Choi	Central Can Company
Mr. Dennis Cornish	Silgan Containers Corporation
Mr. Lee Cox	Independent Can Company
Ms. Maureen Dalton	Darex Container Products
Ms. Susan Eastridge	Shell Chemical Company
Mr. Charles Erikson	Campbell Soup Company
Mr. Ralph Fasano	White Cap Incorporated
Mr. Don Fay	AKZO Nobel
Mr. Mark Finch	Silgan Containers Corporation
Ms. Barbara Francis	Chemical Manufacturers Association (CMA)
Mr. John Friedman	Darco Metal
Mr. Alan Gans	U.S. Can Company
Mr. Robert Gere, P.E.	Mostardi-Platt Associates, Inc.
Mr. Don Gust	Silgan Containers Corporation
Ms. Stephanie John	Dexter Packaging Products
Mr. Lee Landauer	The Valspar Corporation
Mr. Robert Lanham	Metal Container Corporation
Mr. Bob Levanduski	PPG Industries
Mr. Michael Levin	McGuire Woods Battle & Boothe, L.L.P. (counsel to CMI)
Mr. Charles Licht	Charles Licht Engineering Associates, Inc.
Mr. Joe McCloskey	Benjamin Moore & Co.
Mr. Andrew Miles	Dexter Packaging Products
Mr. Dwayne Mock	The Valspar Corporation Packaging Coatings Group
Mr. Tim Moczulewsi	AKZO Nobel Coatings
Mr. Bob Nelson	National Paint & Coatings Association
Ms. Carol Niemi	C.J. Consulting (consultant to CMA Solvents Council)
Mr. Leon Parker	Brockway Standard, Inc.
Mr. Steve Pearson	CMI
Mr. David Pennings	PPG Industries
Ms. Sueann Pfifferling	IT Corporation (CMI)

TABLE A-1. INDUSTRY STAKEHOLDERS

Name	Affiliation
Mr. Marlin Plejdrup	Smith Environmental Engineering Corporation
Dr. Alexander Ross	RadTech International North America
Mr. Terry Taylor	Ohio Art Company
Mr. Robert Tucker	Sexton Can Company
Mr. Greg Verret	ERM- North Central office
Mr. Geoff Wortley	American National Can Company

TABLE A-2. REGULATORY SUBGROUP

Name	Affiliation
Ms. Cheryl Bradley	Oklahoma
Ms. Stacy Coburn	Ohio EPA Division of Air Pollution Control
Ms. Donna Cosper	TNRCC Office of Air Quality, New Source Review-Permits Division, COCO Section
Mr. Fran Craner	New York State DEC Division of Air Resources
Ms. Kathy Davey	U.S. EPA
Mr. Kirk Drucker	Georgia DNR, Air Protection Branch
Mr. Joseph Eller	South Carolina DHEC
Mr. Robert Fegley	U.S. EPA Office of Regulatory Development
Mr. Steven Lyda	Forsyth County Environmental Affairs Department
Mr. Brent Marable	U.S. EPA Region V
Mr. Paul Matthai	USEPA, OPPT pollution prevention
Mr. Arnold Medbery	U.S. EPA Small Business
Ms. Elizabeth Munsey	Georgia DNR, Air Protection Branch
Mr. Dan Nickey	Iowa Waste Reduction (small business ombudsman)
Mr. Carlos Nunez	U.S. EPA/ORD/APPCD
Mr. Venkata Panchakarla	Florida DEP
Ms. Kelly Rimer	U.S. EPA
Mr. Jason Schnepp	Illinois EPA
Ms. Candace Sorrell	U.S. EPA
Mr. Bruce Varner	U.S. EPA Region V
Mr. Ken Zarker	TNRCC EXEC Pollution Prevention & Modeling