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Standard Guide for Source Reduction Reuse, Recycling, or Disposal of Steel Cans¹

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1. Scope

1.1 This guide provides general information to public officials and business and industry managers regarding the source reduction, reuse, recycling, or disposal of steel cans under 5-gal (wet) or 40-lb (dry) capacity. It presents a comprehensive overview of the steel can life cycle. Five-gallon pails and larger containers, up to 55-gal drums, will be in a separate guide due to their inherently different use and management when empty.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

A623 Specification for Tin Mill Products, General Requirements

D5488 Terminology of Environmental Labeling of Packaging Materials and Packages (Withdrawn 2002)³

E701 Test Methods for Municipal Ferrous Scrap

E702 Specification for Municipal Ferrous Scrap

E1134 Specification for Source-Separated Steel Cans (Withdrawn 2001)³

3. Summary of Guide

3.1 Steel can container applications are described, including food, beverage, and general purpose. The processes for steelmaking, steel sheet production, and steel can manufacturing are discussed. The methods of source reduction, reuse, recycling, or disposal of steel cans are explained.

¹ This guide is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.19 on Sustainability & Recycling.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

4. Significance and Use

4.1 This guide will familiarize public officials and business and industry managers with source reduction, reuse, recycling, or disposal of steel cans.

5. Typical Steel Can Container Applications

5.1 *Food Cans*—More than 90 % of metal food containers, also known as sanitary cans, are made of steel (1).⁴ While they have been commonly called “tin” cans, the tin coating on steel sheet has become extremely thin as technology advanced. It has been supplemented or replaced by other alternative coatings and treatments so that about one third of all steel cans are now made with tin-free steel (2). Steel food cans contain many types of food products, such as meat, fruit, vegetables, soup, infant formula, and pet food. (See Fig. 1.)

5.1.1 *Single-Serving or Home-Use Container*—Steel food cans vary in size and style, in accordance with product and consumer requirements. Can size may range from a few ounces to the typical one-pound net weight container used in the home. They are normally opened with an ordinary manual or electric can opener, but some have aluminum or steel easy-open lids for greater convenience to the consumer.

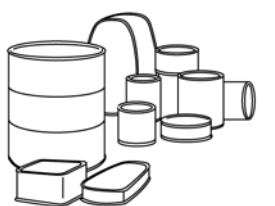
5.1.2 *Multi-Serving or Commercial/Institutional Container*—Steel food cans are widely used in business and institutional food service facilities and food manufacturing plants. This includes 1-gal (#10) cans and oblong cans, such as for olive oil.

5.2 *Beverage Cans*—Steel cans are widely used for juices and other non-carbonated beverage applications. They may also be used for beer or soft drinks. (See Fig. 1)

5.2.1 *Single-Serving Container*—Steel beverage cans vary in size and style. The 6-oz juice can, commonly used for school lunches, has a foil peel-off closure on the lid, although some now have an all-steel stay-on tab.

5.2.2 *Multi-Serving or Commercial/Institutional Container*—Larger beverage containers, from 46 oz (#5) to 1 gal (#10), are used for home, business, institutions, and food manufacturing.

⁴ The boldface numbers in parentheses refer to the list of references at the end of this guide.



FOOD CANS AND GENERAL PURPOSE CANS



BEVERAGE CANS



PAINT CANS



AEROSOL CANS

FIG. 1 Steel Container Applications

5.3 *General Purpose Cans*—Steel cans have many non-food and non-beverage applications, wet or dry, for the household, business, and industry. (See Fig. 1)

5.3.1 *Single-Serving or Home-Use Container*—Smaller cans up to 1 gal are typical. Numerous styles and sizes of cans are required because of the wide array of products and applications, including liquid products (such as paint), powders (such as talc), semisolids (such as paste wax), aerosols (such as hair spray), and dry goods (such as adhesive bandages or roller bearings). Many have replaceable lids that are pried off to open the container. Aerosol cans are sealed and release product through a spray valve until empty.

5.3.2 *Industrial or Commercial/Institutional Container*—Larger general purpose containers, including 5-gal pails and steel drums of various capacities will be covered in a separate guide.

6. Manufacture of Steel and Can Sheet for Steel Cans

6.1 Scrap steel is used in making new steel in the basic oxygen furnace, electric arc furnace, and foundry. Scrap steel is categorized as “home,” “prompt,” or “obsolete” scrap. Home scrap is unsalable steel scrap generated from the steelmaking process. It is “run-around” in the mill to be used as part of the scrap charge for future production. Prompt scrap is leftover or unused scrap material from industrial fabricating processes, such as trimmings from steel can manufacturing. Obsolete scrap is any product collected for scrap metal at the end of its useful life, such as major appliances, tools, automobiles, construction and demolition salvage, and steel cans. Steel scrap is collected, processed, and shipped to the closest melting location.

6.2 *Basic Oxygen-Furnace Production*—About 60 % of the steel produced in the United States in 1994 was made in the basic oxygen furnace by the integrated mills (3). This highest-

quality steel is required for cans, appliances, automobiles, and other flat-rolled steel products. Domestic mills use an average of 75 % molten iron and 25 % scrap steel in the furnace charge. Thus, this steel has about 25 % recycled content.

6.2.1 The basic oxygen process is very large in scale, making 200 to 300 tons of steel per melt (batch) (4). Hot metal (or molten iron) is first made separately in the blast furnace, using iron ore, coke, and limestone. Then the basic oxygen furnace is loaded with a charge of steel scrap and molten iron. Limestone is also added as flux. An oxygen lance is lowered into the furnace to blow oxygen onto the surface of the molten iron. The blow of oxygen continues until the impurities and a certain amount of carbon in the molten iron have been reduced through oxidation and the desired composition of steel has been made. These chemical reactions take place very rapidly so the process is completed in about 20 min.

6.2.2 Due to technological limitations, the maximum amount of scrap used relative to the hot metal is approximately 30 % in the basic oxygen furnace. Any higher percentage of scrap would require supplemental energy to the chemical reaction process (5). In 1994, the North American integrated steel producers averaged more than 25 % total scrap steel use, with about 10 to 15 % being obsolete scrap and the balance from home scrap and prompt scrap.

6.2.3 The modern method of continuous casting transforms the liquid steel into solidified semifinished steel. This is done by delivering the liquid steel in a ladle to the casting floor, where it is poured into a special mold arrangement that allows the steel to flow and form directly into a red-hot continuous ribbon of solidified steel which is cut automatically into specified slab lengths.

6.3 Manufacture of Can Sheet:

6.3.1 Steel slab destined for steel can application is rolled or flattened into an intermediate gage in the hot strip mill (6). The hot band is then cleaned before going through a cold reduction mill to strengthen and form it into the desired sheet gage. It then passes through an annealing furnace, which softens it in preparation for other processing. The sheet steel, in the form of very large coils (rolls), goes either to a temper mill for final finish or to a double cold-reduction mill, where it becomes even thinner and stronger. Called “black plate” up to now, the single- or double-reduced product is ready for coating with tin or chromium.

6.3.2 As the steel goes through the coating line, it is washed and cleaned. It is electroplated in a bath employing soluble tin anodes. If coated with tin, the steel sometimes is passed through a high-frequency induction or resistance heater. There, the tin melts and flows to form a lustrous coating that is cooled in water, treated electrochemically, rinsed, then electrostatically coated with oil. Alternatively, the steel is electroplated in a chromium bath, producing a burnished, darker finish, as with a tuna can. Finally, the steel, tin-coated or tin-free, as described in Specification A623, is inspected, packaged, and shipped as coils or flat cut sheets to the canmaking facility (7).

6.4 *Electric Arc-Furnace Production*—In 1994, the remaining 40 % of domestic steel was produced in the electric arc furnace by the so-called mini-mills (3). This steel is for heavy shapes, such as I-beam, channel, billet, rod, reinforcing bar,

nail, and wire. Some mini-mills are now making flat-rolled sheet for appliances, but are not capable of steel can and automotive applications. While the basic oxygen furnace combines raw material and steel scrap to produce new steel, electric arc furnaces are charged with virtually 100 % steel scrap. Thus, this steel has almost 100 % recycled content. Specific grades of steel scrap are selected and charged with small amounts of raw material into the furnace. Charging typically takes place through the furnace roof, which is lifted or swung aside. During the steelmaking process, three large cylindrical electrodes are lowered through openings in the roof to melt the steel scrap. Chemistry of the molten steel is verified so that adjustments may be made with the addition of needed elements. It is then continuously cast into slabs or other long shapes (4).

6.5 *Foundry Production*—While foundries use a variety of methods to melt steel scrap, their furnaces tend to be much smaller and more specialized than a steel mill’s furnace. Therefore, foundries may be more selective about the steel scrap used for recycling and its preparation. As a source of steel scrap, steel cans are made from a high grade of steel with predictable chemical characteristics. The steel can’s very slight tin content acts as an alloy in the casting process, thereby reducing a foundry’s dependency on other alloying agents. Tin also promotes the end product’s pearlitic microstructure while improving its strength and hardness (8).

7. Fabrication of Steel Cans

7.1 Steel cans are fabricated from tin-coated or tin-free steel with three-piece or two-piece construction as shown in Fig. 2.

7.2 To produce three-piece cans, lids and bottoms are punched from can sheet unwound from coil or from cut sheets. (After being filled with holes, the sheet is called a “skeleton” and sent to a detinning company or directly to a steel mill as prompt scrap.) Can bodies are made by cutting can sheet into the desired size and rolling it into a cylinder. The side seams are joined by electric resistance welding at speeds higher than 500 can bodies per minute. (Lead-soldered side seam construction is no longer used in the United States.) The majority of three-piece cans have tin-coated bodies, but may have either tin-coated or tin-free steel ends, which are mechanically crimped to the body during can-making and after filling. Three-piece cans provide manufacturing flexibility in height and diameter for varied can sizes and smaller production runs. Most cans are cylindrical; however, some have oblong or other specialty configurations.

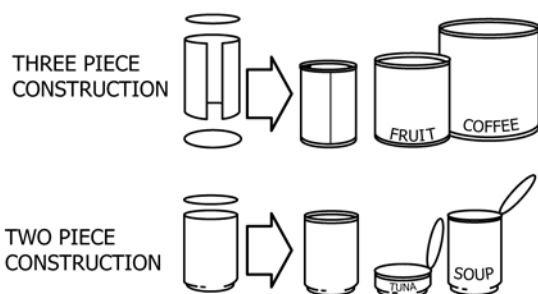


FIG. 2 Three-Piece and Two-Piece Construction of Steel Cans

7.3 About one fifth of all steel cans are two-piece cans made with either the draw-redraw (DRD) or the drawn and ironed (D&I) process. The body and bottom are drawn from one piece of steel, so that the only seam is ultimately between the single unit body and the separately made lid. More than 90 % of two-piece steel DRD cans are made of tin-free steel (2). All two-piece D&I cans are made from tin-coated steel. Tin-coated steel may be used for lids for a shiny appearance and for bodies that will be subjected to a more corrosive product environment. In the DRD production process for food cans, a shallow cup is produced from a flat circular blank that is punched or cut from the can sheet. The diameter of the cup is reduced as the can is deepened. In a similar manner, the D&I process is used for food and beverage can bodies. The basic difference between a DRD and D&I can is that the latter produces a thinner sidewall, as the metal is stretched through elongation. Lids are formed and then later crimped to the body after filling, as with three-piece cans.

7.4 Beading is sometimes performed to add strength to the thinner-walled, modern can body, two-piece or three-piece. Beads are grooves formed along the side of the container to stiffen the can body. Beading also improves label retention.

8. Source Reduction, Reuse, Recycling, and Disposal of Steel Cans

8.1 *Source Reduction Options*—Steel cans have been dramatically source reduced over the years since their original invention in the early 1800’s. The steel used in food cans was reduced 10 to 20 % in the years between 1980 and 1990 (9). These reductions resulted from improvements in steel strength and quality, creating cans with thinner walls that use less metal. New can-making techniques also provide for the thinner wall construction. Source reduction also applies to the can manufacturing process itself. Because of increased efficiency in can-making technology, less prompt scrap is created. The amount of tin used has also been reduced because of much thinner tin coatings and the use of tin-free steel.

8.2 *Reuse Options*—Most steel cans, as covered by this guide, are for single-use application. Empty cans are incidentally used for home storage, for growing trees and plants, and other similar reuse needs.

8.3 *Recycling Options*—Steel cans are recycled through various forms of collection, processing, and transportation to end market industrial users. Because steel cans (like most steel and iron products) are magnetically attracted, they are magnetically handled in ferrous scrap yards and automatically sorted with magnetic separation in material recovery facilities, resource recovery facilities, and mixed waste processing facilities (10).

8.3.1 *Residential Collection Methods for Recycling*—As described in Specification E1134, steel cans are source separated and collected for recycling in curbside and drop-off programs and at multi-commodity buyback recycling centers. Steel food and beverage cans should be empty and rinsed clean. Lids of all kinds should also be recycled. To save water, residents are encouraged to use leftover dishwasher or empty spaces in the dishwasher. Steel aerosol cans are emptied